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꽃다발과 편지 대신 신기술 의약품으로



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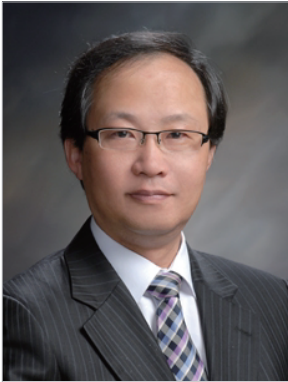
[생명공학, 의학분야의 첨단치료기술개발]

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life's ingredients



# INVITATION 학회장 인사말



존경하는 대한의용생체공학회 회원 여러분께,

우리 학회는 그 동안 전임 회장님을 비롯한 선배님들의 많은 노고 덕분에 국내 의공학 분야의 중추적 역할을 수행하는 단체로 성장하였습니다. 저는 앞으로 이러한 훌륭한 전통을 이어받아 학회의 내실을 다지고 국가와 사회에 보다 더 기여할 수 있도록 우리 학회를 더욱 발전시켜 나가고자 합니다.

이를 위해서 학회는 무엇보다도 회원님들 간에 활발한 학문적 교류가 일어날수 있는 학술활동의 장이 되어야 합니다. 앞으로 1년 동안 집행부에서는 회원님들의 다양한 의견을 수렴하여 수준 높은 학술활동이 마음껏 이루어지도록 최선을 다해 노력하고 지원을 아끼지 않을 생각입니다.

이번 2016년도 춘계학술대회를 통해 이러한 노력의 첫 결실을 아름다운 항구도시 부산의 부경대학교에서 맺게 되어 매우 기쁘게 생각합니다. 부경대학교 의공학과는 짧은 역사에도 불구하고 여러 학제간 융합연구를 통해 뛰어난 연구수준 및 교육환경을 보유한 학과로 거듭나고 있습니다. 특히 의광학 분야에서 탁월한 역량을 보여주고 있어, 올해 춘계학술대회 주제인 “Let there be light: Evolution of biomedical optics” 에 맞는 소통과 협업의 학술공간으로 더없이 훌륭한 장소라는 생각이 듭니다. 이 곳에서 많은 분들이 오셔서 의공학 분야의 최신 연구결과들을 공유하고 열정적인 논의와 교류가 있기를 기대합니다.

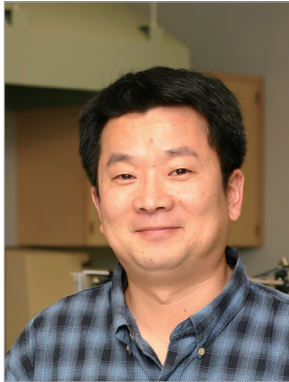
마지막으로 학술대회 준비에 열과 성을 아끼지 않으신 오정환 조직위원장을 비롯한 부경대학교 관계자 여러분, 그리고 윤인찬 학술이사를 포함한 학회임원 및 학술위원님들께 진심으로 감사를 표합니다. 본 춘계학술대회의 성공을 위해 마지막까지 모든 회원 여러분들의 적극적인 참여와 협조를 부탁드립니다. 감사합니다.

2016년 5월

대한의용생체공학회 회장 차은종 배상

# INVITATION

조직위원장



2016년도 춘계학술대회를 맞이하여

2016년도 제 51회 대한의용생체공학회 춘계학술대회를 부경대학교에서 개최하게 된 것을 진심으로 기쁘게 생각합니다.

부경대학교는 부산 최초의 국립대이며, 세계수산대학 유치 및 글로벌 첨단정보사회를 주도하는 대학으로서 산·학·연·관을 이어주는 중점 역할을 하고 있으며 해양 융복

합 산업 발전에 중추적인 역할을 수행하고 있는 대학입니다

부경대학교 의공학과는 2010년에 국립대 최초로 신설되어 현재 7분의 전공교수님들과 BK21 사업단 소속 대학원에 8개국 120여 명의 연구원들이 BT 융합기술을 기반으로 첨단의료기기의 개발과 의료기기산업 발전에 기여하고 있으며, 특히 2015년도에 시작된 해양융복합 바이오닉스 MIBC 연구단에서는 해양 생물소재를 이용한 의료용 융복합 바이오닉스 기기 개발에 주력하고 있습니다.

본 학과에서는 첨단 동물실험실, 조직 생리학실, 세포 실험실, 의공학 연구실, 해양소재 기반 의공학 연구실 등을 확보하여 세계최고 수준의 인프라를 보유하고 있으며, 글로벌 경쟁력을 보유한 학생들의 교육에 최선을 다하고 있습니다. 이러한 시점에서 의공학의 학술적 발전과 인력 양성에 중심적인 역할을 하고 있는 대한의용생체공학회 학술대회를 부경대학교에서 개최하게 된 것에 대해서 매우 뜻 깊게 생각합니다.

2016년도 춘계학술대회의 성공을 위해 조직위원회는 최선을 다하여 학술대회를 준비하였습니다. 특히 차은종 학회 회장님 이하 사무국 관계자분들, 부경대학교 총장님 이하 관계자분들께 깊은 감사의 말씀을 드립니다.

또한 이번 학술대회를 위해서 축사를 수락하여 주신 이상희 전 과학기술부 장관님과 지역 인근에서 큰 힘을 보태어 주신 의공학과 관련 교수님들께도 깊은 감사의 말씀을 드립니다.

찾아주신 모든 회원님들을 환영하며, 이번 학회를 통해 저희 부경대학교 및 의공학과를 알리고 이해하는 자리가 되기를 바라고, 의공학 전문가들의 학문적 교류와 건승을 바랍니다.

감사합니다.

2016년 5월

대한의용생체공학회 조직위원장 오정환 배상

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양승태 (건국대)

척추-고관절 회전의 생체역학적 협응: 프로골퍼 성별의 차이

최안렬 (성균관대)

손목 착용형 3축 가속도계를 이용한 신체 활동 구분에 관한 연구

박희수 (한국과학기술연구원)

상지재활을 위한 FES와 모션센서를 결합한 모바일 재활 시스템 개발

임홍준 (계명대)

• POSTERS I	57
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• POSTERS II	109
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# 대한의용생체공학회 제23대 임원

The Korean Society of Medical & Biological Engineering

직책	성명	소속
명예회장	송시영	연세대학교
회장	차은종	충북대학교
수석부회장	박한국	경희대학교(서울)
부회장	이경중	연세대학교
	황해령	루트로닉
감사	오창현	고려대학교
	이태수	충북대학교
총무이사	최영빈	서울대학교
	이기자	경희대학교(서울)
	김경아	충북대학교
기획이사	신태민	연세대학교(원주)
	김명남	경북대학교
	이우철	을지보건대
학술이사	윤인찬	KIST
	변경민	경희대학교(수원)
	정병조	연세대학교(원주)
편집이사	이상훈	고려대학교
	이재성	서울대학교
	지영준	울산대학교
	남기창	동국대학교
교육이사	김성민	동국대학교
	심은보	강원대학교
	이정한	건국대학교

직책	성명	소속
산학협력이사	남상희	오송센터
	이상일	대구센터
	허영	전기연구원
	박순만	보건산업진흥원
	김국한	대성마리프
국제협력이사	김희찬	서울대학교
	우응제	경희대학교(서울)
	김인영	한양대학교(서울)
	남윤기	KAIST
	신현정	KAIST
재무이사	이원진	서울대학교
	최병철	춘해보건대학교
	유문호	전북대학교
정보전산이사	안원식	경희대학교
	노정훈	부산대학교
	오정환	부경대학교
융합특임이사	정동근	동아대학교
	김묘원	의공사협회
	이종민	경북대학교
홍보이사	김법민	고려대학교
	유규하	성균관대학교
	송철규	전북대학교
	이레나	이화여자대학교

## 학술위원회

직위	성명	소속
학술이사	윤인찬	KIST
	변경민	경희대학교
	정병조	연세대학교
위원	김필한	KAIST
	구정훈	계명대학교
	김성필	UNIST
	김형민	KIST
	남승윤	부경대학교
	박중열	중앙대학교
	박지호	KAIST
	박형원	성균관대학교
	성준경	고려대학교
	신항식	전남대학교
	양성	광주과기원
	오정환	부경대학교
	유형석	울산대학교
	유홍기	한양대학교
	윤종인	대구가톨릭대
	이상훈	경희한의대학교

직위	성명	소속
위원	이상훈	한의학연구원
	이종호	서울대학교
	임도형	세종대학교
	임창환	한양대학교
	장동표	한양대학교
	장태안	서울대학교
	전상범	이화여자대학교
	정용	KAIST
	정의현	GIST
	정철우	서울대학교
	주세경	울산의대
	천홍구	고려대학교
	최명환	성균관대학교
	최병문	울산의대
	최성용	경희대학교
	최연호	고려대학교
	추준욱	한국기계연구원
	황석원	고려대학교

## 교육위원회

직위	성명	소속
교 육 이 사	오정환	부경대학교
	이상민	인하대학교
	지영준	울산대학교
위 원	권기진	영남이공대학
	권춘기	순천향대학교
	김경환	연세대학교
	김성민	동국대학교
	김영철	한중대학교
	김주명	광양보건대학교
	김휘영	동주대학교
	류근택	강동대학교
	문치웅	인제대학교
	박장연	건국대학교
	박준식	강릉영동대학
	박해암	남부대학교
	박현진	가천의과학대학
	박희준	계명대학교
	변창수	폴리텍3대학 원주캠퍼스
	송동진	중원대학교

직위	성명	소속
위 원	심은보	강원대학교
	오대호	한림성심대학교
	원철호	경일대학교
	유문호	전북대학교
	윤의철	대구가톨릭대학교
	이기영	관동대학교
	이동훈	동명대학교
	이석재	서남대학교
	이우철	을지대학교
	이종민	한양대학교
	이주원	안동과학대학교
	임용규	상지대학교
	정광손	상지영서대학
	조민형	경희대학교
	진경수	충북도립대학
	최승한	대구한의대학교
	최연호	고려대학교
	태기식	건양대학교
	한현용	춘해보건대학교



# 대한의용생체공학회 제23대 임원

The Korean Society of Medical & Biological Engineering

## 편집위원회

직위	성명	소속
편집이사	지영준	울산대학교
	남기창	동국대학교
편집위원	김경아	충북대학교
	김주명	광양보건대학교
	김호철	을지대학교
	노미숙	한국기계전기전자시험연구원
	박경민	인천대학교
	송병섭	대구대학교
	양윤석	전북대학교
	우지환	울산대학교
	윤의철	대구가톨릭대학교
	윤장원	호서대학교

직위	성명	소속
편집위원	이 전	UT Southwestern University
	이계한	명지대학교
	이상준	선문대학교
	이주석	Leibniz Institute for New Materials
	이충근	식품의약품안전평가원
	임도형	세종대학교
	임용규	상지대학교
	조성보	가천대학교
	최성욱	강원대학교
	최재순	서울아산병원
	허두창	한국전기연구원

## 정보위원회

직위	성명	소속
정보이사	노정훈	부산대학교
	안원식	서울대학교
	오정환	부경대학교

## 조직위원회

직위	성명	소속
조직위원	오정환	부경대학교
	남승윤	부경대학교
	박상현	부경대학교



## 2016년도 대한의용생체공학회 춘계학술대회 프로그램

The Korean Society of Medical &amp; Biological Engineering

5월 13일 (금요일)				
시간/장소	본관 건물	미래관 건물 (2~4층)		
	대강당	Convention Hall (3층)	Lecture Room 1 CEO실 (2층) 204호	Lecture Room 2 효림홀 (2층) 203호
10:00-12:00		등록	Tutorial 1: National Instrument	임시평의원회 (11:30)
12:00-13:00	점심식사 (개별) 및 포스터 1 (4층)			
13:00-13:20	개회식 및 임시총회 사회: 정병조 교수 (연세대)			
13:20-14:00	기조강연 1 박광석 교수 (서울대): Past and Future of KOSOMBE 좌장: 정병조 교수 (연세대) (본관 대강당)			
14:00-14:40	기조강연 2 박승한 교수 (연세대): Multimodal nonlinear optical microscopy for label-free biological imaging 좌장: 정병조 교수 (연세대) (본관 대강당)			
14:40-15:00	Tea break			
15:00-16:30		일반연제 1 좌장: 이종민 교수 (한양대)	Special Session 1 (대구첨복 동물실험센터) 좌장: 김충용 교수 (대구경북첨단의료산업 진흥재단)	Special Session 2 (측정소급성, 불확도와 참조표준) 좌장: 안원식 교수 (경희의료원)
16:30-18:00		일반연제 2 좌장: 오동인 교수 (경희대)	일반연제 3 좌장: 최영빈 교수 (서울대)	Special Session 3 (헬스케어앱연구회) 좌장1: 김인영 교수 (한양대) 좌장2: 유규하 교수 (성균관대)
18:10-20:10	저녁 만찬 (학회 제공)			

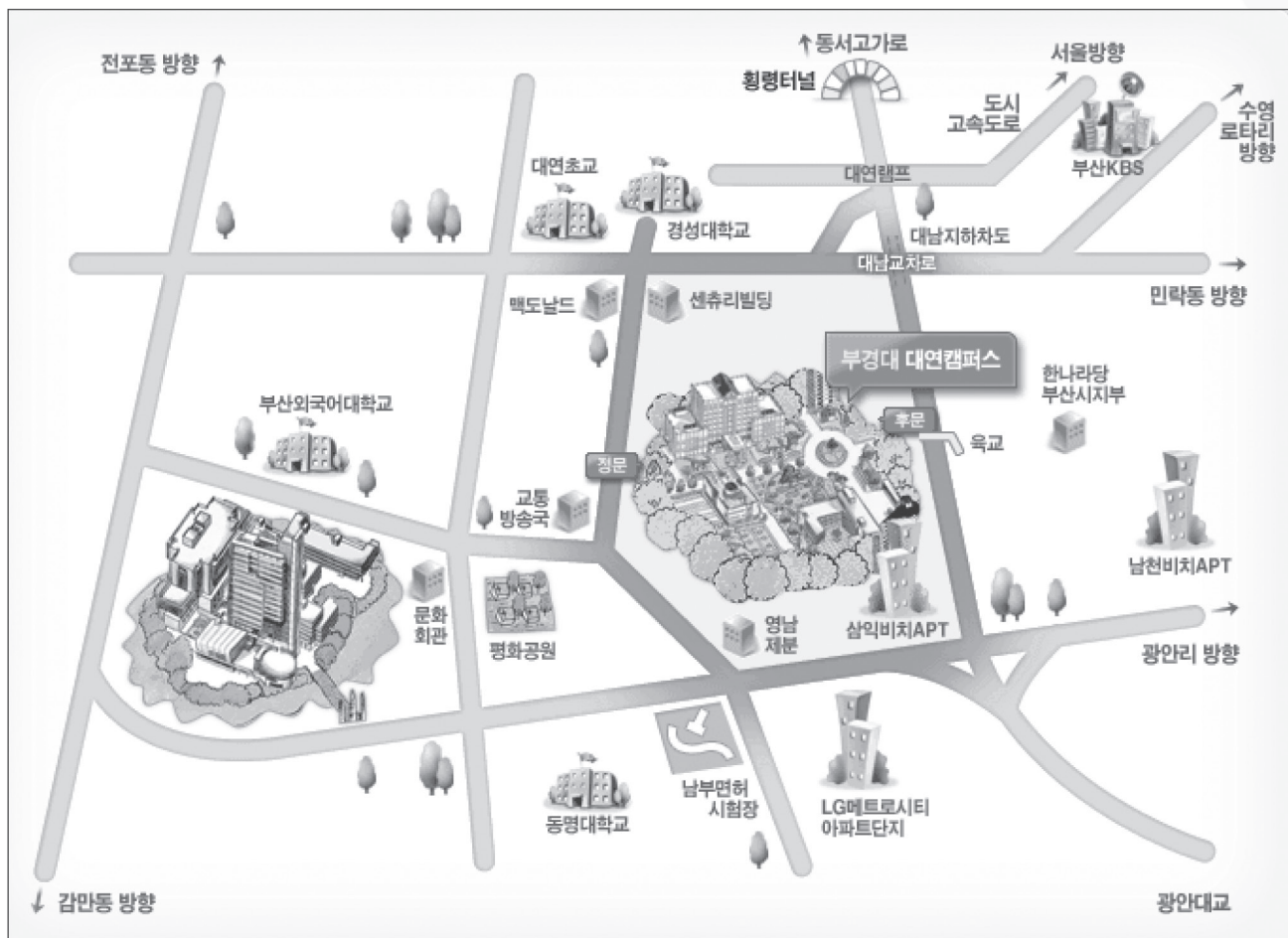
# 2016년도 대한의용생체공학회 춘계학술대회 프로그램

The Korean Society of Medical & Biological Engineering

5월 14일 (토요일)				
시간/장소	본관 건물	미래관 건물 (2~4층)		
	대강당	Convention Hall (3층)	Lecture Room 1 CEO실 (2층) 204호	Lecture Room 2 효림홀 (2층) 203호
08:00-09:00	포스터 2 (미래관 4층)			
09:10-09:50		기조강연 3 Dr. Congedo : Riemannian geometry in EEG research and practice: theory and application to Brain-Computer Interfaces. 좌장 : 임창환 교수 (한양대) (Convention Hall)		
09:50-10:30		기조강연 4 이정구 교수 (단국대) : Low Level Laser (Light) Therapy (LLLT) 좌장 : 임창환 교수 (한양대) (Convention Hall)		
10:30-12:00		일반연제 4 좌장 : 장동표 교수 (한양대)	Special Session 4 (연구재단 ICT 융합단) 좌장 : 김성완 교수 (서울대)	일반연제 5 좌장 : 유홍기 교수 (한양대)
12:00-13:20	점심식사 (학회 제공) 및 Tea Break			
13:30-15:00		Special Session 5 (신진연구자세션) 좌장 : 변경민 교수 (경희대)	Special Session 6 (의료기기 국제 표준 최신 동향) 좌장 : 안원식 교수 (경희의료원)	일반연제 6 좌장 : 추준욱 박사 (기계연구원)
15:10-15:30	폐회식 및 경품 (대강당) 사회: 윤인찬 교수(KIST)			



- 행사명 : 2016년 제51회 대한의용생체공학회 춘계학술대회
- 일시 : 2016년 5월 13일 ~ 14일
- 장소 : 부경대학교 대연캠퍼스 미래관



- 찾아오시는길  
(48513) 부산광역시 남구 용소로 45

#### 1.자가용

- 김해공항 → 학교 : 낙동대교 → 동서고가도로 → 황령산터널 → 부경대
- 김해시 → 학교 : 초선대 → 구포대교 → 산업도로 → 학장동 → 동서고가도로 → 황령산터널 → 부경대
- 양산시 → 학교 : 도시고속도로 → 대연램프 → 부경대
- 양산 → 남양산 → 동서고가도로 → 황령산터널 → 부경대

# 2016년도 대한의용생체공학회 춘계학술대회 프로그램

The Korean Society of Medical & Biological Engineering

## 2. 지하철 이용 노선안내

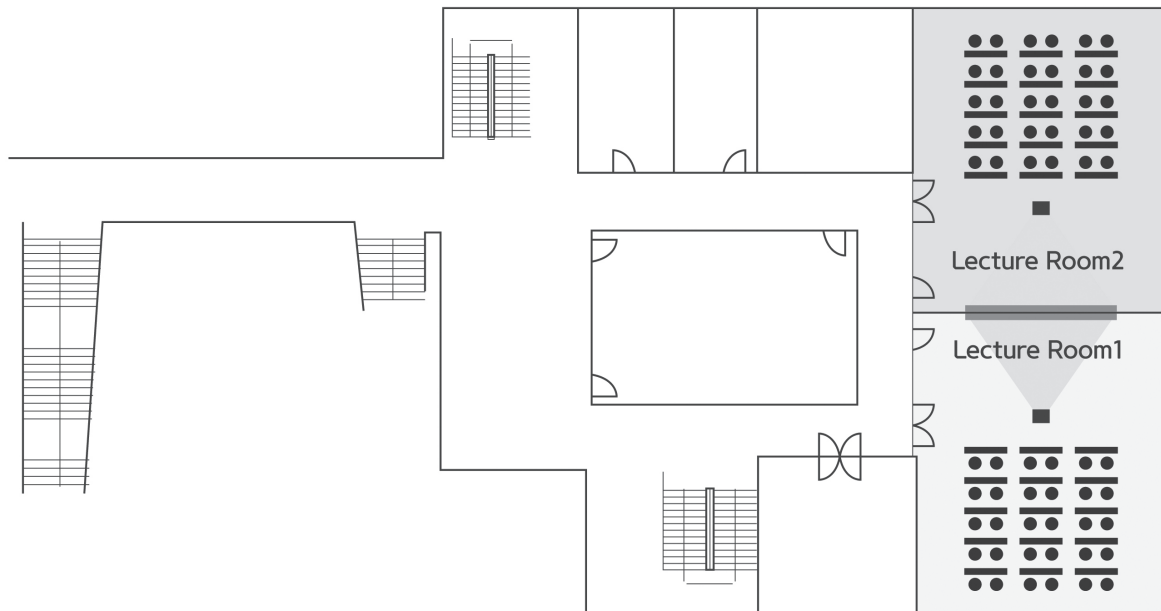
- 1호선 : 고속버스터미널에서 학교로 노포동 → 서면(환승) → 경성대,부경대역 3번 출구
- 1호선 : 부산역에서 학교로 부산역 → 서면(환승) → 경성대,부경대역 3번 출구
- 2호선 : 서부시외버스터미널에서 학교로 사상 → 서면 → 경성대,부경대역 3번 출구

## 3. 시내버스 노선안내

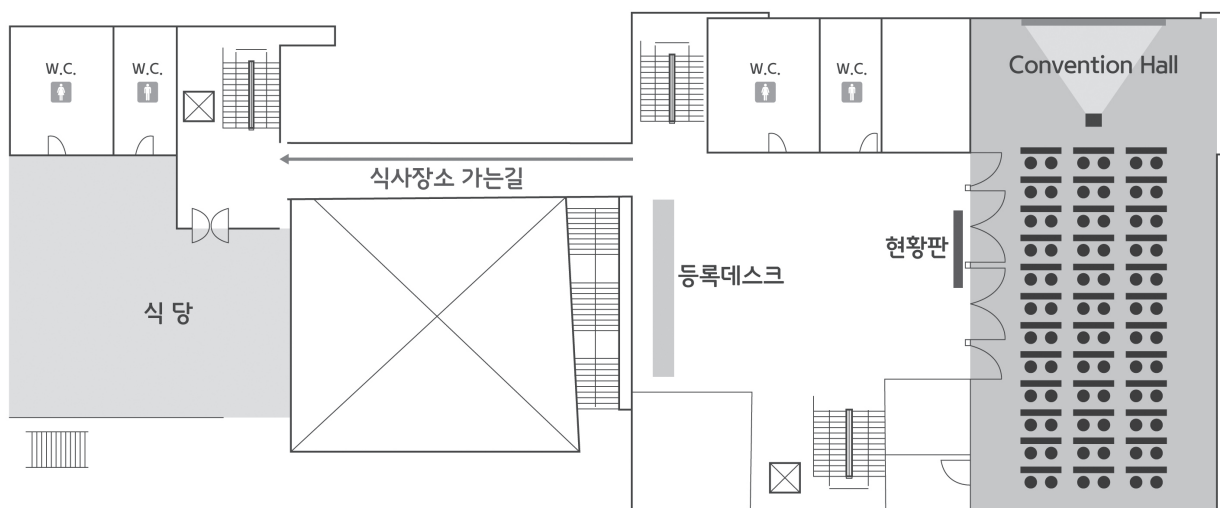
- 10, 20, 22, 24, 27, 39, 40, 41, 42, 51, 83, 83-1, 108-1, 131, 139, 155, 583, 1003



## 미래관2층: Lecture Room1,2



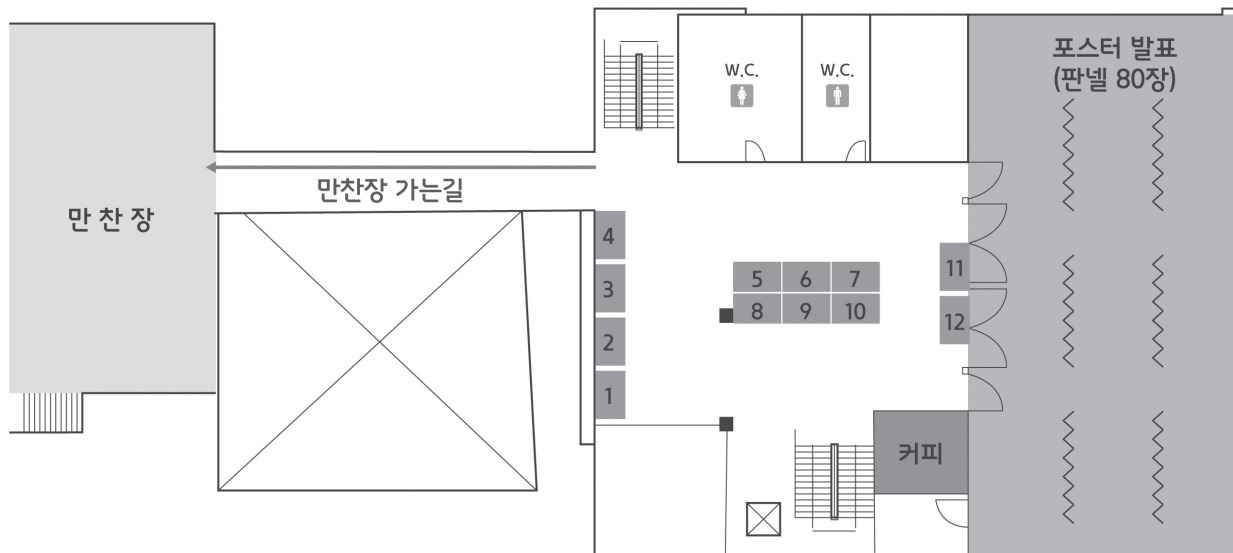
## 미래관3층: 등록데스크, 컨벤션홀, 식당



# 2016년도 대한의용생체공학회 춘계학술대회 프로그램

The Korean Society of Medical & Biological Engineering

미래관4층: 만찬장,포스터,전시부스,커피부스



## 전시부스명단

1	 SAIHST 의료기기산업학과
2	 NATIONAL INSTRUMENTS 한국내쇼날인스트루먼트
3	 Bionet 바이오넷
4	 BIOPAC Systems Korea 바이오팩
5	 (주)메디아나 메디아나
6	 KBIO 오송첨단의료기기개발지원센터
7	(주)레이언스
8	 ROKIT 로킷
9	 BLUECORE COMPANY 블루코어
10	 4science.net 포사이언스
11	 SeongKyeong Photonics (주)성경 포토닉스 성경포토닉스



2016년도 제51회

대한의용생체공학회 춘계학술대회

## 기조강연 I

기조강연1 13:20-14:00 (본관 대강당)

기조강연2 14:00-14:40 (본관 대강당)

좌장 : 정병조 교수 (연세대)

### Past and Future of KOSOMBE

박광석 교수 (서울대)

### Multimodal nonlinear optical microscopy for label-free biological imaging

박승한 교수 (연세대)



# 기조강연 I

## Past and Future of KOSOMBE



이름: 박 광 석

직위: 교수

소속: 서울대학교 의과대학 의공학교실

### Abstract

대한 의용생체공학회는 1979년에 창립하여 37년의 역사를 갖고 오늘에 이르고 있다. 초기의 열악한 환경에서 5000여명 회원규모를 갖는 오늘의 대규모 학회로 성장하기 까지에는 여러 선배 회원님들의 헌신적인 노력이 있었기 때문이다. 의공학회는 다양한 노력으로 의공학의 학문적 발전에 기여하였다. 그 중에서 매년 두차례 개최된 학술대회와 연 4~6회 발간된 학회지는 학회의 지속적인 발전에 근간이 되었으며, 우리 학회를 국제 학술지를 발간하고 국제학술대회를 개최하는 국제화된 학회로 발전시키는 동력이 되었다. 이제 의공학은 단지 의학과 공학 경계의 한 학술분야에서 의학을 발전 시키는 첨단 학문 분야로, 그리고 우리나라의 산업의 발전을 담당하여야 할 미래의 먹거리로 자리매김 되어가고 있다. 이와 같은 시점에서 과거 우리학회의 역사와 현황을 되돌아보고 이를 바탕으로 후배 회원들이 보다 견고한 미래를 준비할 수 있도록 대한의용생체공학회의 과거 37년의 역사를 간추려 소개하고자 한다.

### Brief Biosketch

Kwang Suk Park received B.S. and Ph.D degree in Department of Electronics Engineering from Seoul National University, Korea in 1980 and in 1985 respectively. He is currently a professor in the Department of Biomedical Engineering in Seoul National University since he joined the department in 1985 as a founding staff member. He is a member of Korean Society of Medical and Biological Engineering and has served as the president in 2014. He also served as the secretary general of World Congress on Medical Physic and Biomedical Engineering which is held in Seoul in year 2006. He is also a member of IEEE EMBS and has been served as an Associate Editor for IEEE Trans. on Journal of Biomedical and Health Informatics since 2005. He also chaired and co-chaired the annual International Conference on uHealthcare during last 11 years. His main research area is biological signal measurement and processing for the diagnosis. Recently he is focusing his research interest on nonintrusive measurements for ubiquitous healthcare.

# 기조강연 I

## Multimodal nonlinear optical microscopy for label-free biological imaging



이름: 박 승 한

직위: 교수

소속: 연세대학교 물리학과

### Abstract

Recently, multimodal nonlinear optical microscopy has attracted much attention due to its various advantages including intrinsic optical sectioning and label-free imaging capabilities with sub-cellular resolution. In this presentation, high-speed multimodal laser scanning microscope, designed for acquiring fast moving cell tracking in a live animal, are introduced. The microscope has multiple functional modalities: one-photon confocal, two-photon, SHG, and THG microscopy. By using our custom-built multimodal laser scanning microscope, we can obtain confocal, two-photon, SHG and THG images simultaneously from the live animals. In particular, high-resolution images of the zebrafish embryo without employing fluorescent probes will be presented. In addition, image of subcutaneous cellular components and peripheral nerve fibers in the eye of zebrafish embryo will be demonstrated.

### Brief Biosketch

Seung-Han Park received his B.S. and M.S. degrees in Physics from Yonsei University, Korea, in 1982 and 1984, respectively, and Ph. D. degree from the Optical Sciences Center at the University of Arizona, in 1988. After working as an assistant professor in the Dept. of Electrical Engineering at the University of Pittsburgh, he joined the Dept. of Physics, Yonsei University, Seoul, Korea, in 1991, where he is currently a professor and the Dean of College of Science. He was the director for National Research Laboratory (2002–2007) and the director of Pioneer Research Center for Neuro-Science and Technology (2008–2014). He is the recipient of Grand Academic Achievement Award (2015) from Optical Society of Korea. He is a member of OSK, KPS, SPIE, and OSA and a fellow of SPIE.



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## 기조강연 II

기조강연3 09:10-09:50 (Convention Hall)

기조강연4 09:50-10:30 (Convention Hall)

좌장 : 임창환 교수 (한양대)

**Riemannian geometry in EEG research and  
practice: theory and application to  
Brain-Computer Interfaces.**

Marco Congedo

(French National Center for Scientific Research)

**Low Level Laser (Light) Therapy (LLLT)**

이정구 교수 (단국대)



# 기조강연 II

## Riemannian geometry in EEG research and practice: theory and application to Brain-Computer Interfaces.



이름: Marco Congedo

직위: Research Scientist

소속: French National Center for Scientific Research (CNRS)

### Abstract

The use of Riemannian geometry for classifying brain-computer interface (BCI) data is currently attracting increasing attention, due to an accumulating documentation of its accuracy, robustness and transfer learning capabilities, including the winning score obtained in three recent international kaggle data science competitions on BCI data. The Riemannian framework is sharp from a mathematical perspective, yet in practice it is simple, both algorithmically and computationally, suiting real-world online operation in adverse conditions. As compared to state-of-the-art approaches, it constitutes a true paradigmatic shift. In this talk we will introduce relevant concepts of related to the Riemannian manifold of symmetric positive definite matrices, including the distance between two data points and the center of mass of a number of them. The Riemannian minimum distance to mean classifier (MDM) will be introduced and explained, providing arguments in support of its robustness and transfer learning capabilities. Finally, we will show some results and point to existing open-source Matlab and Python code for using Riemannian geometry in the design of a BCI.

### Brief Biosketch

Marco Congedo has obtained the Ph.D. degree in 2003 from the University of Tennessee, Knoxville. From 2003 to 2006 he has been a post-doc fellow at the French National Institute for Research in Informatics and Control (INRIA) and at France Telecom R&D. Since 2007 he is a Research Scientist at the “Centre National de la Recherche Scientifique” (CNRS) in the GIPSA Laboratory, Grenoble, France, working on biomedical signal processing.

Dr. Congedo is interested in human electroencephalography (EEG), real-time neuroimaging (neurofeedback and brain computer interface) and analytic mathematical tools useful for EEG data such as inverse solutions, blind source separation and Riemannian geometry.

Dr. Congedo has authored and co-authored over 90 scientific publications. He is a Fellow of the International Society for Neurofeedback and Research and an Academic Editor for journal PLoS ONE.

# 기조강연 II

## Low Level Laser (Light) Therapy (LLLT)



이름: 이 정 구

직위: 명예교수

소속: 단국대학교 의과대학, 의학레이저 연구센터

### Abstract

We just had the 50th anniversary of the discovery of the laser, last year. The development of lasers for medical use, which became known as low-level laser therapy (LLLT) or photobiomodulation, followed in 1967. It refers to 1 – 1000 mW in the range of red or infrared laser or light, alters cellular behavior in the absence of heat. It has become a popular treatment option and finding a variety of uses in medical practice. In recent years, LLLT has become an increasingly mainstream modality, especially in the areas of physical medicine and rehabilitation. At first used mainly for wound healing and pain relief, the medical applications of LLLT have broadened to include diseases such as stroke, myocardial infarction, degenerative or traumatic brain disorders and inner ear diseases. Near infrared light penetrates more deeply than red light. Pulsed lasers may penetrate more deeply into tissue. This presentation will cover the mechanisms of LLLT that operate both on a cellular and a tissue level. Mitochondria are thought to be the principal photoreceptors, and increased adenosine triphosphate (ATP), modulation of reactive oxygen species (ROS), increased intracellular calcium, and release of nitric oxide are the initial events. Activation of transcription factors then leads to expression of many protective, anti-apoptotic, anti-oxidant, and pro-proliferation gene products. Animal studies and human clinical trials of LLLT for indications with relevance to neurology, such as stroke, traumatic brain injury, degenerative brain disease, spinal cord injury, and peripheral nerve regeneration, have been studied.

LLLT has been known to be effective to treat hearing loss induced by noise and ototoxicity, tinnitus, vestibular dysfunction, nasal allergy, oral mucositis, and cervical pain. Its clinical applications are expected to become more popular in the near future as the LLLT related researches are carried out very actively.

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## Special Session I

동물모델을 이용한 의료기기 유효성 평가

15:00-16:30 ( Lecture Room 1 CEO실 )

좌장: 김충용 교수(대구경북첨단의료산업진흥재단)

### 의료기기 개발을 위한 동물모델

손대구 교수 (계명대)

### Strategie of preclinical evaluation for cardiovascular devices

박세일 교수 (연세대)

### 의료산업에 활용되는 전임상 분자영상 기법과 적용

이태관 책임연구원 (대구경북첨단의료산업진흥재단)

### 의료기기 개발을 위한 전임상시험 지원

안상현 연구원 (대구경북첨단의료산업진흥재단)





# Special Session I

## 의료기기 개발을 위한 동물모델



이름: 손 대 구

직위: 교수

소속: 계명대학교 의과대학 성형외과학교실

### Abstract

인체적용을 목적으로 하는 의료기기개발단계에서 적절한 동물모델을 확보하는 것은 매우 중요하다. 개발의 기간을 단축시킬 수 있을 뿐만 아니라 되먹임을 통하여 재빠르게 수정, 보완을 거듭하여 최상의 제품을 만들 수 있기 때문이다.

피부에 적용하는 의료기기를 개발하기 위해서는 인체의 피부와 가장 유사한 동물을 선택하여야 하는데, 이때 가장 적합한 동물은 돼지이다. 특히, micropig종류는 성체에서도 25 kg 내외이므로 조작하기가 편하다. 피부 상처는 급성상처와 만성상처로 구분할 수 있다. 동일한 환경에서 개발된 제품들을 비교 관찰하여야 하므로 급성상처에서는 반드시 같은 깊이의 상처를 얻어야 한다. 동물에서 4주 이상 낫지 않는 만성상처를 얻기는 매우 어렵지만 방사선조사를 이용하여 이를 극복하고 있다. 대표적인 만성상처중의 하나인 욕창모델은 조직을 압박하여 허혈-재관류 손상을 유발시켜 만들 수 있다.

### Brief Biosketch

학력1988 계명의대 의학사1997 계명의대 의학석사2002 경북의대 의학박사

이력1997성형외과 전문의2005수부외과 세부전문의

1997 ~ 현재 계명대학교 동산의료원 성형외과 교수, 2016 ~ 연구처장

2002 ~ 2003 University of Texas MDAnderson Cancer Center, research fellow

논문,특허 국내외 논문127편 / 특허 12

진료분야 유방재건 및 성형/ 선천성 손, 발 기형/ 미용성형 / 만성상처 / 흉터 및 켈로이드

연구분야 Skin wound healing/ 지방줄기세포 / 창상피복제, 혈관문합기 등의 의료기기개발

학회활동 대한성형외과학회, 대한미세수술학회, 대한수부외과학회 이사

# Special Session I

## Strategie of preclinical evaluation for cardiovascular devices



이름: 박세일

직위: 조교수

소속: 연세대학교 심혈관계 유효성평가센터

### Abstract

In spite of brilliant development of medical technology, Cardiovascular diseases are the first leading cause of death and morbidity in most of the countries. Cardiac and vascular complications are complex multi-factorial pathologies, in which both physical and hemodynamic factors are implicated, there are limitations on reflecting the functional characteristics of the human heart. A medical devices for cardiovascular disease should have durability, strength and flexibility to withstand through the lifetime. Equally important are the materials' biologic properties, the most desirable of which being anti-thrombogenicity, noncalcification, hemostasis and endothelialization capability. For this reason, it is one of the main advantages to the use of larger animals as a model of preclinical safety and efficacy testing for intravascular stents, valve replacement, cardiac transplant, and cardiac assist devices. Swine function as important models of acute and chronic myocardial infarction, including ischemic reperfusion injury, heart failure and cardiomyopathy. They have been also offered as important pre-clinical models for investigating system of preclinical safety and efficacy evaluation for various medical devices with new pharmacological agents and relative therapy as well as stent therapy.

### Brief Biosketch

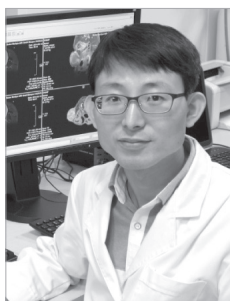
2010 ~ present, Cardiovascular product evaluation center, Yonsei University (Assistant professor)

2008 ~ 2010, Dept of Orthopedic Surgery. College of Medicine. Yeoungnam University (fellowship)

2003 ~ 2007, Graduate school of Veterinary Medicine. Kyungpook National University (PhD degree)

# Special Session I

## 의료산업에 활용되는 전임상 분자영상 기법과 적용



이름: 이태관

직위: 책임연구원

소속: 대구경북첨단의료산업진흥재단 실험동물센터

### Abstract

In vivo imaging is increasingly being deployed across clinical diagnosis and preclinical drug development process. It enables to monitor the treatment response for early indications of efficacy in animal models. Popular imaging modalities are currently optical (bioluminescence and fluorescence), magnetic resonance imaging (MRI), positron emission tomography (PET). In vivo optical imaging is widely used for molecular imaging to investigate disease mechanism and drug efficacy. Optical imaging provides reliable labelling of gene and proteins. It is low cost and high throughput screening technique. The nuclear medicine tomographic imaging technique provides highly sensitive molecular imaging with radio-labeled compounds. This superior sensitivity labeling makes it possible to monitor pharmacodynamics and pharmacokinetics of the target compound absorption. MRI provides high resolution anatomical and functional images. Recently, combinations technology between imaging modality produces fusion imaging for better localization of molecular signals, for example, PET and CT, PET and MRI, optical and CT, etc.

In this talk, I will introduce principles and applications of various imaging modalities in animal models.

### Brief Biosketch

- Ph.D., Psychology, Yale University, New Haven, CT, USA, 2006
- Daegu-Gyeongbuk Medical Innovation Foundation Laboratory Animal Center, Principal Researcher, 2013- present
- MIT, Biological Engineering, Cambridge, MA, Research Associate, 2009 - 2013,

# Special Session I

## 의료기기 개발을 위한 전임상시험 지원



이름: 안상현

직위: 의료기기지원 팀장

소속: 대구경북첨단의료산업진흥재단 실험동물센터

### Abstract

Laboratory Animal Center at Daegu-Gyeongbuk Medical Innovation Foundation (LAC-DGMIF) has endeavored to develop medical products by collaboration with other institutes and medical companies. LAC-DGMIF is a non-profit scientific organization established with the aim of investigating the safety and efficacy of drugs and medical devices using animal models related to human health. The collaborative projects in Laboratory Animal Center (LAC) have been conducted for performance and safety evaluation followed by the International Organization for Standardization (ISO) documents 10993 (Biological Evaluation of Medical Device). DGMIF-LAC also provides a comprehensive review and the ISO document reports of medical devices during development process with feedback of debugging errors. With these utilities including a wide range of in vivo models and analysis tools, we have successfully carried out various preclinical evaluations for new medical devices. Thus, our ultimate goal is to establish research cluster which leads to commercialization of prototypes and authorization of medical devices.

### Brief Biosketch

- 2005 ~ 2006 경북대학교 생체재료평가연구소 연구원
- 2006 ~ 2007 도쿠시마대학교 생체재료학교실 연구원
- 2007 ~ 2008 한국기계연구원 재료연구소 연구원
- 2008 ~ 2009 오사카대학교 조직공학교실 연구원
- 2009 ~ 2013 오사카대학교 치과대학 치의학박사
- 2013 ~ 현재 대구경북첨단의료산업진흥재단 실험동물센터 연구원

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## Special Session II

측정소급성, 불확도와 참조표준

15:00-16:30 ( Lecture Room2 효림홀 )

좌장 : 안원식 교수 ( 경희의료원 )

**임상 의사 관점에서 살펴본 온도 측정**

유병훈 교수 (인제대)

**전자체온계와 체온: 측정 소급성과 불확도**

최종오 (한국표준과학연구원)

**전자체온계: 보건의료 분야 참조표준**

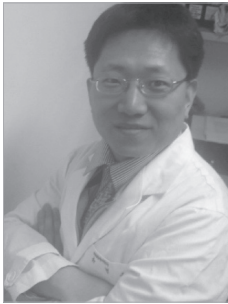
김창근 책임연구원 (한국표준과학연구원)





## Special Session II

### 임상 의사 관점에서 살펴본 온도 측정



이름: 유병훈

소속: 인제대학교 상계백병원 마취통증의학과

#### Abstract

포유류와 조류는 정온동물이어서 내부 체온이 거의 일정하게 유지되어야 합니다. 내부체온이 정상에서 유의하게 벗어나면, 대개 대사기능이 손상되어 사망에 이를 수 있습니다. 사람의 정상 심부체온은 약 37° C인데, 우리의 체온조절 체계는 37° C 근처에서 약 수십 분의 1° C 차이 이내로 심부체온을 유지하고 있습니다.

전신마취를 받는 사람의 체온은 마취의 영향으로 많은 변화가 생기게 됩니다. 전신마취제는 심부체온(core temperature) 조절 기전인 혈관수축(vasoconstriction)과 전율(shivering) 유발 역치(threshold)를 2-3° C 감소시킵니다. 따라서 전신마취 때는 정상보다 체온이 2-3° C 낮아도 혈관수축과 전율이 발생하지 않게 됩니다. 그러므로, 마취 중에는 환자의 체온은 적절히 유지하기 위하여 많은 노력을 하게 됩니다.

이러한 상황에서 정확한 심부체온을 측정하기 위해서 어떠한 기구를 어떠한 장소에서 사용하는 가는 매우 중요한 요소가 될 것입니다.

#### Brief Biosketch

이력

- 1994년 인제대학교 의과대학 졸업
- 1999년 마취통증의학과 전문의 취득
- 2003년 - 현재 인제대학교 상계백병원 마취통증의학과 재직

활동

- . 대한마취통증의학회 정회원, 고시위원, 홍보위원
- . 대한마취약리학회 정회원, 기획위원
- . 대한뇌신경마취학회 정회원
- . 인제대학교 상계백병원 마취통증의학과 책임교수

# Special Session II

## 전자체온계와 체온: 측정 소급성과 불확도



이름: 최종오

소속: 한국표준과학연구원

### Abstract

과학 및 기술 관련 모든 연구·개발은 측정을 통해서 이루어집니다.  
많은 분들이 측정은 기기가 하는 것으로 생각하고, 이야기 하고,  
연구결과를 발표합니다.

‘측정은 사람이 합니다.’

‘측정은 소급성으로 시작되어 불확도로 마무리 합니다.’

소급성과 불확도를 알아야 제대로 된 측정결과를 낼 수 있습니다.

이제 소급성과 불확도는 연구·개발을 하는 분들의 필수 지식입니다.

전자체온계를 예로 들어, 측정, 소급성 및 불확도의 기본 개념을 이야기합니다.

### Brief Biosketch

#### 연구

- (화학) 측정학, 불확(실)도, 표준물질, 숙련도 평가, 데이터 신뢰성 연구
- 국가지정 ‘화학분석 신뢰성’ 연구실 운영
- 품질경영시스템 (ISO17025, 34, 43, 9001) 운영
- 측정능력평가, 측정 품질, 측정표준 종합관리 및 관련 교육 및 세미나

#### 활동

- . 측정 및 표준 교육 (개념, 용어, 국제단위, 불확도, 소급성, 신뢰성 등) 및 가이드 9권
- . 불확도 교육 및 자문 (교육/세미나 400회 이상)
  - 측정신뢰성 및 품질경영 (ISO 9001, 17025): 터키, 이란, 우즈베키스탄 등 중앙아시아 10 국
  - 해외 초청 세미나 및 자문 40회 : IAEA, APMP, APLMF, IMEKO, 필리핀, 인도네시아, 영국, 프랑스

## Special Session II

### 전자체온계: 보건 의료 분야 참조표준



이름: 김창근

직위: 책임연구원

소속: 한국표준과학연구원 국가참조표준센터

#### Abstract

국가표준기본법에 명시되어 있는 3대 표준분야는 측정표준, 성문표준, 참조표준이다. 특히, 참조표준은 엄밀한 평가 과정을 거쳐 그 신뢰성이 보장된 수치 데이터를 의미한다. 데이터의 신뢰성을 보장하기 위해서는 데이터의 평가기준 수립, 평가기준에 의거한 데이터 평가 과정을 거쳐야 한다. 이렇게 개발된 의료분야 생체데이터 생산 현황 및 활용 사례 그리고 의료기기 개발 지원에 대한 방향에 대해 알아보하고자 한다.

#### Brief Biosketch

학력

한양대학교 물리학 학사

한양대학교 플라즈마 물리학 석사

한양대학교 플라즈마 물리학 박사

이력

캐나다 INRS-EMT 연구소 박사후연수원 (핵융합장치의 divertor simulation)

한국 기초과학지원연구원 박사후 연수원 (KSTAR Divertor simulation)

한국표준과학연구원 국가참조표준센터 책임연구원



2016년도 제51회

대한의용생체공학회 춘계학술대회

## Special Session III

헬스케어앱연구회

16:30-18:00 ( Lecture Room2 효림홀 )

좌장1 : 김인영 교수 (한양대)

좌장2 : 유규하 교수 (성균관대)

**7년간 부정맥 질환을 가진 환자에서 원거리 실시간 부정맥 감시를 위한 앱과 서비스 경험**

김윤년 교수 (계명대)

**모바일 앱, 기획에서 수익모델까지**

김경진 팀장 (SK플래닛 HCI팀장)

**재활에서의 모바일 어플리케이션 활용**

구정훈 교수 (계명대)

**디지털 헬스케어 서비스 모델의 해외진출 전략**

김홍진 이사 ( (주)인성정보 )





## Special Session III

### 7년간 부정맥 질환을 가진 환자에서 원거리 실시간 부정맥 감시를 위한 앱과 서비스 경험



이름: 김윤년

소속: 계명대학교 동산의료원

#### Abstract

임상적 요구사항을 공학적 기술로 해결하기 위해 많은 노력을 하였으며, 특히 진료기록의 단순 분석을 넘어 소프트웨어 컴퓨팅 및 데이터마이닝 기술의 지식 공학적 방법론을 적용한 지능형 임상 의사결정지원시스템, 생체신호 처리 및 영상분석기술을 활용한 생체진단 및 예측기술을 개발하고, 유헬스 환경과의 통합을 통한 차세대 의료 서비스 원천기술을 개발함. 의료기기 개발 분야에서 많은 국책과제를 진행하여 다양한 경험을 가지고 있음

#### Brief Biosketch

1980.02 경북대학교 의과대학  
1983.08 - 1987.08 경북대학교 대학원(석박사)  
2002.03 - 현재 계명대학교 보건의료정보기술연구소 소장  
2007.04 - 현재 계명대학교 동산의료원 전산운영팀 정보위원  
2004.10 - 현재 첨단 진단/예측 의료기술 클러스터사업단 실행위원  
2004.09 - 현재 계명대학교 생체정보기술개발사업단 단장  
2005.01 - 현재 대한의용생체공학회 영남지부 부회장  
2003.12 - 2008.02 (주)엠디웨어 대표이사  
2006.12.13 - 현재 보건의료정보(ISO/TC215)전문위원회  
2008.10 - 2010.10 대한심장학회 의료정보이사  
2008.08 - 2010.08 계명대학교 의과대학 내과학교실 주임교수  
2009.03 - 2013.02 계명대학교 의과대학 의공학과장  
2013.03 - 2015.02 계명대학교 의과대학 의료정보학교실 주임교수

부정맥은 질환의 특성상 일시적으로 발생하였다가 사라지는 특성 때문에 병원을 방문하여 진단되는 경우가 20% 미만이라는 보고가 있으나, 모니터링하는 시간이 길면 길수록 진단율이 높아지는 경향을 보인다. 본 연구는 2013년 이후 스마트 폰 앱을 이용하여, 병원 방문시 특이 소견이 없는 600명의 환자를 대상으로 Heartcall 모바일

# Special Session III

## 모바일 앱, 기획에서 수익모델까지



이름: 김 경 진

소속: SK플래닛 HCI팀장

### Abstract

SK텔레콤 HCI팀을 거쳐 현재 SK플래닛에서 HCI팀장을 맡고 있다. 소비자의 행동패턴을 분석하여 모바일 서비스의 기회가 있는 잠재 니즈를 기반으로 서비스 컨셉을 도출하는 Human centered innovation을 추진하고 있다. 헬스케어 관련한 연구로는, 교통재활환자들을 위한 서비스컨셉 도출과 만성질환자들을 위한 모바일 서비스 컨셉 도출 등이 있다.

### Brief Biosketch

본 강연에서는, 모바일서비스 기획, 어플리케이션 UX디자인, 서비스개발 등 앱 개발 과정 및 방법을 개략적으로 전하고자 한다. 특히 헬스케어앱기획 경험을 토대로 한 실제 개발 사례를 통해 전반적인 앱개발 과정 중 핵심적인 포인트를 이해할 수 있다. 마지막으로 앱이 어떻게 돈을 버는가, 즉 수익모델의 유형을 말한다.

## Special Session III

### 재활에서의 모바일 어플리케이션 활용



이름: 구정훈

소속: 계명대학교 의과대학 의용공학과

#### Abstract

가상현실을 이용한 정신재활 및 재활 시스템 개발  
모바일 어플리케이션 개발 및 적용  
fMRI 및 EEG 분석을 통한 뇌메커니즘 분석

운동기능 손상의 회복을 위해서는 환자의 잠재력과 더불어 초기에 재활요법을 적용하는 것이 무엇보다도 중요하지만, 지루한 훈련내용으로 인해 환자의 자발적인 훈련 참여를 이끌어 내기 힘들었다. 보다 나은 재활치료를 위해 재활과 게임을 접목한 다양한 시도들이 이루어져 왔으며 최근에는 모바일 헬스케어 기술의 급속한 성장이 재활 환경의 더욱 큰 변화를 이루어내고 있다. 모바일 기반의 게임재활은 흥미롭고 다채로운 콘텐츠와 시청각적 피드백으로 재활치료의 참여의지를 고취시켜주고 모바일의 간편한 휴대성이 운동환경으로의 접근을 용이하게 해준다. 모바일 재활은 꾸준하고 지속적인 운동이 가능하여 재발을 방지하는 이점이 있다..

본 연구실에서는 다양한 재활치료 기술에 모바일 헬스케어 기술을 접목한 스마트 재활운동 시스템을 개발하고 있다. 스마트폰과 데이터글러브, FES, 뇌파분석장치 등을 결합한 상·하지 재활에서부터 실내자전거를 결합한 심장재활, 호흡센서를 이용한 호흡재활까지 우리 신체의 재활이 필요한 곳에 스마트한 재활치료법을 제안한다. 아울러 이러한 모바일 시스템을 확장시켜, 심폐소생술 교육을 위한 스마트폰 어플리케이션을 개발하는 등 스마트 헬스케어 프로그램을 다방면으로 적용하고 있다. 본 강연에서는 다양한 모바일 기반의 스마트 헬스케어 시스템을 소개하고자 한다.

#### Brief Biosketch

1994~ 1998 한양대학교 전기공학과 학사  
1998~ 2000한양대학교 의용생체공학 석사  
2000~2005 한양대학교 의용생체공학 박사  
2005~2010 한양대학교 연구교수  
2010~ 현재 계명대학교 조교수

# Special Session III

## 디지털 헬스케어 서비스 모델의 해외진출 전략



이름: 김홍진

소속: (주)인성정보

### Abstract

現 (주)인성정보 u-Health사업부 본부장 / 이사

(사)한국u헬스협회 정책위원

식품의약품안전처 의료기기제도개선 추진위원회 위원

산업통상자원부 ‘스마트 헬스 정책자문단’ 자문위원

국무조정실 ‘신산업투자위원회’ 바이오헬스케어분과 위원

보건복지부 정밀의료 발전위원회 위원

헬스케어애플리케이션 협력이사

서울대학교 법과대학 공법학과 졸(1993)

前 (주)대웅제약 기획조정본부 부장

제2회 IT융합기업인상 수상

### Brief Biosketch

디지털 헬스케어의 시장의 구조적 특성과 이에 따른 해외 시장 진출 전략을 도출하고, 특히, 마트헬스케어 분야에서의 진출 사례 및 추진 전략을 검토해 봄.

2016년도 제51회

대한의용생체공학회 춘계학술대회

## Special Session IV

한국연구재단 소개 및 Soft Robot

10:30-12:00 ( Lecture Room 1 CEO실 )

좌장 : 김성완 교수 (서울대)

**연구재단소개 및 Soft Robot R&D 전략**

김성완 교수 (서울대)

**Soft Robot 연구동향 및 발전 방향/전략**

김정 교수 (KAIST)

**Soft Robot 핵심 기술 #1**

조규진 교수 (서울대)

**Soft Robot 핵심 기술 #2**

박문정 교수 (포항공대)





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# Special Session V

신진연구자세션

13:30-15:00 (Convention Hall)

좌장 : 변경민 교수 (경희대)

**Speckle correlation reflection phase microscopy**

최영운 교수 (고려대)

**Engineering functional nanoparticles for diagnostic and therapeutic applications**

주진명 교수 (울산대 의대)

**Bring photonic tools into living system**

최명환 교수 (성균관대)

**Silicon nanowire based high-resolution neural stimulation electrode for retinal prosthetic systems**

이상민 교수 (경희대)

**Nanoconstructs for multimodal in vivo imaging in cancer theranostics**

기재홍 교수 (연세대)



# Special Session V

## Speckle correlation reflection phase microscopy



이름: 최영운

직위: 조교수

소속: 고려대학교 바이오의공학부

### Abstract

Here we present a quantitative phase microscopy operating in a reflection mode which is featured with single-shot and wide-field capability using time-varying speckle-field as an illumination source. Introducing an identically varying speckle-field on two different arms of the interferometry automatically generates a correlation process through the interferometric measurements. The system achieves the confocal-equivalent depth selectivity with the decorrelation of the 3D speckle-field while being based on the wide-field measurement. The proposed technique will facilitate the measurement of static profiles or dynamics motions of specimens with higher sensitivity.

### Brief Biosketch

Youngwoon Choi has received his B.S., M.S., and Ph.D. in the Department of Physics and Astronomy from Seoul National University in 2001, 2003, and 2009, respectively. He worked as a postdoctoral researcher in Korea University in 2009–2011, and at Laser Biomedical Research Center in MIT in 2012–2014. Youngwoon Choi is an Assistant Professor in the School of Biomedical Engineering, Korea University since 2015. His research interests are in developing high-resolution and deep-tissue imaging techniques, multi-functional endomicroscopic techniques, and optical microscopy with sub-nanometer motion sensitivity for non-contact and wide-field measurements.

# Special Session V

## Engineering functional nanoparticles for diagnostic and therapeutic applications



이름: 주진명

직위: 조교수

소속: 울산대학교 의과대학, 서울아산병원 의공학연구소

### Abstract

Nanotechnology is of great importance to molecular biology and medicine because life processes are maintained by the action of a series of molecular nanomachines in the cell machinery. Recent advances in nanotechnology offer great potential applications in biomedical research and clinical diagnostics, and the development of a novel tool-kit is critical to understand the inner world of complex biological nanosystems at cell, tissue and whole-body level. In particular, the unique combinations of material properties that can be achieved with nanomaterials provide new opportunities in biomedical applications, in which a number of functional nanomaterials have been investigated and become a new interdisciplinary frontier between biomedical science and materials engineering. In this talk, engineering strategies of functional nanomaterials and their applications for diagnostics and therapeutics will be discussed. The successful demonstrations of functional nanomaterials are expected to contribute on better understanding of living systems and promising translational nanomedicine.

### Brief Biosketch

Jinmyoung Joo received B.S. (2007) and Ph.D. (2012) degrees in Chemical Engineering from POSTECH. His Ph.D. thesis under the guidance of Prof. Sangmin Jeon involved the studies on the synthesis of nanoscale materials and characterization of the unique properties of these materials, along with the demonstration in diagnostic applications. He then continued his studies on the functional nanomaterials for biomedical applications as a postdoctoral research associate at University of California, San Diego under Prof. Michael J. Sailor, together with Prof. Erkki Ruoslahti (SBP Medical Discovery Institute) and Prof. Sangeeta N. Bhatia (MIT). He has been interested in understanding the interaction of nanomaterials with complex biological systems, engineering novel nanostructures that can effectively target diseases such as cancer, and developing theranostic nanoplatfroms for bioimaging and drug delivery. He is currently an Assistant Professor at Asan Medical Center and University of Ulsan College of Medicine.

# Special Session V

## Bring photonic tools into living system



이름: 최명환

직위: 조교수

소속: 성균관대학교 바이오메디컬공학과

### Abstract

Light is an attractive tool to interface with living biological systems. Various photonic tools have been developed to read cellular status and to control its behaviors. Despite success in ex vivo and in vitro settings, the translations toward in vivo systems have been often hampered. In this talk, I will discuss the challenges for translation and our continued endeavors to find solutions, focused on three aspects: intravital microscopy, nonlinear optical modulation and implantable optical devices.

### Brief Biosketch

Myunghwan Choi is currently appointed as an assistant professor in the Department of Biomedical Engineering at Sungkyunkwan University. He completed his undergraduate and doctoral studies in the department of Bio and Brain Engineering at KAIST, and continued his research career as a postdoctoral fellow at Harvard Medical School and Wellman Center for Photomedicine until he recently joined to Sungkyunkwan University as a faculty member. His research has been focused on developing new optical tools at the interface of biomedicine and photonics, including intravital microscopy, nonlinear optical modulation, and implantable optical devices. Recent research projects are tuned to neurophotonics, aiming to develop new optical tools for decoding functional neural activity in a mouse and primate model with close collaboration with Center for Neuroscience and Imaging Research.



# Special Session V

## Silicon nanowire based high-resolution neural stimulation electrode for retinal prosthetic systems



이름: 이상민

직위: 조교수

소속: 경희대학교 생체의공학과

### Abstract

Method to restore vision for blinds have been researched since the 1970' s. In 1988, it was reported that the inner nuclear and ganglion cell layers survive at fairly high rates in patients with retinal degenerative diseases even after a near-total loss of the macular photoreceptors. Several research groups of medical doctors, engineers and scientists from worldwide have been developing various types of retinal prosthetic devices for more than twenty years. Among those approaches, electrical retinal stimulation showed the most promising results for restoring vision. Recently, some clinical results of electrical stimulation method have shown partially successful vision restoration in patients with retinal degeneration. However many issues still remain to be investigated before the practical use of the retinal prostheses. Especially, to achieve tasks such as facial-recognition or reading, a high resolution of visual data is required. It is reported that at least 1,000 pixels need to be integrated in the restricted area of 5 mm × 5 mm in a retina for patients to experience useful activities, such as navigating a room. While some results show successful implementation of high-resolution MEAs, challenges such as wiring complexity and device flexibility still remains as issues to be resolved. In this seminar, a silicon nanowire based high-resolution microelectrode for minimizing the wiring complexity without compromising device flexibility will be shown. Also, recent development of silicon nanowire integrated microelectrode will be discussed for applications in retinal prostheses.

### Brief Biosketch

Sangmin Lee received the B.S. and Ph. D. degrees in the School of Electrical and Computer Engineering from Seoul National University, Korea, in 2005 and 2013, respectively. He had

conducted several research projects in inertial sensors, which include MEMS accelerometer/gyroscope sensing element fabrication and wafer-level hermetic/vacuum packaging. Also, he had implemented silicon-nanowire FET switch integrated with microelectrodes for high-resolution neural stimulation electrodes for retinal prostheses. From 2013 to 2016, he was a research staff member in Samsung Advanced Institute of Technology (SAIT), Samsung Electronics, Inc. In SAIT, he participated in a research for stretchable epidermal electronics, such as conductive elastomeric composite based stretchable interconnects and graphene/QD based stretchable LEDs. In 2016, he joined the Department of Biomedical Engineering, Kyung Hee University, Korea, where he is currently working as an assistant professor. His research interests include MEMS fabrication based neural stimulation microelectrodes for neural prostheses, microfabrication of biodegradable polymer for drug delivery, and epidermal electronics for medical health-care.

# Special Session V

## Nanoconstructs for multimodal in vivo imaging in cancer theranostics



이름: 기재홍

직위: 조교수

소속: 연세대학교 보건과학대학 의공학부

### Abstract

Most cancer deaths are due to cancer spreading from its primary site to other organs called metastasis. Thus, the early detection of cancer is vital to improve patient's survival. However current imaging modalities such as MRI, PET, CT, and ultrasound are not adequate to find the specific location of the early stage cancer. In addition, the cancer treatments such as chemotherapy and radiation therapy are not very effective resulting in high recurrence rates and severe side effects. Cancer theranostics represents a combinatorial diagnosis and therapeutic approach to cancer in which the ultimate goal is to find early stage cancer and to specifically terminate it at the same time. Nanoparticles can be a promising approach to deliver multiple components in a tiny nanostructure encapsulating imaging and therapy components with targeting ligands and stealth polymers, which can completely change pharmacokinetics and pharmacodynamics in the body. In this work, we demonstrate various multifunctional nanoconstructs for effective delivery of therapeutic and imaging agents by precisely adjusting size, shape, surface properties and mechanical stiffness. The nanoconstructs demonstrate high accumulation in cancer, which is validated by multiple imaging modalities including MRI, PET-CT, and optical imaging.

### Brief Biosketch

Prof. Key earned his M.S. degree in biomedical engineering, college of medicine in Yonsei University and Korea Institute of Science and Technology (KIST) in 2006 and received his Ph.D. degree in biomedical engineering in Purdue University, Indiana, USA in 2012. He moved to the Houston Methodist Research Institute in Texas Medical Center where he focused on the development of top-down fabrication methods to synthesize discoidal nano- and micro-constructs for MRI/PET-CT/Optical multi-modality cancer imaging as well as combinatorial drug delivery system. Prof. Key is currently working in biomedical engineering, college of health science in Yonsei University, Wonju.

2016년도 제51회

대한의용생체공학회 춘계학술대회

## Special Session VI

의료기기 국제 표준 최신 동향

13:30-15:00 ( Lecture Room 1 CEO실 )

좌장 : 안원식 교수 (경희의료원)

### 치과의료기기 (ISO/TC 106) 국제표준 최신동향

김경남 위원장 (대한치과의사협회 치과의료기기표준  
개발기술위원회)

### 의료기기 상호운용성 국제표준 최신동향

이성기 교수 (경북대)

### 의료제품분야 산업표준 관리 및 운영계획

장정윤 기준규격팀장 (식품의약품안전처)



## Special Session VI

### 치과의료기기 (ISO/TC 106) 국제표준 최신동향



이름: 김경남

직위: 위원장

소속: 대한치과의사협회 치과의료기기표준개발기술위원회

(Korean Dental Association, Chairman of Dental Devices Standard Development Committee)

#### Abstract

의과진료와 달리 치과진료는 반드시 치과의료기기(치과재료, 기구 및 장비)를 사용해야 하므로 국민 구강보건 향상을 위해 치과의료기기의 안전성 및 유효성을 검증할 수 있는 공통된 치과 표준(기준 및 시험방법)이 필수적이다. 이러한 표준은 검증된 치과의료기기를 사용해야 하는 치과의사뿐만 아니라 제조업체와 정확한 안전성 및 유효성 정보를 갖고 수입해야 하는 수입업체에게도 매우 중요하다.

국제표준화기구/치과(ISO/TC 106) 분야는 미국, 독일, 일본 등 27개국의 P-member국가와 17개국의 O-member국가가 서로 경쟁하며 견제하므로 침체된 분위기였으나, 최근 신규 표준 제안 등 한국의 적극적인 참여와 활동으로 상당히 활성화 되고 있어 새로운 소위원회(SC) 및 작업반(WG)이 탄생되고 있다.

한국에서는 매년 20여명의 전문가가 참여하고 있으며, 한국이 제안한 표준이 2015년 9월15일 한국 최초로 국제표준으로 발행되었으며, 현재 1건의 FDIS, 1건의 DIS, 2건의 CD 및 1건의 NWIP가 심의 진행 중에 있다.

본 강연에서는 이러한 치과 분야의 활동 내용을 소개하여 한국 의료제품 표준 발전에 보탬이 되고자 한다.

#### Brief Biosketch

치의학박사

대한치과의사협회 치과의료기기표준개발기술위원회 위원장

ISO/TC 106 한국대표

연세대학교 치과대학 명예교수

경동대학교 치과위생학과 석좌교수

# Special Session VI

## 의료기기 상호운용성 국제표준 최신동향



이름: 이성기

직위: 교수

소속: 경북대학교 컴퓨터학부

### Abstract

건강에 대한 관심이 증가하면서 의료기기의 사용이 병원 내에서 뿐만 아니라 병원 밖에서도 급속도로 증가하고 있으며, 이에 따라 의료기기의 상호운용성을 위한 국제표준의 적용이 매우 중요한 것으로 인식되고 있다. 본 강연에서는 의료기기에서 생성된 자료의 표현, 전송에 대한 국제표준의 최신동향에 대해서 소개하고자 한다. 의료기기에 생성된 생체신호를 표현하고 전송하는데 필요한 표준은 국제적으로 ISO/TC 215, IEEE PHD(Personal Health Device), IHE PCD(Personal Care Devices), HL7 HCD(Health Care Devices)에서 주도적으로 개발하고 있다.

의료기기에서 생성한 생체신호를 국제표준에 맞게 표현하여 의료서비스를 위한 서버로 전송하기 위해서는 ISO와 IEEE가 협력하여 개발한 ISO/IEEE 11073표준과 HL7표준을 기반으로 한 IHE DEC(Device Enterprise Communication)프로파일이 활용되고 있다. 본 강연에서는 국제표준 개발기관들의 활동과 현재까지 개발된 국제표준, 국제표준을 적용하기 위한 환경에 대해서 살펴보고자 한다.

### Brief Biosketch

경북대학교 컴퓨터학부 교수

IHE Korea 공동의장

미국 University of Utah, Computer Science 박사

연구관심 분야: 의료정보학, 의료영상처리



# Special Session VI

## 의료제품분야 산업표준 관리 및 운영계획

이름: 장정윤

직위: 기준규격팀장

소속: 식품의약품안전처

### Abstract

산업통상자원부(국가기술표준원) 소관 한국산업표준(KS, 이하 산업표준)과 부처별 소관 기술기준은 동일한 국제표준(ISO, IEC 등)에 기반 함에도 소관 부처가 상이하여 그 체계, 내용 및 준수 의무가 상이하여 효율적인 관리에 어려움이 있었다. 이에, 정부는 표준(자율인증)과 기술기준(강제인증)에 따른 인증제도 간 중복을 근원적으로 해소하기 위해, 부처별 소관분야의 산업표준 개발·운영 등을 각 부처에 위탁하는 ‘범부처 참여형 국가표준 운영체계’를 15.7월 도입하였고, 식품의약품안전처(이하 식약처)도 전체 표준의 약 4%에 해당하는 827개의 표준 이관으로 그 간 의료기기 인·허가를 위해 준수해온 의료기기 기준규격과 효율적인 통합관리 방안을 우선적으로 마련하는 작업을 추진하고 있다. 표준은 기술투자의 중복방지와 기술이전 등을 용이하게 만들고 국제 교역을 증대하는 산업발전 및 무역자유화의 기반이다. 그러나, 우리나라는 의료제품 분야의 표준 활동이 소홀하여 선진국 주도로 마련된 국제표준을 따라가기 급급했고 이는 국내 업체에게 보이지 않는 무역장벽으로 작용하였다. 따라서, 안으로는 국내 업계에 표준에 대한 인식을 확산 및 산업표준을 국제 표준과 부합화하는 등 활성화 기반을 마련하고, 밖으로는 세계무대에서 국내 업계의 이익을 대변하기 위한 국제표준화 활동을 지속적으로 강화해나가야 한다. 이를 위해 식약처는 국가표준기본계획에 맞춰 국내 제품의 경쟁력 강화 및 세계시장 진출을 위한 지원방안을 지속적으로 발굴·추진 할 계획이다.

### Brief Biosketch

식품의약품안전처 기준규격팀장

서울대학교 약학대학 약학박사



2016년도 제51회

대한의용생체공학회 춘계학술대회

## 일반연제

### Medical Imaging

좌장 : 이종민 교수 (한양대)  
15:00-16:30 ( Convention Hall )

### U-Health, e-Health, m-Health Technology

좌장 : 오동인 교수 (경희대)  
16:30-18:00( Convention Hall )

### Medical Nano and Microtechnology & Tissue Engineering and Biomaterials

좌장 : 최영빈 교수 (서울대)  
16:30-18:00 (Lecture Room 1 CEO실)

### Neural Engineering

좌장 : 장동표 교수 (한양대)  
10:30-12:00 (Convention Hall )

### Biomedical Optics

좌장 : 유흥기 교수 (한양대)  
10:30-12:00 (Lecture Room 2 효림홀 )

### Orthopedic and Rehabilitation Engineering

좌장 : 추준욱 박사 (기계연구원)  
13:30-15:00 (Lecture Room 2 효림홀 )



# 일반연제

## 일반연제 1

### 간 특이적 조영 증강을 위한 고리 구조 리간드 DO3A-EOB의 가돌리늄 착물의 합성 및 조영 증강 효과 분석

백아름<sup>1</sup>, 김희경<sup>2</sup>, 김소연<sup>1</sup>,  
이슬람 M. D. 캄룰<sup>1</sup>, 최가람<sup>1</sup>,  
성보경<sup>1</sup>, 정기혜<sup>4</sup>, 김태정<sup>2</sup>, 장용민<sup>1,2,3</sup>  
<sup>1</sup>경북대학교 의용생체공학과,  
<sup>2</sup>경북대학교 의공학연구소,  
<sup>3</sup>경북대학교 의과대학 분자약학교실,  
<sup>4</sup>한국원자력의학원

We designed macrocyclic type hepatobiliary contrast MR agent, Gd-EOB-DO3A to compared with commercial liver specific MR agents(Primovist<sup>®</sup>, Multihance<sup>®</sup>), Gd-EOB-DO3A is prepared according to the general synthetic methods, and characterized by spectroscopic analysis. In vivo MR images, maximum signal enhancements in liver and bileduct are respectively observed within 5 min, 15min.  $r_1$ ,  $r_2$  relaxivities are  $10.78 \text{ mM}^{-1} \text{ s}^{-1}$ ,  $11.74 \text{ mM}^{-1} \text{ s}^{-1}$ , significantly higher than those of Primovist<sup>®</sup> ( $r_1 = 4.7 \text{ mM}^{-1} \text{ s}^{-1}$ ,  $r_2 = 5.1 \text{ mM}^{-1} \text{ s}^{-1}$ ), Multihance<sup>®</sup> ( $r_1 = 4.0 \text{ mM}^{-1} \text{ s}^{-1}$ ,  $r_2 = 4.3 \text{ mM}^{-1} \text{ s}^{-1}$ ).

### 3D프린터를 턱관절 MRI 검사에 사용되는 TMJ Device 제작

장혜원<sup>1,2</sup>, 이태수<sup>1</sup>  
<sup>1</sup>충북대학교 의용생체공학과,  
<sup>2</sup>충북보건과학대학교 방사선과

Temporomandibular(TM) joint disorders are often found to have the joint disc displaced to the anterior, so by opening mouth as much as possible, the disc to be checked returns to the normal position. Therefore, the TM joint testing must be performed

with the mouth open in order to accurately observe the change in position of the disc and especially MRI scanning requires a TMJ device that can fasten the mouth because MRI scanning takes a long time. However, commercially available fixing devices are not often used in hospitals due to their high cost. In this study, a TMJ device was manufactured by using 3D printing technology and applied to MRI scanning. The average size of patients with TM joint disorders was measured and TMJ device 3D models of 3-7cm within a range of  $\pm 2\text{cm}$  was created, and converted into STL files, after which a G-code file was created to print out the model. A comparison between the use of the printed out TMJ device before and after MRI scanning revealed that its use enabled easier observation of the disc and significantly reduced motion artifacts.

### 광음향 영상 유도 수술용 항법 장치

박사라<sup>1</sup>, 장종성<sup>2</sup>, 김지수<sup>1</sup>, 김영수<sup>2</sup>, 김철홍<sup>1</sup>  
<sup>1</sup>포항공과대학교 창의IT융합공학과 전기전자공학과,  
<sup>2</sup>한양대학교 창의수술기술연구소

We have developed a photoacoustic (PA) image-guided surgical navigation system by integrating conventional navigation technologies and PA imaging. The system can provide both anatomical and functional information through real-time registration of photoacoustic/ultrasound (PA/US) images and three-dimensional models. The PA/US images acquired by the clinical PA/US imaging system in real time and are overlaid on the three-dimensional models which are derived from anatomical imaging modalities such as MRI or CT. We evaluate the feasibility of the developed system through

# 일반연제

phantom experiment. Results show that the system can be used in various clinical application of diagnosis and treatment.

## 안저 영상에서의 망막 혈관 자동 영상 검출 기술 개발

송준영<sup>1</sup>, 이보름<sup>1</sup>

<sup>1</sup>광주과학기술원 융합기술원 의생명공학과

The analysis of fundus photograph is one of useful diagnosis tools for diverse retinal diseases such as diabetic retinopathy and hypertensive retinopathy. Specifically, morphology of retinal vessels in patients is used as a measure of classification in retinal diseases and the automatic processing of fundus image has been investigated widely. The automatic segmentation of retinal vessels is essential and needs to precede computer-aided diagnosis system. In this study, we propose the method based on BCOSFIRE (Bar Combination Of Shifted Filter Response), CLAHE (Contrast-Limited Adaptive Histogram Equalization) and BPDFHE (Brightness Preserving Dynamic Fuzzy Histogram Equalization) approaches for retinal vessel automatic segmentation.

## Dual-energy CBCT를 이용한 micro-CT와의 골 미세구조에 대한 상관관계 향상

강세룡<sup>1</sup>, 유지용<sup>1</sup>, 이상정<sup>1</sup>,  
우상윤<sup>1</sup>, 이우진<sup>2</sup>, 이원진<sup>1,3</sup>

<sup>1</sup> 서울대학교 융합과학기술대학원 방사선융합의생명전공

<sup>2</sup> 서울대학교 의과대학 협동과정 방사선응용생명과학

<sup>3</sup> 서울대학교 치과대학 구강악안면방사선학교실

In this study, we evaluated the application of dual-energy CBCT for assessment of trabecular bone microarchitecture and com-

pared the performance of dual-energy and single-energy CBCTs with micro-CT. The dual-energy CBCT images based on the energy weighting method could enhance the contrast of the trabecular bone. The binary bone image from dual-energy CBCT could provide more similar image to the original bone image by the contrast enhancement at thin bone areas of lower density. Most of microstructural parameters from dual-energy CBCT images showed significantly higher correlations with micro-CT images than those from single-energy CBCT.

## Resting-state functional MRI를 이용한 주의력 결핍 및 과잉 행동 장애 환자의 뇌 신호 지연시간 분석

박보용<sup>1</sup>, 이유부<sup>2</sup>, 박현진<sup>2,3</sup>

<sup>1</sup>성균관대학교 전자전기컴퓨터공학과

<sup>2</sup>뇌과학이미징연구단, 기초과학연구원

<sup>3</sup>성균관대학교 전자전기공학부

Attention Deficit Hyperactivity Disorder (ADHD) is a common neuropsychological disorder that shows symptoms of inattention, hyperactivity, and impulsivity. Brain activations in resting-state functional magnetic resonance imaging (rs-fMRI) might show different time lag between brain regions. In this study, we computed time lag between all voxels pairs in rs-fMRI data of 5 ADHD and 5 typically developing control (TDC) subjects. Twenty three brain regions showed significant group-wise time delay differences between ADHD and TDC groups. Eleven brain regions showed significant correlations between time lag and ADHD related clinical scores. Our results might provide new insights for further ADHD related studies.

## 일반연제 2

### 피부 체온 및 심박을 이용한 운동 중 비침습적 생체 피로 지수 모니터링

심수영<sup>1</sup>, 고명준<sup>1</sup>, 주광민<sup>1</sup>, 박광석<sup>2</sup>

<sup>1</sup>서울대학교 공과대학 바이오엔지니어링 협동과정

<sup>2</sup>서울대학교 의과대학 의공학교실

Physiological strain monitoring during exercise is indispensable to prevent risk from dehydration or hyperthermia. Physiological strain can be evaluated using core temperature and heart rate. However, current invasive core temperature monitoring methods cause discomfort during exercise. Therefore, we investigated the feasibility of noninvasive skin temperature monitoring for physiological strain index (PSI) assessment. As a result, PSI based on skin temperature measured from arm or forearm and heart rate showed high correlation with PSI based on core temperature and heart rate. Also, PSI based on skin temperature gradient between thigh and arm showed strong correlation with PSI based on invasive method.

### Success factors of reverse innovation based on DCV : Through case studies of medical devices

J. JUNG, H. LEE

Samsung Advanced Institute for Health Sciences & Technology

In this study, we studied a reverse innovation integrating with resource-constrained innovation in emerging markets and found environments and capabilities are important to implement reverse innovation

through case studies analysis of medical devices. For this study, we used a dynamic capabilities view theory and concluded six capabilities along with three phases which are sensing, seizing, and reconfiguration. In sensing phase, two capabilities that sensing emerging market segments and sensing emerging technologies are required. Two capabilities that selecting affordable product features, managing global resources are compulsory for seizing phase. Lastly, two capabilities that reconfiguring for localization of strategy and combination of knowledge and know-how for expanding to other markets are of enormous importance.

### Convolutional Neural Network를 이용한 딥스 센서 기반 휴먼 행위 인식

박준혁, 박성연, 박정민,

무가헤드 알-안타리,

모하메드 알-마스니, 김태성

경희대학교 생체의공학과

Human activity recognition (HAR) has become an active research topic in the various fields. In this paper, we propose a new HAR system via Convolutional Neural Network (CNN), one of deep learning algorithms. In order to evaluate our system, we have compared the performance of our CNN based HAR against the Hidden Markov Model (HMM) and Deep Belief Network (DBN) based HAR using a database of Microsoft Research Cambridge-12 (MSRC-12). Our test results show that the proposed CNN-based HAR is able to recognize twelve human activities reliably and it outperforms the HMM and DBN based systems.



# 일반연제

## 다양한 소음 상황에서 유발된 정신적 스트레스의 검출

장민혜, 박희수, 정인원, 이연주, 윤인찬  
한국과학기술연구원 의공학연구소

In this study, the detection of stress which was induced under noisy conditions was investigated by using heart rate variability (HRV). In the experiment, three subjects performed mental arithmetic with three different noises (none, environmental noise, sine wave sound). Three different classifiers (linear SVM, SVM with RBF kernel, and logistic regression) assessed stress with statistically changed HRV parameters: a linear SVM showed the highest accuracy for (rest vs. environmental noise) case. Sequential feature selection methods were also applied to select the best HRV parameters with highest accuracy. The parameters selected by sequential backward selection (SBS) showed the highest accuracy of 90.0% for (rest vs. environmental noise) case.

## Development of device for sleep apnea and snoring and its analysis

S.M. Baek<sup>1</sup>, J. S. Jeong<sup>1</sup>, J. H. Park<sup>1</sup>,  
J. H. Shin<sup>1</sup>, M. H. Hwang<sup>1</sup>, H.G. Nam<sup>1</sup>,  
C.M. Yoo<sup>1</sup>, H. G. Son<sup>1</sup>, J. W. Lee<sup>1</sup>,  
J. H. Choi<sup>2</sup> and H. Choi<sup>1</sup>

<sup>1</sup>Department of Medical Sciences,  
Graduate School of Medicine,  
Korea University, Seoul, Korea

<sup>2</sup>Department of Otorhinolaryngology-Head  
and Neck Surgery, Korea University  
Ansan Hospital, College of Medicine,  
Korea University, Ansan, Republic of Korea

Sleeping is critical factor in recovering accumulated fatigue and deciding quality of

life. There are some obstacles disturbing our quality of sleep, and obstructive sleep apnea and snoring are the typical examples. In order to diagnose these sleep disturbances, polysomnography is required, however, this test has temporal and spatial limitations due to hospitalization. The need of home sleep apnea screening device is on the rise due to demerits of polysomnography. We have comparatively analyzed oxygen saturation and noise intensity of obstructive sleep apnea and snoring. As a result, the measurements of oxygen saturation of eupnea and obstructive sleep apnea was  $98.3 \pm 0.27\%$  and  $94.86 \pm 0.34\%$ , respectively, and also, hyper apnea due to automatic nerve stimulation was measured as  $94.23 \pm 0.35\%$ . The oxygen saturation level of snoring was measured as  $94.76 \pm 0.52\%$ , which is similar to the level of obstructive sleep apnea. Based on these data, our study group has developed of home sleep apnea screening device using Photoplethysmography (PPG). This device enables self-screening and self-screen treatment progress at home.

## 모바일 기반의 소형 다중 분광 이미지 시스템 개발을 통한 지루성 피부염 진단 및 관찰

김만재, 김세웅, 김지훈, 황재윤  
DGIST 정보통신융합공학전공

We here demonstrate a portable multispectral imaging system, which is attached to a smartphone, for discrimination between psoriasis and seborrheic dermatitis of the scalp. The system allows to obtain multispectral images of scalp lesions at 10 consecutive wavelengths within the range of 400nm to



700nm. Thus, it can offer quantitative analysis of the target lesions. In this paper, our developed multispectral imaging system and spectral classification based on spectral angle measurement, the seborrheic dermatitis region was discriminated from normal scalp. Thus, we show the potential of our developed system to discriminate between normal skin and seborrheic dermatitis of the scalp.

### 일반연제 3

#### 광유전학적 방법으로 세포 내 단백질 탑재된 엑소좀의 전달 효율과 기능성

이수진, 임남빈, 류승욱, 최경선, 최철희  
KAIST 바이오 및 뇌공학과

Exosome-mediated drug delivery has been of growing interest for research and pharmaceutical purpose. Exosome is vesicle released by cells with 30-100nm diameter. By incorporating optogenetic induction of protein-protein interaction technology into natural exosome biogenesis in cells, we have developed a efficient platform for loading exosomes with desired proteins. In this research, super-repressor-I $\kappa$ B, a non-degradable form of intracellular protein - inhibitor of  $\kappa$ B(I $\kappa$ B), was used as cargo protein. I $\kappa$ B is a potent inhibitor of NF- $\kappa$ B pathway which is hyper-activated in immune cells of inflammatory disease. We have demonstrated the intracellular delivery of super-repressor-I $\kappa$ B as functional protein in vitro and in vivo

#### 3차원 플라즈모닉 나노헬멧 어레이

지용구, 최연호  
고려대학교 바이오융합공학과

A real-time label-free detection method is crucial in biological, chemical, and medical applications. Surface-enhanced Raman spectroscopy is one of the best way of label-free detection method. Thus, a variety of fabrication methods of SERS substrates have been developed. However, conven-

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tional 2D SERS substrates have problems which the limited number of hot spots and its voluntariness, so it's difficult to sense the biomolecules such as influenza virus and exosome because it's specific morphology. Herein we developed nanohelmets array, to solve the problem of conventional 2D SERS substrates, which is shaped more suitable and advantageous for detecting biomolecules such as influenza virus.

## Portable photoacoustic probe for biomedical imaging

Nhat Quang Bui,<sup>1</sup> 오정환,<sup>2,3</sup>  
<sup>1</sup>부경대학교 의생명융합공학과,  
<sup>2</sup>부경대학교 의공학과,  
<sup>3</sup>해양과학 MIBT 융복합 센터

We developed a reflection-mode photoacoustic tomography (PAT) system capable of imaging optical absorption contrast in biological tissues with the use of a portable photoacoustic (PA) probe. The simultaneous portable and reflection-mode imaging capacity of the probe was enabled by delicately integrating a 45-Mhz intravascular ultrasound (IVUS) transducer under a 10X microscope objective lens with the numerical aperture of 0.25. The PA probe can employed both a 532-nm pumping source and a tunable optical parametric oscillator with a wavelength range of 650~1064 nm by using a multimode optical fiber for light delivery. By using the system, both structure and functional compositions of breast cancer cells labeled with phycocyanin-polypyrrole nanoparticles (P-P-NPs) were clearly

imaged ex vivo with high imaging contrast and high sensitivity. The results suggests that the portable PA probe can be a useful tool for biomedical imaging.

## 골격근 재생을 위한 삼차원 환경의 조직공학용 지지체

고웅현<sup>1\*</sup>, 박석희<sup>2</sup>, 서준호<sup>1</sup>,  
정진승<sup>1</sup>, 한제현<sup>1</sup>, 신현정<sup>1</sup>

<sup>1</sup>한국과학기술원 기계항공시스템 학부  
<sup>2</sup>한국생산기술연구원 마이크로/나노공정 그룹

Adult skeletal muscles have an ability to repair itself after minor injury; however, it cannot perform its innate repair function after severe injuries that cause volumetric muscle loss (VML). One strategy to treat VML is to develop biomimetic scaffolds that trigger myogenic differentiation and functional muscle tissue regeneration in large-damaged sites. This study introduces a uniaxially aligned 3D scaffold enriched with collagen gel, and verifies its suitability to promote skeletal muscle tissue regeneration.

## 감태에서 추출한 플로로타닌과 혼합된 폴리비닐 하이드로겔

박현호, 정원교

부경대학교 의공학과

부경대학교 BK21 Plus 해양 MIBT 융복합사업단

부경대학교 해양융복합바이오닉스 MIBC 연구단

When skin wound occur, hydrogels have been generally used as wound dressing for wound healing. Poly(vinyl alcohol) (PVA) is one of the common materials which can make hydrogel. It has non-toxicity, non-carcinogenicity, biocompatibility and easy processing. To make more effective hydrogel, we designed to blend PVA with *Ecklonia cava* (*E.cava*) phlorotannin which is a type of polyphenols found in brown algae. Then, we evaluated swelling property in water and proliferation of normal human dermal fibroblast-neo cells (NHDF-neo). As a result, PVA hydrogel blended with *E. cava* phlorotannin had high water absorption and activity to stimulate proliferation of NHDF-neo cells.

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### 신경세포 활성 측정을 위한 광학 및 전기 신호 동시 측정 시스템 구축

김래영, 남윤기

KAIST 바이오및뇌공학과

Various neuronal activity measurement techniques have been developed to research the electrophysiological characteristics of neuronal networks. Electrical measurement platform provides highly precise temporal data but their spatial resolution is limited, whereas optical measurement techniques have high spatial resolution. In this study, we developed a simultaneous optical and electrical signal measurement system for cultured neuronal networks in vitro. The electrical and optical signals were collected by a microelectrode array system and voltage sensitive dye imaging system, respectively. The two independent systems were combined through a single TTL signal. The developed measurement system is expected to provide novel information of neuronal activity

### 정상상태시각유발전위를 이용한 영화 상영 중 집단의 감정 변화 추적 기술

박성훈<sup>1</sup>, 김도원<sup>1,2</sup>, 한창희<sup>1</sup>, 임창환<sup>1</sup>

<sup>1</sup>한양대학교 생체공학과

<sup>2</sup>Technische Universität Berlin, Berlin, Germany

There are an increasing number of neurocinematics studies that attempt to track temporal changes in cognitive and/or emotional states of the brain during movie

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screening; e.g., attention, emotional engagement, and cognitive load. However, it is generally difficult to find efficient and robust EEG features that can be used to track brain states over a long period of time. In the present study, we propose a method for estimating changes in emotional arousal of a group of individuals during movie screening, using a new type of visual stimuli that can elicit steady-state visual evoked potential.

## 효율적인 동물실험을 위한 전기 증착 이리듐 옥사이드 신경 전극의 제작

신수원<sup>1</sup>, 이성은<sup>1</sup>, 김진형<sup>2</sup>, 장진우<sup>2</sup>, 김성준<sup>1</sup>

<sup>1</sup>서울대학교 공과대학 전기·정보공학부

<sup>2</sup>연세대학교 의과대학 신경외과

This research presents the development of neural electrodes with a high charge storage capacity using electrodeposited iridium oxide film (EIROF). We validated the characteristics of the fabricated polymer-based flexible neural electrodes with EIROF sites using electrochemical, mechanical, microscopic, and spectroscopic methods. Moreover, in vivo neural recording experiments were done to demonstrate the feasibility of the proposed EIROFs as an electrode site material.

## 청각자극에 따른 ECoG 신호 분석

나영민<sup>1</sup>, 김태경<sup>2</sup>, 장동표<sup>2</sup>,

강중구<sup>3</sup>, 우지환<sup>1</sup>

울산대학교 의공학과<sup>1</sup>,

한양대학교 의공학과<sup>2</sup>,

울산대학교 의과대학<sup>3</sup>

A brain-computer interface (BCI) has been

investigated to develop a neuroprosthetic device. It is essential to understand human brain activities in response to either external stimulation or patient intentions. Moreover, accurate decoding of hearing and imagined words from brain signals is a prerequisite. In this preliminary study, we presented the new approach for classification of spoken words from electrocorticograms using the machine learning algorithm. The results show that the eight words were correctly predicted with mean accuracy of 74 %.

## 뇌전도를 이용한 가상 운전자의 실시간 졸음 검출

장효중, 안상태, 전성찬

광주과학기술원 전기전자컴퓨터공학부

Detection of driver's drowsiness has emerged as a major interest because of the advent of concept of futuristic car technology in terms of the safety enhancement of the driver. In this research, we hypothesized that drowsiness may be related to the crossing between relaxation-related alpha and sleep-related theta band. For this investigation, we recorded 32-ch EEG with drowsiness trigger and video simultaneously during driving simulation task for 0.5-2 hours. As informative features, three ratio indices —  $\theta/(\theta + \alpha + \beta)$ ,  $\alpha/(\theta + \alpha + \beta)$ , and  $\beta/(\theta + \alpha + \beta)$  — were calculated every 5 seconds with 1 minute epoch, respectively. We observed some correlated behaviors between three ratio indices and the drowsiness triggers.

## 뇌파 신호원 국소화를 이용한 긍정 부정 감정 상태 디코딩

김현, 최종두, 최정우, 김경환  
연세대학교 의공학과

In this study, we tried to explore whether the positive and negative emotional states during watching movies can be decoded using cortical activities from electroencephalograms (EEGs). The amplitude of cortical sources was reconstructed using weighted minimum norm estimation. Spectral power and asymmetry index which is derived from inter-hemispheric difference in spectral power at the cortical level were used as features for emotional state decoding. The best decoding accuracy was as high as 94.71% using only the asymmetry index. The most informative features were power in theta band at anterior cingulate cortex and frontal lobes, and asymmetry index in beta band at frontal lobes, temporal lobes, occipital lobes. Our results indicate that the asymmetry indices might provide significant information about positive and negative emotional responses.

## 일반연제 5

### 마우스 생체 내 대장 영상화를 위한 광 파면 보정 기반 이광자 미세내시경

왕태준<sup>1</sup>, 이길구<sup>2</sup>, 김기현<sup>1,2</sup>  
POSTECH 융합생명공학부<sup>1</sup>, 기계공학과<sup>2</sup>

Gradient index (GRIN) lenses were widely used in endomicroscopic imaging, but its intrinsic aberration property causes distorted wavefront of incident light and disrupts clear image detection. We corrected GRIN lens transmitting wavefront of a GRIN lens-based two-photon endomicroscopy (TPEM) setup and investigated luminal side of normal and colorectal cancer mouse colon in cellular-level, in vivo. An improved GRIN lens-based TPEM could be helpful for in vivo preclinical studies in inflammatory bowel disease model.

### Photodynamic Therapy of Hypericin-treated Laryngeal Carcinoma in Rabbit.

S.W.Kim<sup>1</sup>, H.S.Lee<sup>1</sup>,  
S.K.Seok<sup>2</sup>, Y.C.Ahn<sup>3</sup>,  
H.W.Kang<sup>3</sup>, C.Oak<sup>4</sup>

<sup>1</sup>Department of Otolaryngology-Head and Neck Surgery, Kosin University College of Medicine, Busan, South Korea

<sup>2</sup>Department of Biochemistry, Kosin University College of Medicine, Busan, South Korea

<sup>3</sup>Department of Biomedical Engineering and Center for Marine-Integrated Biomedical Technology, Pukyong National University,

# 일반연제

Busan, South Korea

<sup>4</sup>Department of Internal Medicine,  
Kosin University College of Medicine,  
Busan, South Korea

Hypericin is a potential photosensitizer for photodynamic diagnosis and therapy of cancer. We have presented that it is selectively accumulated in laryngeal cancer in rabbit after intravenous administration. The fluorescence of the hypericin was acquired from tumor surface via rigid laryngoscopy and photodynamic therapy was performed using diffusing fiber with 590 nm diode laser via transoral approach. Results of hypericin-treated photodynamic therapy in laryngeal tumor is partial response or complete remission. Average survival period is longer than the control group. The results suggest hypericin-treated PDT may be useful treatment method for laryngeal cancer.

## 반복적 세포수준 생체영상 기반 항암제 후보물 질의 생체 내 효능 모니터링

송은주, 최기백, 황윤하, 서호원, 안진호,  
안소연, 박인원, 문지은, 김필한  
KAIST 나노과학기술대학원

For the development of anti-cancer drugs, an extensive preclinical screening and optimization of lead compounds with animal model is a critical step. However, conventional assessment method based on T/C% measure is time-consuming, which takes several months. In this work, we performed a rapid in vivo efficacy monitoring of anti-cancer drug candidates by direct repetitive cellular-level imaging of identical site through the dorsal skinfold chamber implanted animal model. By fluorescent la-

beling of either vasculature or apoptotic cell membrane, we could directly quantify the efficacy of drug candidates presented by the reduced vessel dilation and vascular density or the increased number of apoptotic cancer cells.

## Biocompatible astaxanthin as a novel contrast agent for biomedical imaging.

Van Phuc Nguyen,<sup>1</sup> 박수현,<sup>2</sup>

오정환,<sup>3,4</sup> 강현욱<sup>3,4</sup>

<sup>1</sup>부경대학교 의생명융합공학과,

<sup>2</sup>삼성종합기술원,

<sup>3</sup>부경대학교 의공학과,

<sup>4</sup>해양과학 MIBT 융복합 센터

The current study demonstrated feasibility of biocompatible astaxanthin as a non-ionizing photoacoustic (PA contrast agent). Unlike indocyanine green (ICG), methylene blue (MB) or other nanosize materials such as gold nanoparticles, single-walled carbon nanotubes (SWNTs), the potential and efficacy of astaxanthin for PA imaging have not been quantitatively assessed. In a phantom study, astaxanthin with different concentrations from 40  $\mu$ M to 640  $\mu$ M was used to acquire PA image. As a result, the optical absorption of astaxanthin was linearly increased with the concentration of astaxanthin due to accumulation of astaxanthin. Therefore, astaxanthin can be an efficient and safe material to identify bladder tumor location at low doses due to its high absorption contrast.



## 확산광 반사 분광기법을 이용한 국소 부종 진행에 따른 생물학적 구성 성분 변화 관찰

김성철<sup>1)</sup>, 김재관<sup>1)</sup>

<sup>1)</sup>광주과학기술원 의생명공학과

In this study, we applied a diffuse reflectance spectroscopy to observe percentage changes of oxy, deoxy hemoglobin, lipid and water during local edema occurrence by fitting the diffuse reflected light spectrum with a photon diffusion equation. Diffuse reflected light spectra were collected from rat paw while edema was induced by 100 $\mu$ L administration of 5% formalin. During the edema formation, the volume of water was increased while tissue oxygen saturation level was dropped for 20min and then increased afterwards. This result showed a potential of diffuse reflectance spectroscopy as a edema monitoring device during a general surgery.

## 알츠하이머 뇌 구조에 대한 비표지식 광학적 정량화

이무성, 이익성, 정재황, 유현승,  
김규현, 이신화, 정용, 박용근  
KAIST 바이오 및 뇌공학과

We present a quantitative label-free imaging of whole brain tissue slices of mice with sub-micrometer resolution, employing holographic microscopy and an automated scanning platform. From the measured light field images, scattering coefficients and anisotropies are quantitatively retrieved, which enables access to structural information about brain tissues. As a proof of principle, we demonstrate that these scattering parameters enable us to quantitatively address structural alteration in the brain tissues of mice with Alzheimer's disease.

## 일반연제 6

### Tendon-driven 기반의 유연한 수동 상지 근력 보조 기구의 hysteresis 분석 및 개선

박대근, 조규진  
서울대학교 기계항공공학부

There are lots of people who suffer from muscular diseases. To assist these people, we suggest a soft wearable weight support device. This device consists of the passive actuator and the tendon-driven mechanism to transmit assistive force from the actuator to body joint. Because of this mechanism, although it can reduce the structural weight on body, huge hysteresis is generated by friction on tendon sheath. In this paper, we measured the hysteresis using the tensile machine. By replacing the sheath material, we improved the tendon-driven structure and it was evaluated from the tensile test of the actuation system.

### Kinect 센서와 Wii Balance Board를 이용한 노인의 선 자세 평가

양승태<sup>1</sup>, 서정우<sup>1</sup>, 김대혁<sup>1</sup>,  
강동원<sup>2</sup>, 최진승<sup>1,2</sup>, 탁계래<sup>1,2</sup>  
<sup>1</sup>건국대학교 의학공학부,  
<sup>2</sup> BK21플러스의공학실용기술연구소

Kinect sensor with Wii balance board was used to analyze standing balance ability of the elderly. Four subjects, who can walk alone and have a normal cognitive level, participated in this experiment. Based on Berg Balance scale test, four subjects were divided into Healthy older (HO) and Impaired older (IO) group. Each subject per-

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formed one-minute standing balance test. Mediolateral & anterior-posterior movements of the COM and COP of IO group were higher than those of HO group. Therefore, it was possible to estimate simple balance assessment using Kinect sensor and Wii balance board at the same time.

## 척추-고관절 회전의 생체역학적 협응: 프로골퍼 성별의 차이

최안렬, 심태용, 문정환  
성균관대학교 생명공학대학  
바이오메카트로닉스학과

The purpose of this study was to evaluate the inter-joint coordination between the lumbar spine and hips during a golf downswing of experienced male and female golfers. Euler angles and CRP were used to calculate joint angles and inter-joint coordination, respectively. As results, faster rotation of the left hip compared to the lumbar spine appeared in the first half of the downswing phase for male golfers. However, rotation velocity between the lumbar spine and left hip in female golfers were comparable. This study has the potential to help develop gender-specific coaching materials for the improvement of golf swings.

## 손목 착용형 3축 가속도계를 이용한 신체 활동 구분에 관한 연구

박희수<sup>1,2</sup>, 정인원<sup>1</sup>, 장민혜<sup>1</sup>, 윤인찬<sup>1</sup>  
<sup>1</sup>한국과학기술연구원 의공학연구소  
<sup>2</sup>과학기술연합대학원대학교 의공학과

This study describes detecting the classification of physical activities among sitting,

standing, level walking, running, ascending stairs and descending stairs activities using several feature extraction methods with a wrist-worn accelerometer. Physical activities using time-domain features and frequency-domain features were accurately classified and the classification accuracy was 90.98%. Our results proved a reliable technique of physical activity recognition.

## 상지재활을 위한 FES와 모션센서를 결합한 모바일 재활 시스템 개발

<sup>1</sup>임홍준, <sup>2</sup>강윤주, <sup>1</sup>구정훈  
<sup>1</sup>계명대학교 의과대학 의용공학과,  
<sup>2</sup>을지대학교 재활의학과

본 논문에서는 상지 재활훈련을 위해 기능적 전기자극(FES: Functional Electrical Simulation) 치료와 모바일 게임을 결합한 새로운 재활 프로그램 개발을 제안하였다. 시스템은 재활게임 어플리케이션을 실행하는 모바일 기기와 FES로 구성되어 있다. 모바일 게임 어플리케이션은 목표하는 관절 각도만큼 들어올려 일정시간 유지할 수 있도록 디자인 되었으며 이를 보조하기 위하여 전기자극을 주었다. 환자의 운동능력에 따라 목표 각과 자극의 세기를 조절함으로써 개개인에 부합하는 재활환경을 제공할 수 있도록 하였다. 개발된 프로그램은 서울 E병원에서 통원치료를 받고 있는 6명의 환자를 대상으로 적용하였으며, 훈련이 끝난 후 설문조사를 통해 프로그램을 평가하였다. 평가 결과 다음에도 개발된 프로그램을 사용하고 싶다는 의지를 들어냈고, 대체로 만족한다는 평가를 했다. 하지만 게임이 다소 지루하게 진행된다는 문제점을 제기 되었으며, 다양한 게임 콘텐츠를 제공한다면 보다 나은 재활 프로토콜이 될 것으로 예상된다.



2016년도 제51회

대한의용생체공학회 춘계학술대회

# POSTER I

12:00-13:00 (미래관 4층)

- Biomedical Engineering Education and Career
- Biomedical Optics
- Biomedical Robotics
- Cardiovascular Engineering
- Medical and Bio-informatics
- Medical Imaging
- Respiratory Engineering
- System Biology, Physiological Modeling



# POSTER I

P1-001

Photoacoustic imaging and cytotoxic killing of breast cancer cells using astaxanthin-reduced gold nanoparticles

Subramaniyan Bharathiraja<sup>1</sup>,  
Panchanathan Manivasagan<sup>1</sup>,  
Nhat Quang Bui<sup>2</sup>, Yun-Ok Oh<sup>1</sup>,  
and Junghwan Oh<sup>1,2</sup>

<sup>1</sup> Department of Biomedical Engineering and  
Marine-Integrated Bionics Research Center,  
<sup>2</sup>BK21 Plus, Pukyong National University

Use of photosynthetic pigments has remarkable potential in photo-based therapy and diagnosis where it used less. Advantage of these natural pigments are biocompatibility, light harvesting ability and promising biological activities range from antimicrobial to anticancer effects. In the present work we used astaxanthin, a photosynthetic pigment for gold nanoparticle formation and nanoparticles were characterized using UV-Vis spectroscopy, transmission electron microscopy, and X-ray diffraction, and the possible presence of astaxanthin functional groups were analyzed by Fourier transform infrared spectroscopy. The synthesized particles showed cytotoxicity against MDA-MB-231 (human breast cancer cells) which was confirmed by tetrazolium-based MTT assay, and it exhibited dose-dependent toxicity. The morphology upon cell death was differentiated through fluorescent microscopy using different stains that predicted apoptosis. The synthesized nanoparticles were applied in photoacoustic imaging to obtain images of treated cells. Astaxanthin-reduced gold nanoparticle has potential to act as a promising agent in the field of photo-based diagnosis and therapy.

P1-002

음파변화기의 채널 개수를 증감할 수 있는 시스템

김진호, 송길수, 신운철,  
차오름, 서종범, 김한성  
연세대학교 의공학과

HIFU treatment is a noninvasive way of destroying cancerous tissues. With a single channel HIFU transducer, there are some drawbacks such as the time consuming process of need to relocate the transducer constantly during the treatment, the difficulty to sonicate internal organs hiding behind bones due to the unique properties of ultrasound, and the possibility to harm other soft tissue. Phased array transducer is a new means to solve the problems mentioned above. In this manuscript phased array transducer driving system, capable of selectively change the number of channels, is suggested by separating the pulse generation circuit into a module and changing the number of modules to operate. The communication protocol is suggested and the validity of the system in HIFU treatment is verified by increasing the temperature of the eye roll of a beef to 59.2°C, enough to induce tissue necrosis.

P1-003

Baseline Drift Removal from Fast Scan Cyclic Voltammetry (FSCV) Data Using High Pass Filter

M. DeWaele, C. H. Park, Y. B. Oh,  
Y. M. Kang, H. J. Shin, I. Y. Kim,  
D. P. Jang

Department of Biomedical Engineering,  
Hanyang University

# POSTER I

Removing baseline drift from fast scan cyclic voltammetry (FSCV) data has long been a problem for data analysis. In this paper, we will introduce a simple method to effectively remove the baseline drift while preserving target data by using a simple high pass filter. This filter can be applied to both in vitro and in vivo data with wide-ranging implications including possible use in real time data acquisition.

## P1-004

국내 의료기기 GPO (구매대행회사) 활성화 방안에 관한 연구

김민호<sup>1</sup>, 정혜임<sup>1</sup>, 지영호<sup>2</sup>, 김윤배<sup>3</sup>

<sup>1</sup>성균관대학교 의료기기산업학과,

<sup>2</sup>서경대학교 물류학과,

<sup>3</sup>성균관대학교 시스템경영공학과,

GPO (Group Purchasing Organization) is a group that is made to leverage the purchasing power to gain discounts from suppliers based on the buying power of the GPO members. A healthcare GPO gives management improvement of the hospitals through service of purchasing, logistics and inventory management. Recently, hospital officials are highly interested in management improvement of the hospital owing to decreasing revenue and increasing personnel expense. Therefore, we need to utilize advanced IT solutions of GPO based on both the transparency and the fairness. The objective of this study to review current situation for using GPO and consider essential requirement for advanced GPO and improvement of using GPO for medical equipment in Korea.

## P1-005

광용적맥파의 삼각형 면적을 활용한 혈압 추정

조은일, 이정직, 임지현, 윤영로

연세대학교 의공학과

The blood pressure is one of the critical indicators of judging of the cardiovascular condition. However, traditional method using cuffs has several limit points such as patient's discomfort induction or discontinuous blood pressure measurement. To solve this problem, the Photoplethysmography (PPG) is used and the continuous blood pressure measurement is practicable. Also, the algorithm which utilizes the area of a triangle formed by connecting characteristic points of the PPG signal is used to improve performance of the estimation of blood pressure. In the case of male subjects, the accuracy of estimated systolic blood pressure values is 96.7% and the accuracy of estimated diastolic blood pressure values is 90.19%. In the case of female subjects, the accuracy of estimated systolic blood pressure values is 93.79% and the accuracy of estimated diastolic blood pressure values is 78.57%.

## P1-006

응급상황 인식을 위한 도플러 레이더 기반의 실시간 움직임 감지 알고리즘

전세훈, 신수연, 김현성,

남윤찬, 황라영, 신태민

연세대학교 보건과학대학 의공학과

As the number of one-person households is increasing, many research for a monitoring system for recognizing an emergency situation have been carried out. However, these studies have disadvantage for apply-

ing to real life because the sensors should be attached to the human body or expensive equipment should be used for monitoring. In this study, therefore, motion detection algorithm was developed using Doppler radar that is low cost, unconstrained, and the algorithm detects the actions such as get close, get away, parallel move, sitting on, get up. As a result of acting all movement five times, the algorithm has 100% detection rate and good performance.

#### P1-007

##### 심전도 부정맥 예측을 위한 QRS 벡터 검출에 관한 연구

이재훈, 허정현, 한지호, 윤영로  
연세대학교 의공학과

Generally the interpretation of ECG(Electrocardiogram) includes obtaining biological signals from the body, noise reduction, detection of QRS complex and diagnosis. ECG has been utilized in the diagnosis of various heart diseases. QRS vector axis represents the direction of electric vector of the heart. In this paper we compare change of QRS vector in arrhythmia patients with that in common ECG. The standard deviation of the change of QRS vector axis in arrhythmia patients is 2.37 and that in common ECG is 0.29. As a result the standard deviation of the change of QRS vector axis in arrhythmia patients is higher than that in common ECG.

#### P1-008

##### 상온상압 DBD 플라즈마의 선택적 암 세포 사멸 작용

권병수<sup>1</sup>, 한세직<sup>1</sup>, 박문영<sup>1</sup>, 최은하<sup>2</sup>, 박현국<sup>1</sup>, 김경숙<sup>1</sup>

<sup>1</sup>경희대학교 의과대학 의공학교실

<sup>2</sup>광운대학교 플라즈마 바이오과학 연구센터

Non-thermal micro-dielectric barrier discharge (micro-DBD) plasma showed apoptotic effects in both human cervical cancer cell lines (HeLa and SiHa) and human fibroblast cell (HFB). By the plasma treatment, caspase-3 activities and percentage of cells in subG0 phase was increased in all cells. The effect of micro-DBD plasma was serious in cancer cells compare to the normal fibroblast. Especially, SiHa cells showed noticeable changes than HeLa cells by the plasma. In plasma treated SiHa, the apoptosis-related genes were significantly enriched and the cellular viability was decreased rapidly by increasing dose of plasma.

#### P1-009

##### 3D 프린팅 기반의 능동뇌파전극 개발

박대우<sup>1</sup>, 이보름<sup>1</sup>

<sup>1</sup>광주과학기술원 융합기술원 의생명공학과

The conventional method for EEG recording is to use Ag/AgCl electrode with conductive gel. However this method is uncomfortable and requires time consuming. To solve this problem, many kinds of dry electrodes have been proposed, but these electrodes have limitations such as high impedance between an electrode and a scalp, difficulty for measurement in hairy site. Moreover it spends a lot of money to develop dry electrode because of using gold or platinum for good conductivity and biosatibility. Therefore we developed dry active electrode through 3D printing in low-cost. To validate the

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proposed electrode, experiments for alpha rhythm and the performance of the comparison between a wet electrode and the proposed electrode were performed.

## P1-010

의료기기 전기기계적 안전에 관한 공통기준규격 시험법 온라인 교육콘텐츠 개발 연구

김태권

의료기기정보기술지원센터

Objectives of this project are to prepare job training text books about utilization of the common standard on electrical and mechanical safety of medical devices, and to make video training materials about test methods. A review contents of this project, and to establish and manage an expert consultation group for technical advices needed in making video training materials and to develop job training text books (text book, 1 volume) and video training contents (video, 1st-10th). It is expected that personnel capacity for medical device test and analysis will be enhanced, and test method related online training contents will be prepared and used by companies.

## P1-011

아두이노를 도입한 심전도 실험교육과정의 설계

양현숙, 노정훈

건국대학교 의과대학 심장내과,  
부산대학교 의과대학 의공학교실

Arduino is a widely adopted open-source microcontroller platform for building electronics projects. Using an Arduino, it is very instructive and simple to implement

laboratory course measuring bio signals like electrocardiogram. We have demonstrated a step by step laboratory course to build an electrocardiograph. A large part of electrocardiograph hardware circuits like the notch filter to eliminate power line noise could be saved using functions of Arduino. Less than ten discrete electronic components could give a good electrocardiogram.

## P1-012

아두이노를 도입한 심전도 실험교육과정의 설계

박성민

강원대학교

장기 이식 후 발생하는 면역거부반응은 주로 공여장기의 세포에 있는 항원에 의해 일어난다. 이러한 세포를 제거하고 남은 세포외질(ECM)은 면역거부 반응을 일으키지 않으며 세포가 착상하여 생존하기 적합한 환경을 제공하데 이를 생체 지지체로 이용하여 인공장기를 만들려는 연구가 널리 진행되고 있다.

## P1-013

초소형 압력센서 카테터 모듈 제작 및 측정 시스템

서호영\*, 김명남\*\*

\*경북대학교 대학원 의용생체공학과

\*\*경북대학교 의학전문대학원 의공학교실

An intra-abdominal measurement through cystometry can be non-inclusively, most easily and accurately measured. In the paper, a new subminiature pressure sensor module and sensing system are developed using a sensor of semiconductor type and

FPCB. The module is more stable, flexible, and small than conventional catheter. The performance of the developed module is evaluated by various quantitative analysis indexes.

#### P1-014

##### 기류 측정 모듈의 보정 및 비교용 기류 발생 시스템

차은중, 박미정, 박재성, 손호선\*,  
김경옥\*\*, 김경아  
충북대학교 의과대학 의공학교실,  
의학연구소\*,  
우송대 간호과\*\*

An air flow generator system was developed to generate air flows of various levels simultaneously applied to two different air flow transducer modules. Axes of two identical standard 3 ℓ syringes were connected in parallel and driven by a servo-motor. The user can select either sinusoidal or square waveform of volume change and manually input any volume as well as maximal flow rate levels ranging 0~3 ℓ and 0~15 ℓ/s, respectively. Various volume and flow levels were input to operate the system, then the volume signal was acquired followed by numerical differentiation to obtain the air flow signal. The measured volumes and maximal air flow rates were compared with the user input data. The relative errors between the user-input and the measured stroke volumes were all within 1%, demonstrating very accurate driving of the system. In case of the maximal flow rate, most measured flow rates revealed relative errors  $\leq 2\%$ . These results demonstrate that the servo-motor controls the syringes with good enough accuracy to generate

standard air flows. Therefore, the present system would be very much practical for calibration process as well as performance evaluation and comparison of two different air flow measurement modules.

#### P1-015

##### 3D 프린터를 이용한 측두골 해부 실습용 모델 제작

이도현<sup>1</sup>, 정은비<sup>1</sup>, 백정환<sup>1,2</sup>  
성균관대학교 삼성융합의과학원  
일반대학원 의료기기산업학과

Mastoidectomy surgery is being practiced using cadavers by many residents. It is required surgical drilling skills and comprehensive anatomical knowledge of the temporal bone in order to protect variety of detailed structures in the temporal bone. However, the number of cadaver is very limited for several reasons. Recently, many methods using the latest technology have proposed to replace the cadavers. In this study, we have created the 3D printed temporal bone model using the powder materials. 3D printed model evaluated with objective and subjective criteria. As a result, we evaluated the possibility that the printed model can replace cadaver temporal bone.

#### P1-016

##### 의료기기의 안전한 사용을 위한 관리 활동

<sup>1</sup>오인택, <sup>1</sup>김만기, <sup>1</sup>신태수, <sup>1,2</sup>주세경  
<sup>1</sup>서울아산병원 의공학과,  
<sup>2</sup>울산대학교 의과대학 의공학교실

In the case of Bio Medical Engineering team of ASAN MEDICAL CENTER, we have been



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managing medical devices by its safety. Especially, there are many times to occur safety accidents when we manage the medical devices that are used in image examination room. In this paper, we sincerely desire to introduce how to implement safety management to medical device in MRI system and fluoroscopic imaging system.

## P1-017

수술장의 원활하고 안전한 멸균 물품 공급을 위한 관리방법 개선

이상률<sup>1</sup>, 김진만<sup>1</sup>, 신태수<sup>1</sup>, 주세경<sup>1,2</sup>

<sup>1</sup>서울아산병원 의공학과,

<sup>2</sup>울산대학교 의과대학 의공학교실

Supply of sterilized instruments is essential in preparing operation at operating room (OR). The authors analyzed the supply process of sterilized instruments in OR at Asan Medical Center to find out on which point the delay occurs. In this paper, we propose several ways for effective management of supply chain of sterilized instruments in OR.

## P1-018

멀티에너지 검출을 위한 HgI<sub>2</sub> 기반의 선량계 적용 가능성 연구

한무재<sup>1</sup>, 김교태<sup>1</sup>, 허예지<sup>1</sup>,

신요한<sup>1</sup>, 박성광<sup>2</sup>, 남상희<sup>1</sup>

인제대학교 의용공학과<sup>1</sup>,

인제대학교 개금백병원 방사선종양학과<sup>2</sup>

In this study, to evaluate the applicability of dosimeter to produce a sensor-based detection HgI<sub>2</sub> material was analyzed for reproducibility and linearity for multi-energy. Reproducibility of results, CV value of keV and MeV range showed respectively 0.026,

0.014. Linearity results in keV range, R<sup>2</sup> showed 0.9856 and exhibited the largest error of 7.78% at 80 mAs. Linearity results in MeV range, R<sup>2</sup> showed 0.9998 and exhibited the largest error of -0.63% at 1000 MU.

## P1-019

모바일 의료용 앱 규제에 따른 글로벌 대응방안 연구

김진환

성균관대학교 의료기기 산업학과

Medical devices industry is changing at a rapid rate, with the popularity of smart phones and mobile medical applications are being developed. However, when a mobile medical application works wrong or incorrect data due to software bugs, it may result in critical risk to patient. In this study analyses and compares with the current regional regulation of a mobile medical application. We then consider the effectiveness method such as approval, cyber security, quality management and post market surveillance for companies which manufacture make mobile medical application.

## P1-020

맥동 유체 모델을 이용한 혈류 측정 기법들의 비교 연구

박지은, 김정훈, 박유진, 안도현,

이도석, 이도병, 최현우, 조숙인, 이종민

경북대학교 의용생체공학과

We did a comparative study of non-invasive blood flow measurement techniques using self-made pulsatile flow model. Reference standards used a electromagnetic



flowmeter. For comparison, we acquired the time-velocity curve using electromagnetic flowmeter, Phase contrast magnetic resonance imaging(PC MRI), Particle Image velocimetry(PIV) and Doppler Ultrasonography. Minimum value, Average value, Full-width at half-maximum, Foot-peak gradient and Peak time of velocity curve was obtained to find a flow characteristic.

#### P1-021

##### 파장에 따른 전립선 비대증 지혈 연구

황지은, 강현욱

1부경대학교 의공학과;

2부경대학교 의생명융합공학과;

3해양MIBT 융복합 센터

The aim of the current study was to validate 980 nm and 532 nm laser for laser hemostasis. To overcome the complications such as bleeding after benign prostatic hyperplasia (BPH) procedure, the study was developed as an alternative method for laser hemostasis. During treatment, coagulation depth compare between 980 nm and 532 nm laser in the liver tissue. The results showed that 532 nm has efficient removal than 980 nm laser about control the bleeding. 532 nm can be effective and safe treatment for control the bleeding in surgical procedure.

#### P1-022

##### 최소 침습적 저출력 레이저 자극이 피부 밀도에 미치는 영향

장슬기, 박지훈, 유성곤,

이상엽, 하명진, 정병조

연세대학교 의공학과

The reduction of skin density is one of the symptoms of skin aging. It is a factor to decrease the elasticity of the skin and form wrinkles. In recent years, the importance of skin care was increased so a number of studies on skin care also have been increased. This study shows the degree of increase on skin density by using a minimally invasive laser needle system. In order to ultimately apply to person without causing side effects, laser parameters should be established.

#### P1-023

##### 시스템 응답 함수 동시 획득을 통한 형광수명 측정의 정밀도 향상

남형수<sup>1</sup>, 이민우<sup>1</sup>, 김대식<sup>2</sup>, 김준영<sup>1</sup>,

강우재<sup>2</sup>, 김진원<sup>3</sup>, 오왕열<sup>2</sup>, 유흥기<sup>1</sup>

<sup>1</sup>한양대학교 생체공학과

<sup>2</sup>KAIST 기계공학과

<sup>3</sup>고려대학교 구로병원 심혈관센터

Fluorescence lifetime is the intrinsic property of a substance, which is insensitive to the fluorescence intensity. In order to measure fluorescence lifetime fast, fluorescence decay signal is directly measured to extract fluorescence lifetime of a sample. However, this method has been suffered from its sensitivity to the jitter noise of the pulsed laser source. Here, we proposed the method for enhancing the accuracy of measurements of fluorescence lifetime by acquiring an instrumental response function. It was validated by the simulation and it showed this method measures fluorescence lifetime with higher precision.

# POSTER I

P1-024

생체모사팬텀에서의 그래핀 옥사이드 삼광자 여기 형광을 이용한 이미징

전승원, 천수경, 박상민,  
강석희, 홍석원, 김창석  
부산대학교 인지메카트로닉스공학과

We obtain two and three-photon induced fluorescence image from graphene oxides (GOs) on the biomimetic phantom to compare both cases. GOs were synthesized from natural graphite with Hummer's method and a custom-built multi-photon microscopy (MPM) was used to obtain the two and three-photon induced fluorescence. The three-photon induced fluorescence from GOs has advantages of improvement of an imaging depth, reduction of a detrimentally photothermal effect, and elimination of an autofluorescence of sample. Our results suggest that the three-photon induced fluorescence from GOs can pave the way for a potential application and a novel approach to bioimaging.

P1-025

유도 라만 산란을 이용한 광음향 이미징용 고속 다 파장 광원 기술

조순우<sup>1</sup>, 박상민<sup>1,2</sup>, 강희성<sup>2</sup>, 이상원<sup>2</sup>, 김창석<sup>1</sup>  
<sup>1</sup> 부산대학교 인지메카트로닉스공학과  
<sup>2</sup> 한국표준과학기술연구원

In this paper, we suggest a multi-wavelength source for photoacoustic microscopy using stimulated Raman scattering (SRS) effect with a repetition rate of 300 kHz. In order to demonstrate the spectroscopic PA imaging with 300 kHz of acquisition rate, we optimized the effective length of fiber

and input pulse energy which generate the high order stokes wave sufficient for PA imaging. As a result, we performed the spectroscopic imaging with 300 kHz, which was implemented the GPU-accelerated processing. Three tubes filled with the blue, red and black ink were used as a sample.

P1-026

광유체 3D 프린팅 기술을 이용한 다채널 SPR 이미징 시스템

이재연<sup>1</sup>, 김병현<sup>1</sup>, 김기범<sup>2</sup>, 박욱<sup>2</sup>, 변경민<sup>1</sup>  
<sup>1</sup>경희대학교 생체의공학과  
<sup>2</sup>경희대학교 전자전파공학과

Surface plasmon resonance (SPR) biosensor has several advantages of label-free detection, real-time and quantitative monitoring for a variety of biomolecular reactions. Using the SPR imaging method, we can measure the biomolecular interactions in multi-channel in real-time. In this study, we fabricate a multi-channel SPR platform using 3D printing technology of optofluidic maskless lithography based on UV-light illumination. Using a well-array SPR imaging substrate, we measure the biomolecular interaction between biotin and streptavidin of various concentrations at the same time.

P1-027

대면적 MoS<sub>2</sub> 단층막을 이용한 은 소재 SPR 바이오 센서의 민감도 특성

최문식<sup>1</sup>, 김정민<sup>1</sup>, 백승현<sup>2</sup>, 최웅<sup>2</sup>, 변경민<sup>1</sup>  
<sup>1</sup>경희대학교 생체의공학과,  
<sup>2</sup>국민대학교 신소재공학과

A noble metal such as gold and silver has been used as a metallic film for realizing

a surface plasmon resonance (SPR) biosensor. Generally, silver with a narrow and deep resonance band shows a better signal quality better than gold. Nevertheless, gold, which is free from oxidation in air or water ambience, is more advantageous in a practical SPR biosensor. In this study, we propose MoS<sub>2</sub> monolayer on a silver film to prevent oxidation and to provide a higher sensitivity better than conventional SPR biosensor. We will show SPR sensitivity characteristics of the sensor through an immobilization test of immunoglobulin G and the obtained SPR angle shift is compared with the case of a bare silver and gold substrate.

#### P1-028

##### 피부에서의 최소 침습적 광 치료를 위한 레이저 프로브 제작

이상엽, 박지훈, 유성곤,  
장슬기, 하명진, 정병조  
연세대학교 의공학과

Light therapy is already known that it affect living cell through photobiomodulation effect. Especially, Light therapy for skin shows positive effect such as wound healing, collagen regeneration, reducing inflammation and etc. There are many studies to figure out optimal dosage of light therapy when using specific wavelength or energy. However, it is very difficult to confirm optimal dosage due to light scattering and absorption in skin tissue. In this study, we fabricated laser needle probe for minimally invasive light treatment to overcome these limitations.

#### P1-029

##### Quantitative analysis on diffusing applicators for cylindrical light transmission

V.G. Truong<sup>1</sup> and H.W. Kang<sup>1,2</sup>

<sup>1</sup>Department of Biomedical Engineering,  
Pukyong National University

<sup>2</sup>Center for Marine-Integrated  
Biomedical Technology,  
Pukyong National University

Optical diffusers have been developed to a uniform and isotropic light irradiation for medical applications, including photodynamic therapy (PDT) and photocoagulation. In this study, we designed a system to make cylindrical fiber and evaluated effect of several factors on the quality of cylindrical fiber. In addition to spatial emission from the diffuser was evaluated by goniometric measurements. The proposed diffusing fiber fabrication system may be a feasible model to optimize the quality emission of cylindrical fiber used in biomedical applications.

#### P1-030

##### Temperature measurement of bovine liver tissue during Laser Induced Interstitial Thermotherapy (LITT) using single FBG temperature sensor

Pham Thi Ngot<sup>1</sup>, Lee Seul Lee<sup>2</sup>,  
Jin Oh Park<sup>1</sup>, Yong Wook Lee<sup>2,3</sup>,  
Hyun Wook Kang<sup>1,3</sup>

<sup>1</sup>Department of Biomedical Engineering  
, Pukyong National University

<sup>2</sup> Department of Electric Engineering,  
Pukyong National University

<sup>3</sup> Center for Marine-Integrated Biomedical

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Technology, Pukyong National University

Laser-induced Interstitial Thermotherapy (LITT) or laser ablation is an emerging medical procedure for the targeted treatment of tumors. LITT generates a selective high-temperature field in the tissue; temperature values and their persistence are directly related to the mortality rate of tumor cells. Thus, the LITT procedure temperature can be monitored during thermotherapy by using sensors operating at the point of treatment. In this study a FBG temperature sensor was used to monitor the temporal response of interstitial temperature during LITT on bovine liver ex vivo. Experimentally, variations in  $\lambda_B$  shift were evaluated as a function of  $\Delta T$  as well as irreversible tissue denaturation.

## P1-031

포도주색 모반 레이저 치료를 위한 이중층 피부 모사 팬텀 제작

김혜진,<sup>1</sup> 김한나,<sup>1</sup> 뉴엔반쪽,<sup>1</sup> 강현욱<sup>1,2,3</sup>

<sup>1</sup>부경대학교 의생명기계전기융합공학 협동과정

<sup>2</sup>부경대학교 의공학과

<sup>3</sup>해양융복합 바이오메디컬 기술센터

Double-layered polydimethylsiloxane (PDMS)-based skin phantoms were used to fabricate human skin tissue with blood vessels to emulate a vascular disease, Port Wine Stain (PWS). The PDMS-based phantoms denoted similar optical properties ( $L \cdot a \cdot b$ ) to those of human epidermis and dermis. Artificial blood vessels were embedded into the PDMS skin phantom at various depths. The proposed double-layered phantoms can be a useful method for development of cost-effective and reliable laser treatment for skin disease related to capillaries.

## P1-032

해양유래 물질을 이용한 피부 모사 팬텀 제조

김한나<sup>1</sup>, 김혜진<sup>1</sup>, 강현욱<sup>1,2,3</sup>

<sup>1</sup>부경대학교 의생명기계전기융합공학과,

<sup>2</sup>부경대학교 의공학과, <sup>3</sup>해양MIBT 융복합센터

Artificial skin patch phantom research is an active field in tissue engineering and has encouraging prospects for clinicians to restore various skin defects. In this study, artificial skin patch phantoms were fabricated by using a 3D printing technique to emulate various skin types for wound healing. Marine materials were applied to epidermal and drug delivery layers due to their nontoxic and biocompatibility. Alginate and fucoidan were selected for functional base materials. Both squid and oyster shell powders represented optical properties of skin types. Double-integrating spheres in conjunction with an adding-doubling method confirmed the optical similarities of the fabricated phantoms to human tissue.

## P1-033

광열치료를 위한 온도 피드백의 응용

박진오<sup>1</sup>, 강현욱<sup>1,2</sup>

<sup>1</sup>부경대학교 의공학과

<sup>2</sup>부경대학교 해양MIBT 융복합 센터

Laser therapy uses high-intensity light to treat illnesses in terms of thermal energy. Diffusing fibers were designed and evaluated to treat tubular tissue. The recent studies presented the development of optical diffusers to circumferentially transmit laser light and to uniformly irradiate tubular tissue structure for thermal treatment. The current research demonstrates the quantification of coagulation depth per unit time

under the constant laser power. To prepare the diffusing fibers, 400- $\mu\text{m}$  multimode optical fibers were used and micro-machined by  $\text{CO}_2$  laser. Thermal imaging validated that the temperature during the irradiation increased up to 70 °C, which was close to the temperature for irreversible tissue denaturation.

#### P1-034

##### 이광자 현미경 및 니들타입 공초점 측면내시현미경을 이용한 in-vivo 피부조직 세포수준 영상화

안진효, 최기백, 송은주, 황윤하,  
서호원, 박인원, 김필한  
KAIST 나노과학기술대학원

By using a custom-built laser-scanning two-photon microscopy, we established an in-vivo repetitive and longitudinal cellular-level visualizing technique for the skin in small animal model. In addition, the penetration of fluorescently labeled material into the collagen layer of the porcine skin was visualized by utilizing second harmonic generation. To investigate the deeper skin structures in a minimally invasive manner, we fabricated a needle-type confocal side-view endomicroscope based on miniature graded-index (GRIN) lenses packaged into a 22G needle.

#### P1-035

##### 5-ALA를 이용한 뇌수술용 종양 관측 시스템 개발

김홍래<sup>1</sup>, 이현민<sup>1</sup>, 유현<sup>2</sup>, 이승훈<sup>2</sup>, 김광기<sup>1</sup>

<sup>1</sup>국립암센터 정밀의학연구부 의공학연구과

<sup>2</sup>국립암센터 이형성 임상 제2연구부 특수암연구과

Glioma is the most primary brain tumor.

Glioma makes complete resection difficult, as tumor margins are unclear. So, fluorescence-guided surgery is a rapidly growing. In this study, we propose a detection system capable of detecting 5-Amino-levulinic Acid(5-ALA) fluorescent dye. We were carried out animal experiments. We were iv injection into nude mice [7.5mg(5-ALA)/150 $\mu\text{l}$ (pbs)]. We were investigate light(410nm, LED) and detect fluorescence image(628nm, bandwidth : 32nm). Filter and LED light source is integrated into a single system of surgical micro scope. By using developed detection system, more efficient surgical operations can be achieved. We expect that the developed system can increase the survival rate of patients.

#### P1-036

##### 수술현미경에서 다중형광영상을 이용한 뇌종양과 혈관영상 검출 시스템 연구

이현민<sup>1</sup>, 김홍래<sup>1</sup>, 윤웅배<sup>1</sup>, 김광기<sup>1</sup>

<sup>1</sup>국립암센터 융합기술연구부 의공학연구과

In this paper, we propose a fluorescence imaging detection system for detecting both a brain tumor and blood vessels in tumor surgery as fluorescence images by using multiple light sources and optical components. The proposed method displays fluorescent images of the tumor and blood vessels on the same display device and also provides accurate information about them to the operator. To acquire a fluorescence image, we utilized 5-ALA (5-aminolevulinic acid) for the tumor and ICG (Indocyanine green) for blood vessels, and we used a beam-splitter module combined with a microscope for simultaneous detection of both.



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P1-037

상용 분광기를 기반으로 한 깊은 조직에서의 혈류 및 혈액 산소포화도 동시 측정에 대한 선행 실험

성명수<sup>1</sup>, Phuong Minh Mai<sup>2</sup>, 이기준<sup>3</sup>, 김재관<sup>1</sup>  
GIST 의생명공학과<sup>1</sup>, 전기전자컴퓨터공학부<sup>2</sup>,  
DGIST 융복합대학기초학부<sup>3</sup>

We performed preliminary test on simultaneous measurement of deep tissue blood flow and oxygenation by employing two laser diodes and an off-the-shelf spectrometer. Two long coherence length laser diodes (785 nm and 852 nm) are coupled to a bifurcated fiber and irradiated to either a blood flow mimicking phantom or the back of a subject's hand and semi-reflected light was collected by a fiber coupled spectrometer. The results show the possibility of simultaneous blood flow and oxygenation measurements in vivo with the simple system configuration. A further optimization of system will enable us to acquire metabolic information from deep tissue in vivo.

P1-038

펄스 레이저를 이용한 신경세포의 활성 메커니즘과 응용

이승희<sup>1</sup>, 윤종희<sup>2</sup>, 최명환<sup>3</sup>, 최철희<sup>1</sup>  
<sup>1</sup>KAIST 바이오및뇌공학과, <sup>2</sup>물리학과  
<sup>3</sup>성균관대학교 글로벌바이오메디컬엔지니어링학과

Femtosecond laser stimulation can generate localized reactive oxygen species (ROS) in neurons which can induce neuronal activation. We found that calcium elevation at the single cell level was blocked after superoxide depletion, while calcium propagation at the network level was blocked by extracellular calcium. Such calcium eleva-

tion, propagation pattern and cell death due to laser stimulation were different when the neurons were treated with A $\beta$ , a protein accumulated in brains with Alzheimer's disease. Our results indicate that femtosecond laser stimulation may distinguish drug treated abnormal neurons and healthy neuron through investigation on laser-induced responses, which may be further applied for drug screening at clinical study.

P1-039

NIRS 기반 혈액 속 ICG 흡광 계수 및 농도 변화량 측정

최종만<sup>1</sup>, 김세훈<sup>1</sup>, 옥철호<sup>2,3</sup>, 김성원<sup>4</sup>, 안예찬<sup>1,2</sup>  
<sup>1</sup>부경대학교 의공학과,  
<sup>2</sup>고신대학교 혁신의학기술 연구센터,  
<sup>3</sup>고신대학교 의과대학 내과,  
<sup>4</sup>고신대학교 의과대학 이비인후과-두경부외과

Near-infrared spectroscopy(NIRS) can optically detect concentrations of target material in living bodies. The near-infrared region has the advantage of photon penetration. NIRS is non-invasive method and real-time measurements also it has portability. The system is based on beer-lambert's law that provides interaction formula of optical density and concentration of target material. The purpose of this experiment is detecting Indocyanine green(ICG) concentration change non-invasively and searching for difference between tumor and control model. Because ICG remain longer in tumor tissue than normal tissue, there will be a difference of concentration change between two models.

## P1-040

## 백색광 정량 위상 현미경

백윤석, 이겨레, 박용근  
KAIST 물리학과

We introduce white-light quantitative phase imaging unit (WQPIU) that enables practical use of quantitative phase imaging with bright field microscopes. The WQPIU measures sample phases under white light illumination. It is a compact stand-alone unit based on lateral shearing interferometry and phase shifting interferometry. The performance of the WQPIU is shown by measuring quantitative phase images of polystyrene beads, human red blood cells, HeLa cells and mouse white blood cells.

## P1-041

## 디지털 미소거울 장치를 이용한 3차원 홀로그래피 현미경

신승우, 김규현, 박용근  
KAIST 물리학과

We developed fast and stable 3-D holographic microscopy using a digital micromirror device (DMD). To generate a plane wave with a desired illumination angle, a binary amplitude hologram is displayed on a DMD. A complex optical field diffracted by a sample is measured via Mach-Zehnder interferometry. From the measured complex optical fields with various illumination angles, a 3D refractive index tomogram of the sample is reconstructed via optical diffraction tomography. The technique is demonstrated by imaging biological samples and 3-D Brownian motion of colloidal particles at the frame rate of 100 Hz.

## P1-042

## 테라헤르츠 의광학 응용 영상

지영빈, 오승재, 서진석  
연세대학교 의과대학부설  
연의-생공연 메디컬 융합연구소

Terahertz (THz) electromagnetic waves are highly sensitive to biomolecules and water; they have been applied to many biomedical applications including diagnosing various types of cancer and disease. Here we introduce THz biomedical optical imaging applications. The imaging method could detect early gastric cancers and has potentials for diagnosing otitis media.

## P1-043

## CT 및 OCT 를 사용한 천식 연구방법 및 토끼 호흡기법 개발

김이근<sup>1</sup>, 채유경<sup>2</sup>, 김재훈<sup>3</sup>,  
김성원<sup>4</sup>, 옥철호<sup>3</sup>, 안예찬<sup>1,2</sup>  
<sup>1</sup>부경대학교 바이오메디컬공학과,  
<sup>2</sup>부경대학교 의생명융합공학과,  
<sup>3</sup>고신대학교 의과대학 내과,  
<sup>4</sup>고신대학교 의과대학 이비인후과-두경부외과

Asthma is not still reported the agents thus this study is suggested new access processor in rabbit model. Spectral domain optical coherence tomography (SDOCT) and multi-detector computed tomography (MDCT) provides pulmonary cross-sectional images. Also advantages of ventilator (TOPO, Kent Scientific Corporation) are continuous scanning of extended volumes within a breath-hold period at rabbit model. Frist of all, breath of prepared about methacholine induced airway remodeling model rabbits change from normal breath-

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ing as peak pressure 17cmH<sub>2</sub>O to inhaled breath as peak pressure 28 cmH<sub>2</sub>O then respiration rate switch 15 to 0 BPM. Acquire images of lung, alveolus and ex-vivo alveolus using MDCT and SDOCT. Due to the SDOCT image of high resolution could be analyzed between experimental groups and control groups.

## P1-044

### 근적외선 자가형광 기반 부갑상선 실시간 이미징

정홍구<sup>1</sup>, 최종만<sup>1</sup>, 김성원<sup>2,3</sup>, 박은기<sup>2,3</sup>, 안예찬<sup>1,2</sup>

<sup>1</sup>부경대학교 의공학과,

<sup>2</sup>동남권 의공학 임상혁신 융합연구단,

<sup>3</sup>고신대학교 의대

Human being usually has four parathyroid glands. In the case that patients have thyroid cancer, they commonly have thyroidectomy and central compartment neck dissection, CCND. It is important for surgeons to detect and preserve normal parathyroid glands because parathyroid glands secrete hormone to maintain calcium homeostasis. It is, however, hard for unexperienced surgeons to distinguish the parathyroid glands from surrounding tissues such as fat or connective tissues. It is not easy for fully experienced surgeons as well. In this study, we present intraoperative autofluorescence imaging system to detect parathyroid glands using simple and cheap cameras.

## P1-045

### 체렌코프 광섬유 방사선 센서를 이용한 고선량을 근접치료용 방사선원의 상대깊이선량 측정

신상훈<sup>1</sup>, 송영범<sup>2</sup>, 김민건<sup>2</sup>, 김혜진<sup>2</sup>,

이동은<sup>1</sup>, 장경원<sup>1</sup>, 유욱재<sup>1</sup>, 박정훈<sup>3</sup>, 이봉수<sup>2</sup>

<sup>1</sup>건국대학교 의료생명대학 의학공학부

의공학 실용기술 연구소

<sup>2</sup>중앙대학교 공과대학 에너지시스템공학부

<sup>3</sup>국립암센터 양성자치료센터

In this study, we fabricated a Cerenkov fiber-optic radiation sensor (CFORS) without any scintillator to measure Cerenkov radiation signals owing to gamma-rays. The relative depth dose (RDD) values of Ir-192 HDR brachytherapy source were obtained by using the CFORS based on a subtraction method and the RDD curve was compared with the simulation result of Monte Carlo N-particle extended transport code (MCNPX). In conclusion, we demonstrated that the CFORS can be used to measure real-time dose information for HDR brachytherapy.

## P1-046

### 광선조사기의 의료기기 허가·심사를 위한 평가기술 개발 연구

이승열, 주초롱, 이태희, 이창형, 박창원

식품의약품안전처 식품의약품안전평가원

의료제품연구부 의료기기연구과

This study is intended to provide guidelines to evaluate the safety and performance of the high powered light irradiator and the low powered light irradiator whose demands have increased for skin treatment. The safety and performance tests of them are essential, since they are directly used on the skin by many people. To develop the guidelines, technical information of the light irradiator medical devices was collected, applicable internal standards and the established test items for guidelines were surveyed and analyzed, and necessary items



for evaluating the safety and performance were derived.

## P1-047

### 공초점 현미경을 이용한 대면적 가상 조직검사

강주형<sup>1</sup>, 김홍래<sup>2</sup>, 송인천<sup>3</sup>, 남형수<sup>1</sup>,  
김현진<sup>2</sup>, 이선혜<sup>2</sup>, 원영재<sup>4</sup>, 김광기<sup>2</sup>,  
최용두<sup>2</sup>, 손대경<sup>2</sup>, 장희진<sup>2</sup>, 유흥기<sup>1</sup>

<sup>1</sup>한양대학교 생체공학과

<sup>2</sup>국립암센터

<sup>3</sup>나노스코프시스템즈(주)

<sup>4</sup>오송첨단의료산업진흥재단

Due to optical sectioning capability of confocal microscopy, virtual histology can be acquired from a fresh tissue. Multichannel confocal fluorescent images were converted using predefined color codes to resemble Hematoxylin and Eosin staining for frozen sections. Since, the single field-of-view of the confocal microscope is limited, mosaicking technique was used to generate large virtual histology section for visualizing the whole tissue at a glance. This virtual histology technique will allow physicians to examine potentially malignant lesions much quickly than the conventional H&E staining and to decide treatment plan within the surgical room.

## P1-048

### 산란물질에서의 광 확산 분석을 위한 몬테 카를로 시뮬레이션용 사용자 인터페이스 개발

정근호<sup>1)</sup>, 김재관<sup>1)</sup>

<sup>1)</sup>광주과학기술원 의생명공학과

Monte Carlo simulation is a popular method for modeling an optical propagation in a scattering medium such as human body.

There are a few Monte Carlo simulation software available online. However, it is not simple and easy to run Monte Carlo simulation for the purpose of each user's applications. One of them requires to run on Linux operating system and another one needs a Matlab to run the simulation. In addition, a user need to set all the parameters including number of layers, geometry of light source and detector, which can be a barrier for many researchers to use. Therefore, in this study, we developed a user-friendly interface to simulate light diffusion in a scattering medium with options to choose number of layers, type of light propagation, number of light source, and so on.

## P1-049

### 혈류순환장치의 성능평가를 위한 모의순환시스템 개발

김동선\*, 강성민\*, 최성욱\*\*

\*강원대학교 융합시스템공학과

\*\*강원대학교 기계의용공학과

A conventional Mock circulatory system for the test of a ventricular assist device (VAD) is difficult to simulate patient's aortic blood pressure. Because expensive and inaccurate ultrasound flowmeter should be used to measure blood flow, a new device have to be developed to be equipped with more economic and accurate sensors that can measure pressure and blood flowmeter simultaneously. IR sensor can measure the height of water pillar in the closed chamber of Mock system and reduce the error of volume within 5%. The measured water height was used to obtain the stroke volume of a VAD immediately. The pressure sensor of the new Mock system was con-

# POSTER I

trolled to simulate aortic blood pressure by adjusting its resistance and compliance of water path with an air solenoid valve and a peripheral valve. A series of in-vitro experiment showed that the new Mock system can contribute the development and estimation of VADs and other blood pumps.

P1-050

CPR 보조장치의 정확도 측정을 위한 디지털 신호 처리

유원상\* · 강성민\*\* · 최성욱†  
\*강원대학교 기계융합공학과,  
\*\*강원대학교 융합시스템공학과,  
\*\*\*강원대학교 기계의공학과의

During the emergency situation such as cardiac arrest, cardiopulmonary resuscitation (CPR) is the most important treatment to maintain patient's blood circulation. Because the quality and effectiveness of CPR cannot be measured or estimated easily, new specialized device containing accelerometer can be useful for the decision of pressing depth and frequency. In this study, new wearable ring type device was used to find the pressing depth and frequency when its user did CPR. The device could measure the user's wrist movement with 3D accelerometer at 50 /sec, sampling rate. For the long lifespan of battery, the sampling rate can not be adjusted to higher and its low sampling rate induced severe error in the conversion process to find pressing depth. In this study, more efficient signal processing algorithm was suggested to reduce the error of the accelerometer by obtaining only one frequency element among Fourier transform Process. The new algorithm was compared with the conventional conversion

process and moving average filter when the wearable device's was set to the automatic CPR machine that can be controlled its pressing rate and depth.

P1-051

최소침습수술용 고곡률 concentric tube 로봇 연구 및 응용

김종우, 조규진  
서울대학교 기계항공공학부

Minimally invasive surgery proceeds with minimized incisions through which tube-like medical devices as endoscope are inserted. It lessens wound healing time, associated pain, and risk of infection. As the surgery is operated under limited space and conditions, the robot needs to have enough dexterity to pass through tortuous passages of inner body system like intravascular ways. To reach cornered area of tissue under such restricted conditions, the tube needs to be small thickness with high curvature and to be stable during operation. In this paper, we suggests a novel mechanism and design to expand the scope of minimally invasive surgery.

P1-052

입자를 이용하는 관상동맥 조영제 거동 시뮬레이션을 위한 가상입자 생성방법

이현석, 이두용  
KAIST 기계공학과

This paper proposes a method of ghost particle generation for contrast medium behavior simulation. Domain filtering algorithm which defines the area where the

ghost particle will be generated is developed. The ghost particle is generated in the filtered domain by using poisson disk sampling method. The simulation result shows that the ghost particle is generated only near the contrast medium particle in real time.

### P1-053

#### 3D 프린터를 이용한 생체구조물 제작

최광진, 김정훈, 김성준  
서울대학교 전기·정보공학부

Recently, there have been many attempts to use biocompatible and biodegradable polymers as 3D printer materials. Also, these attempts have raised an application of a 3D printing technology into bioengineering areas. In this poster presentation, a model of human mandibula is printed using a commercial 3D printer (Q3D Printer, QUBD One up, Arkansas, US) with the purpose of medical visualization.

### P1-054

#### 악교정수술용 보조로봇을 위한 정합방법과 로봇동작 연구

우상윤<sup>1</sup>, 이상정<sup>2</sup>, 이우진<sup>2</sup>,  
강세룡<sup>1</sup>, 유지용<sup>1</sup>, 이원진<sup>3</sup>

<sup>1</sup>서울대학교 융합과학기술대학원 방사선융합의생명전공

<sup>2</sup>서울대학교 의과대학 협동과정 방사선응용생명과학

<sup>3</sup>서울대학교 치의학대학원 영상치 의학교실

The aim of this paper was to study registration method and robot movement for a robot-assisted orthognathic surgery system. Registration procedure was performed in coordinates among a robot, an optical tracking system and CT image. According

to surgical plan in CT image coordinate, robot arm moved to corresponding robot position. Eight tooth landmarks on the maxillary model were selected and root mean square error (RMSE) of the landmarks was measured by our image-guided navigation system. RMSE between planned position and measured position was 0.29mm which was acceptable for clinical tolerance (2mm).

### P1-055

#### 신경근육질환 환자에서 보행보조로봇의 적용이 보행 중 대사에너지소모량에 미치는 영향

황선희, 홍영빈, 이항재, 김연희, 최병욱  
삼성서울병원 신경과,  
삼성서울병원 재활의학과,  
성균관대학교 의과대학

Neuromuscular disease often causes gait disturbance. The Charcot-Marie-Tooth(CMT) disease results in distal muscle weakness and atrophy, which demands gait-assistive devices. The hip assist robot recognizes the gait cycles and generates torque to assist hip flexion and extension. Four CMT patients walked on treadmill for 6 minutes with and without the hip assist robot. The averaged net metabolic energy costs of the last three minutes were compared. The results showed the reduction in metabolic energy cost in walking with the hip assist robot. The hip assist robot can provide the energy effective ambulation in neuromuscular disease patients.

# POSTER I

P1-056

Exo-Glove Poly의 착용성 사용성 평가

강병현, 이해민, 조규진  
서울대학교 기계공학과

Exo-Glove Poly is tendon-driven wearable robotic hand based on polymer. Exo-Glove Poly is developed to assist lost hand function for spinal cord injury patients or stroke patients. In order to increase wearability, usability test has been performed with two spinal cord injury patients with two different default hand postures. Wearing time has been measured with four different design of Exo-Glove Poly. Based on the results, final Exo-Glove Poly design has been decided to increase wearability.

P1-057

전방 시각 정보 제공을 위한 멀티센서 기반 스마트 안경

김정훈<sup>1</sup>, 박지은<sup>2</sup>, 박유진<sup>2</sup>,  
안도현<sup>2</sup>, 조진호<sup>1</sup>, 이종민<sup>2,3</sup>  
경북대학교 대학원 전자과<sup>1</sup>,  
경북대학교 대학원 의공학공학과<sup>2</sup>,  
경북대학교 의학전문대학원 영상의학교실<sup>3</sup>

In this study, development of a smart glasses was based Multi sensor. Using the multi-sensor to identify the position of the object in three-dimensional space was system for reconstructing image. The ultrasonic sensor is composed of upper, middle, below on the front and measuring distance. Motion sensor using the current coordinates is composed the three-dimensional image. It can be applied to the visually impaired using the development system.

P1-058

기압 압력 센서를 사용한 손가락 터치-힘 측정 연구

차주영, 오성호, 정지욱  
한국기계연구원 대구융합기술연구센터 의료기계연구실

Finger touch sensors were fabricated for force measurements using off-the-shelf barometric pressure sensing modules. Silicone layer with various thickness and rigidity was added to cover the top of the sensing modules. After deciding on the adequate silicone volume and softness we performed a simple experiment, where the measurements were shown to be sensitive to the fingers pressing lightly on a solid surface.

P1-059

혈류순환장치의 성능평가를 위한 모의순환시스템 개발

김동선\*, 강성민\*, 최성욱\*\*  
\*강원대학교 융합시스템공학과  
\*\*강원대학교 기계의용공학과

A conventional Mock circulatory system for the test of a ventricular assist device (VAD) is difficult to simulate patient's aortic blood pressure. Because expensive and inaccurate ultrasound flowmeter should be used to measure blood flow, a new device have to be developed to be equipped with more economic and accurate sensors that can measure pressure and blood flow-meter simultaneously. IR sensor can measure the height of water pillar in the closed chamber of Mock system and reduce the error of volume within 5%. The measured water height was used to obtain the stroke volume of a VAD immediately. The pressure sensor of the new Mock system was controlled to simulate aortic blood pressure

by adjusting its resistance and compliance of water path with an air solenoid valve and a peripheral valve. A series of in-vitro experiment showed that the new Mock system can contribute the development and estimation of VADs and other blood pumps.

### P1-060

#### 맞춤형 전자청진기를 이용한 심음 측정장치 개발

서효창<sup>1</sup>, 권정훈<sup>1</sup>, 유태균<sup>1</sup>, 주세경<sup>1,2</sup>

<sup>1</sup>울산대학교 의과대학 의공학교실,

<sup>2</sup>서울아산병원 의공학과

Even now, stethoscope is widely used in medical field. Sound from our organs are a good marker for diagnosing patient status. After the development of electro-stethoscope, physicians can record the sound and analyze the sound from heart, lung, and so on. In this paper, we developed a system for recording heart sound from esophageal stethoscope, which can automatically detect S1-sound and S2-sound. The detection performance was compared with commercial recording tool and showed very high accuracy ( $r^2=0.9$ ).

### P1-061

#### 주기성 사지 운동증 환자와 정상인의 수면 시 주기성 사지 운동 구간의 심박 변이율 변화

권현빈<sup>1</sup>, 최재원<sup>2</sup>, 이유진<sup>2</sup>, 정도연<sup>2</sup>, 박광석<sup>3</sup>

<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링 전공

<sup>2</sup>서울대학교병원 수면의학센터

<sup>3</sup>서울대학교 의과대학 의공학교실

Previous studies have demonstrated the presence of associations between au-

tonomic nerve system and periodic limb movement (PLM) during sleep. This study investigated physiological comparison between PLMs during normal sleep and PLM disorder sleep. In this study, autonomic activity was quantified by heart rate variability parameters and significant difference between patients and controls was validated with analysis of variance.

### P1-062

#### 대동맥 반사파를 재현한 Windkessel 모델

최성욱

강원대학교 기계의용공학전공

Windkessel model is useful method to describe the relationship between cardiac output and blood pressure. It has been also used to validate cardiac output estimation with blood pressure. However, because blood pressure is not only dependent blood pressure but also peripheral resistance which can be changed in wide range according to stress, exercise and other hemo-dynamic events, cardiac output estimation methods using BP have applied additional analyzing algorithm for BP waveform to find cardiac output without the measurement of SVR. In the case of previous Windkessel model, it could not generate realistic blood pressure waveform that contains various inflection caused by the wave reflections. In this study, we developed newly reformed Windkessel models that can simulate various wave reflection. And we made various BP-CO data using the new model to validate the accuracy of two cardiac output estimation algorithms.



# POSTER I

P1-063

선형판별분석을 이용한 수면 단계 분류

최상호<sup>1</sup>, 윤희남<sup>1</sup>, 주광민<sup>1</sup>,  
정다운<sup>1</sup>, 권현빈<sup>1</sup>, 박광석<sup>2</sup>

<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링 전공

<sup>2</sup>서울대학교 의과대학 의공학교실

Polysomnography (PSG) is considered the gold standard to assess sleep, however it is expensive, time-consuming and uncomfortable to subjects because a lot of sensors are attached to the body. This study developed automatic sleep stage classification models based on linear discriminant analysis (LDA) method. Twenty subjects' PSG data were used to develop sleep stage estimation models and five subjects' data were used to test the model. To develop the model, we extracted parameters from electrocardiography and acceleration signal. From extracted parameters, we selected parameters which showed the highest performance result. In epoch-by-epoch REM sleep, Wake, and DEEP sleep detection, Cohen's kappa value were 0.58, 0.41, and 0.37, respectively. Accuracy were 87.9, 87.1, and 77.8, respectively. Cohen's kappa and accuracy to detect four sleep stages were 0.43, 62.4.

P1-064

부정맥 치료용 고주파 카테터 설계 및 제작 연구

진소연<sup>1,2</sup>, 황창모<sup>1,2\*</sup>, 김영학<sup>1,2</sup>,  
남기병<sup>1,2</sup>, 최재순<sup>1,2</sup>, 정기석<sup>2</sup>  
울산대학교 의과대학<sup>1</sup>  
서울아산병원<sup>2</sup>

Radiofrequency(RF) ablation is one of treatment of many symptomatic cardiac arrhythmias. The mechanism of RF ablation

is heated directly to the tissue lesion using high radiofrequency from the electrode. The lesion size by ablation is influenced by many factors such as temperature at electrode-tissue interface, power delivery from the generator, size of the electrodes, irrigation system and etc. Therefore, technical improvement of catheter ablation is required to have better outcomes who underwent cardiac intervention. In this study, we designed and irrigated tip electrode and cardiac tissue ablation efficacy was evaluated.

P1-065

원심형 혈액 펌프 구동 효율 향상을 위한 자기결합 회로 시뮬레이션 분석

신희안<sup>1</sup>, 박지흠<sup>1</sup>, 김희찬<sup>2,3</sup>

<sup>1</sup>서울대학교 대학원 협동과정 바이오엔지니어링전공

<sup>2</sup>서울대학교 의학연구원 의용생체공학연구소

<sup>3</sup>서울대학교 의과대학 의공학교실

Extracorporeal membrane oxygenation (ECMO) system based on a centrifugal pump is being widely used to support critically ill patients with heart or lung failure by assisting blood circulation as well as blood oxygenation. Magnetic coupling involved in the operation of the centrifugal pump needs to be optimized as it determines not only the efficiency of pump driving but also the blood damage level. However, previous studies were limited to focusing on the effect of the magnet's field strength only, even though the material and structure of the substrate where magnets are placed are also important factors in optimizing the magnetic coupling circuit. In this study, we evaluated the resultant air gap magnetic flux produced by different materials of the substrate and

structural arrangements of the magnets on the substrate using FEMM4.2 simulator. Our simulation results suggest that the configuration of magnets with low magnetic permeability material on their sides while high permeability material on their bottom produced the most effective magnetic flux in the air gap.

#### P1-066

##### 1차원 딥 컨볼루션 네트워크를 이용한 심전도기반 생체인증

유승민<sup>1</sup>, 김태현<sup>1</sup>, 이종실<sup>1</sup>, 김인영<sup>1</sup>  
<sup>1</sup>한양대학교 의공학교실

This paper presents a novel electrocardiogram (ECG) based biometric approach by using the 1-dimensional Convolutional Neural Networks (CNNs). A subject-specific authentication algorithm was implemented by constructing 1-D CNNs which are able to classify genuine and imposter class for each subject's ECG. This study used ECG data recorded from 20 healthy subjects (Male: 16, Female 4). Proposed algorithm achieved 98.8% as classification accuracy, 91.0% as sensitivity and 99.1% as specificity on average.

#### P1-067

##### 다양한 상황에 따른 심전도 신호를 이용한 개인 인증

이은혜, 홍성준, 이종실, 김인영  
 한양대학교 의공학교실

Electrocardiography (ECG) has been recently proposed as biometric trait. Intra-individual variations of ECG might affect authentication performance. These variations are mainly due to Heart Rate Variability

(HRV). This paper proposes a novel biometric authentication method based on ECG that measured in a variety of situations. The proposed method achieved an authentication accuracy of 95.6% for 7 subjects.

#### P1-068

##### 심음 기반 상시 심장상태 감시 기술 개발

안지민<sup>1</sup>, 안현준<sup>1</sup>, 김주영<sup>1</sup>, 남경원<sup>1</sup>, 김인영<sup>1</sup>  
 한양대학교 생체공학과

Although regular daily life is possible for patients with the risk of cardiac arrest, a heart monitoring system is necessary. Noise reduction in the monitoring system is needed for both internal noises such as respiratory sounds and lung sounds and also for environmental noises such as speaking and eating. In this paper, we propose both a filtering method to suppress these noises and also the parameters for a heart rate extraction algorithm to monitor heart rate.

#### P1-069

##### 두 사람의 수면에서 나타나는 심박동의 상호작용

윤희남<sup>1</sup>, 김상경<sup>1</sup>, 이원규<sup>1</sup>, 정다운<sup>1</sup>,  
 최재원<sup>2</sup>, 이유진<sup>2</sup>, 정도연<sup>2</sup>, 박광석<sup>3</sup>  
<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링 전공  
<sup>2</sup>서울대학교병원 수면의학센터  
<sup>3</sup>서울대학교 의과대학 의공학교실

In this research, we analyzed inter-cardiac interaction in couples during sleep. Couple's electrocardiogram (ECG) were recorded using a patch-type device simultaneously when they slept together in same bed and separately. Cardiac interaction was

# POSTER I

accessed with cross correlation method for averaged heart rate. As a result, significant cardiac interaction was shown when couple slept together ( $p < 0.05$ ). Interaction of physiological signals recorded from different subjects has not been studied in previous researches. Our result implies that physiological rhythm can be changed by external stimuli. Further, the interaction may influence on cardiovascular system and sleep structure.

## P1-070

자동회귀 모델과 시간 가변성 파워 스펙트럼 밀도를 이용한 심전도 기반 사용자 인증 알고리즘

김한빛, 전세영  
UNIST 전기전자컴퓨터공학부

Electrocardiogram (ECG) have been investigated as potential biometrics for user authentication by many research groups. Feature extraction is critical to yield good performance for ECG based user authentication and many methods have been proposed. In this paper, we propose a method of feature extraction using time-varying power spectral density (PSD) and auto-regressive (AR) model. We also investigated the impact of AR model order on the performance of user authentication. Our proposed method yielded 4.3% EER (equal error rate) and 99.13% AUC (area under curve) with public ECG-ID database when using the 4<sup>th</sup> order AR model.

## P1-071

돼지 동물모델에서의 단순 혈관문합 장치 개발

김준식<sup>1</sup>, 유래형<sup>1</sup>, 전경수<sup>1</sup>, 김상동<sup>1</sup>, 김단비<sup>1</sup>,  
민한솔<sup>1</sup>, 김민우<sup>2</sup>, 윤장규<sup>2</sup>, 변강일<sup>2</sup>, 손정우<sup>3</sup>,  
주희진<sup>3</sup>, 오성석<sup>3</sup>, 손대구<sup>4</sup>, 안상현<sup>1</sup>, 김충용<sup>1</sup>  
<sup>1</sup>대구경북첨단의료산업진흥재단 실험동물센터  
<sup>2</sup>덴티스

<sup>3</sup>대구경북첨단의료산업진흥재단 의료기기개발지원센터  
<sup>4</sup>계명대 동산의료원

This project was funded by grants from the technological innovation project, the Small and Medium Business Administration (SMBA) of Korea. Dentis Co., Ltd and Keimyung University Dongsan Medical Center have designed a prototype of an anastomotic ring device. We applied prototype devices manufactured in several different design in pig model that contain similar size of jugular vein compared to humans. To provide the efficient and reliable end-to-end vessels anastomosis, the device system that can be used for jugular veins was designed, fabricated and evaluated. We were assessed with biocompatibility, anastomotic leakage and functional outcome: angiographic imaging system, graft patency, foreign body reaction, clinical observation and histological analysis at Daegu-Gyeongbuk Medical Innovation Foundation-Laboratory Animal Center (DGMIF-LAC).

## P1-072

단일 세포 내 정량적 유전자 주입을 통한 비바이러스성 형질전환

권효성, 박향수, 유제원, 홍성희, 최연호  
고려대학교 보건과학대학 바이오융합공학과  
고려대학교 보건과학대학 의생명융합학과

Transfection is a widely used analytical tool



allowing study of the function of genes and control gene expression. However, in spite of its usefulness, conventional transfection methods have difficulty to control gene expression levels or the quantity of delivered materials in single cell unit. Here, we present a controlled transfection strategy using quantitative injection into a single cell. Using a single cell injection system, we quantitatively delivered DNA into a single cell at a desired location and time. Then through this method, we obtained optimal gene delivery and expression conditions based on the amount of the delivered DNA and the transfection efficacy.

Our study demonstrates that spatio-temporally controlled transfection by quantitative transfection is a useful technique for regulating gene expression in a single cell which suggests that this technique may be used for cell biological researches including the creation of induced pluripotent stem

trapping for determination of invasiveness in a suspended state. The results show that the invasiveness of between suspended cells can be discriminated without any notable damages, thus suggesting its potential as a novel tool for determination of invasiveness of a suspended cancer cell.

#### P1-074

##### 스마트폰을 이용한 응급실 내 실시간 소아 키 추정

이지수<sup>1</sup>, 김희찬<sup>2</sup>, 김규석<sup>3</sup>, 정재윤<sup>3</sup>, 이정찬<sup>2</sup>

<sup>1</sup>서울대학교 대학원 협동과정 바이오엔지니어링전공

<sup>2</sup>서울대학교 의학연구원 의용생체공학연구소,  
서울대학교 의과대학 의공학교실

<sup>3</sup>서울대학교 의과대학 응급의학교실 및  
분당서울대학교병원 응급의학과

Calculation of optimal drug dosage is critical in providing proper treatment effects and preventing adverse reactions simultaneously. To compute the correct dosage for a child patient, physician must get the patient's weight and/or height exactly. However, especially in emergency room, it is hard to measure the weight or height of a child patient while conducting medical procedures. Herein we propose a simple method to estimate child patient's height using a smartphone. Homography, a technique of projective transformation, was implemented and a smartphone application was developed for convenient use. The average error rate was 3.45%, and the best photographing angle at which the algorithm showed 0.64% of average error rate was also found.

#### P1-073

##### 초음파 집계를 이용한 부유 세포의 포획과 칼슘이온 변화에 따른 암세포 전이성 판별

윤상연, 김지훈, 박진만, 최진우,  
장진호, 김희찬, 황재윤  
DGIST 정보통신융합전공

Recent study suggested that high frequency ultrasound microbeam stimulation can be applied to determine the invasiveness of a breast cancer cell by monitoring of calcium responses. However, the method was limited to be applied to determine the invasiveness of a cultured cell. In this paper, we demonstrate the potential of acoustic tweezers based on single beam acoustic

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P1-075

## Miniaturized Implantable Antenna for Wireless Communication

Y. Cho, and H. Yoo

Department of Biomedical Engineering,  
School of Electrical Engineering,  
University of Ulsan

For implantable medical applications, an implantable antenna is the important component for communicating with external equipment. Furthermore, the size of the antenna should be smaller due to the size restriction. In this research, miniaturized implantable antenna with dual-band operation are proposed. A meandered radiating patch and open-end slot placed on the ground plane are used for the miniaturization. The performance of the proposed antenna was checked from simulation and measurement which shows the good agreement.

P1-076

## Extraction of Retinal Blood Vessels Utilizing 2D Matched Filter

M. A. Al-antari<sup>1</sup>, M. A. Al-masni<sup>1</sup>,

H. M. Bu-Omer<sup>2</sup>, A. M. Anam<sup>2</sup>,

S. U. Park<sup>1</sup>, J. H. Park<sup>1</sup>, N. H. Solouma<sup>2</sup>,

S. M. Han<sup>1</sup>, and T.-S. Kim<sup>1</sup>

<sup>1</sup>Department of Biomedical Engineering,  
Kyung Hee University

<sup>2</sup>Department of Biomedical Engineering,  
Cairo University

Retinal image analysis considered as an emerging techniques that used for retinopathy diagnosis in early stages. In this study, we propose filtering method using two-dimensional matched filter (MF) which is a fundamental process to extract the ret-

inal blood vessels. Two distinct Gaussian filters are applied to detect both thick and thin blood vessels. Our results demonstrate that the extracted vessels have prominent efficiency comparing with the ground truth.

P1-077

## 부착형 산소포화도 측정기 연구

백창훈<sup>1</sup>, 김준민<sup>1</sup>, 서종모<sup>1,\*</sup>

<sup>1</sup>서울대학교 공과대학 전기정보공학부,

<sup>2</sup>서울대학교병원 의생명연구소

Pulse oximeter is a widely used device for monitoring patients' heart rate and oxygen saturation level. It is portable, cheap, and non-invasive making it a very popular choice, even in clinical environment. However, conventional oximeters are clip-style which are accurate but bulky and limited in measurement site. This paper presents a patch-style flexible pulse oximeter design with wireless communication capabilities. It is 55mm x 45mm in size and weighs only 3.56g for user comfort. It is based on thin flexible PCB for tight attachment to the skin for both comfort and for reduced noise. Pulse data was successfully acquired from tip of index finger and radial artery.

P1-078

## 규격에 따른 휴대형 인공신장 시스템의 안전성 및 성능평가

호예지<sup>1</sup>, 박상훈<sup>1</sup>, 조경민<sup>1</sup>, 최바름<sup>1</sup>, 최재순<sup>1,2</sup>

서울아산병원 의공학연구소<sup>1</sup>, 울산대학교 의과대학<sup>2</sup>

This paper presents an investigation on international standards and guidances related to evaluation of safety and performance in the dialysis system and wearable device.

The safety and performance can be evaluated by usability, and environment of home healthcare, such as vibration, shock. The relevant international standards and guidance are provided as a table. Based on this results, we will suggest new guidelines for mechanical and biological safety evaluation of wearable kidney system.

#### P1-079

##### 주시 평가를 위한 시유발안진에서의 억제자극 연구

유선영<sup>1</sup>, 서종모<sup>\*1,2</sup>

서울대학교 전기정보공학부<sup>1</sup>,  
서울대학교병원 의생명연구소<sup>2</sup>

In this study, parameters of the suppression stimuli in optokinetic nystagmus (OKN) were investigated. Fixed-point and moving dot with various contrasts were given as a suppression target on the background of moving black-and-white stripes by the LCD monitor, and the OKN was observed by recording electrooculogram (EOG). Stripes were moved from left to right direction and the moving dot was presented in the opposite direction to the stripe motion. Contrast of the suppression stimuli was gradually increased to evoke the suppression of OKN, and the contrast value of fixed-point stimuli was higher than that of the moving stimuli for suppressing OKN in the same examinee.

#### P1-080

##### 정규분포를 이용한 환자유래암세포의 약물반응성 예측

김정은

성균관대학교 삼성융합의과학원 의료기기산업학과

Clinical trial responses largely depend on the genomic predictors. However, such approaches may be challenging because of the molecular heterogeneity and complexity of refractory cancers. Here we have established a clinical trial response prediction model using chemical screening of patient-derived cells (PDCs). According to the normal distribution (or Gaussian distribution) of PDC drug responses, we assume the sensitivity with z-score. This study demonstrated the ideal number for drug responsiveness reference set to plot a normal distribution graph.

#### P1-081

##### 비ST 분절 급성 심근경색증 환자의 진단을 위한 NT-proBNP의 역할

손호선\*, 김경아\*\*, 차은종\*\*

\*충북대학교 의학연구소,

\*\*충북대학교 의공학과

Recently, N-terminal pro-brain natriuretic peptide is used for diagnosis and prognosis decision about a cardiac disorder. Especially, it appears in proportion to the symptom of cardiac insufficiency and is used for diagnosis of cardiac insufficiency and prognosis decision. In this paper, we plan to estimate the prognosis through NT-proBNP as a risk evaluation marker, when the patients who are as risky as STEMI patients visit a hospital despite early NSTEMI patients. As the estimation method, we classified NT-proBNP measured values into two groups and conducted the survival analysis of MACE and Death about NT-proBNP, matching the variables necessary for revision through propensity score matching. We found out that as log (NT-proBNP) val-

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ue increase by 1 through hazard function of COX's analysis, the risk of MACE increases 1.312 times. This means that according to the degree of measured value of NT-proBNP, it is possible to evaluate the prognosis estimation to NSTEMI patients and it influences MACE.

P1-082

## 핵의학 의료기기의 허가·심사 기술문서 작성을 위한 가이드라인 개발 연구

이승열, 김재량, 김은림,  
이준호, 이창형, 박창원  
식품의약품안전처 식품의약품안전평가원  
의료제품연구부 의료기기연구과

The market size of the medical devices in the nuclear medicine and the number of their approval by Ministry of Food and Drug Safety (MFDS) has increased, with a trend of increasing aging population. Therefore, it is need to develop guidelines on the technical documents for SPECT (Single Photon Emission Computed Tomography)·SPECT-CT·Gamma camera. These guidelines were suitable to international and domestic condition, including test evaluation methods and offering appropriate examples.

P1-083

## 다중 2차원 초음파 영상의 3차원 공간의 위치 결정을 위한 수학적 모델

안치영<sup>1</sup>, 윤상운<sup>2</sup>  
<sup>1</sup>국가수리과학연구소 융합수학연구부  
<sup>2</sup>성균관대학교 수학교육과

In this paper, we deal with a 3D reconstruction problem of left ventricle (LV)

using multiple 2D echocardiography data. Especially, we propose a mathematical model for reconstructing 3D LV using only 2D echocardiography data, without using a 3D ultrasound imaging scanner. The mathematical model is designed from the fact that the angles between apical long-axis 4, 2 and 3-chamber views are approximately 60° toward each other. The relationship between the extracted 2D LV contours and the corresponding 3D positions is expressed as a linear equation. In order to compute the unknowns in the derived linear equation, we consider a non-convex constrained minimization problem and apply a quadratically constrained quadratic program (QCQP).

P1-084

## 9.4 T에서 양성자 자기공명분광을 이용한 지방간 쥐의 간 지질 변화

김주연<sup>1,2</sup>, 백현만<sup>2</sup>, 이태수<sup>1</sup>  
<sup>1</sup>충북대학교 의공학교실,  
<sup>2</sup>한국기초과학지원연구원 생체영상연구팀

Non-alcoholic fatty liver disease is the most common cause of chronic liver diseases. The aim of this study was to characterize hepatic lipid metabolites changes in high-fat diet induced liver steatosis model by in vivo short-echo time (TE) <sup>1</sup>H-MRS. This study included 17 male C57BL/6 mice, 8 high-fat diet mice for 20 weeks and 9 normal mice. Significant increase in lipid signals. 0.9, 1.3, 2.1, 2.3, 2.8, 4.1, 4.3 and 5.2+ 5.3 ppm was found in animals with 20 weeks ( $p < 0.01$ ,  $p < 0.001$ ). Therefore, <sup>1</sup>H-MRS is useful in detecting and characterizing various hepatic lipid alterations at early phase in mouse liver steatosis prior to development of fibrosis.

## P1-085

표면 정합 시 병변 정합 오차에 영향을 미치는 요인:  
표면 분포

박현준, 문정환, 유학제, 김태형, 심태용  
성균관대학교 바이오메카트로닉스학과

In this study, we investigated how the changes of facial surface points distribution effects on target registration error (TRE). A rigid head phantom was specially designed, and facial surface points acquired by CT were deformed according to the direction of residual rotation error. As results, if the direction of residual rotation error and the dense region of facial surface points are matched, TRE decreased, and if not, then TRE increased.

index control will be needful for the optimized surface scattering layer.

## P1-087

인도시아닌 그린을 이용한 당뇨병 혈관합병증의 혈류 특성 분석 및 진단

안유리<sup>a</sup>, 강유정<sup>b</sup>, 이정설<sup>c</sup>, 안철우<sup>d</sup>, 최철희<sup>a,c</sup>

<sup>a</sup>KAIST 바이오및뇌공학과

<sup>b</sup>(주)뷰웁스

<sup>c</sup>(주)셀렉스 라이프사이언스

<sup>d</sup>연세대학교 의과대학

Diabetes mellitus(DM) is one of the most common disease which can induce life-threatening complications in world. It is occurred by impaired blood glucose level. One of the serious complications of DM is diabetic microvascular disease. Because it is impossible to fully recover from diabetic microvascular disease, it is important to diagnose it in early stage. In this study, we suggest a fluorescent image analysis method for diagnosis of diabetic microvascular disease with indocyanine green, ICG. Furthermore, this novel diagnosing method is expected to describe the lying background of diabetic vascular insufficiency.

## P1-086

간접방식 검출기에서 광효율 개선을 위한 표면산란층에 관한 연구

김교태\*, 신요한\*, 한무재\*, 허예지\*,  
김주희\*\*, 박지균\*\*\*, 남상희\*  
인제대학교 의용공학과,  
인제대학교 재난관리학과,  
한국국제대학교 방사선학과

This study was focused on the parylene, the organic transparent thin film, based surface scattering layer. According to the result, it was proved that the penetration ratio and light optical property are related with 'Trade-off relationship', and it is considered to be able to be used as surface scattering layer with the enhancement of luminance efficiency by scattering mechanism when fabricate with lower penetration ratio of light than 90%. it is considered that the variety researchs about refractive

## P1-088

다중 뇌 영상을 이용한 알츠하이머성 치매의 조기 진단

윤혁진, 광기창, 이종민  
한양대학교 생체공학과

In neuroimaging researches, patients with Alzheimer's disease (AD) have been found



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to have different patterns from those of normal controls (NC). As biomarkers, structural magnetic resonance image (MRI) for cortical atrophy and 18F-Fluorodeoxyglucose-positron emission tomography (FDG-PET) for hypometabolism have been investigated for AD pathology and each pattern of them have led to the development of diagnosis of AD from NC. In this paper, we introduce a method to discriminate between AD and NC, based on complementary information of multimodal image using combination of FDG and MRI biomarkers.

P1-089

형광 동역학 영상의 주성분 분석을 이용한 당뇨병 혈관합병증의 진단

서지혜<sup>a</sup>, 안유리<sup>a,b</sup>, 이정설<sup>c</sup>, 구태윤<sup>d</sup>,  
강유정<sup>e</sup>, 안철우<sup>f</sup>, 최철희<sup>a,b,c,d</sup>

<sup>a</sup>KAIST 바이오및뇌공학과

<sup>b</sup>KAIST KI

<sup>c</sup>(주)셀렉스 라이프사이언스

<sup>d</sup>KAIST 의과학대학원

<sup>e</sup>(주)뷰웍스

<sup>f</sup>연세대학교 의과대학

Indocyanine green (ICG) fluorescence imaging has been clinically used for vascular flow check and other diseases diagnosis. We have previously developed algorithm which can detect vascular disorders using ICG time-series dynamics. However, because of the characteristics of raw data, which is high-dimensional, there is difficulty to analyze the ICG dynamics. In this study, we used principal component analysis (PCA) to extract important elements from ICG time-series dynamics. We examined ICG spatiotemporal profiles and iden-

tified critical features related to vascular disorders without any significant data loss. PCA time courses showed a distinct pattern in diabetic patients. Among the components, the second principal component (PC2) represented arterial-like feature. We propose that PC2 can be used as a promising bioimaging marker for the screening of vascular diseases. It may also be used as a simple extraction of arterial-like features.

P1-090

적외선센서를 이용한 최대흡기상태 검출기 개발

옥성호, 박재성, 이태수, 김경아, 차은종  
충북대학교 의용생체공학과

Infrared sensors have been used to increase the quality of daily life in our ambient environments, such as security alarm, fire detection or medical thermography, etc. We used this sensor to measure the subject's motion and capture the MIP(Maximal Inspiratory Position) state to reduce artifacts such as image blurring, low quality images due to insufficient lung expansion. The distance of sensor to subject's left shoulder was used to capture MIP state. After capturing, our detector can inform radio-technologist the optimal moment of MIP state to improve their x-ray shoot time accuracy. In an experimental result, this detector operated normally, but we found several problems. After these challenges can be addressed efficiently, this detector or detecting system looks like to be useful in clinical environments.

## P1-091

위스콘신 카드 솔팅 테스트에서 귀뚜라미 소리가 여성들에게 미치는 영향에 대한 뇌자기공명영상 비교

김은지<sup>1</sup>, 차현실<sup>1</sup>, 장용민<sup>1,2</sup>

<sup>1</sup>경북대학교 의용생체공학과

<sup>2</sup>경북대학교 의학전문대학 영상학과, 분자의학교실

Senses are known positive effects on cognition. Therefore, we investigated the effect of exposure to sounds of crickets using fMRI to measure the brain activity such as executive function. A total of 35 healthy participants (19 sound-exposure and 16 healthy controls) were included. There are two experimental groups who had listened cricket's sound but high accuracy score or low accuracy score in pre test. All the participants conducted the Wisconsin Card Sorting Test(WCST) task during the MR image acquisition. Paired t-test analyses showed meaningful difference at only low accuracy score experimental group in the left middle frontal area and DLPFC. This study found that exposure to sound to stabilize mental affects brain activation neuro-networks.

## P1-092

핵의학 동적 신장팬텀 시스템의 개발 및 적용

박훈희<sup>1</sup>, 이주영<sup>2</sup>, 이태수<sup>2</sup>

신구대학교 방사선과<sup>1</sup>,

충북대학교 의용생체공학과<sup>2</sup>

This study has produced the dynamic kidney phantom to reproduce images through the simulation of dynamic renal blood flow, and it desires to evaluate the usefulness in the field of nuclear medicine imaging. In this study, its fabrication was based on

the normal adult data, by using the volume pump, whose flow speed can be adjusted, so it can be integrated continuously with radioactive isotopes in the kidney by using <sup>99m</sup>Tc-pertechnate. The used radioactive isotope was supplied through two pumps. The results showed that the dynamic kidney phantom system is able to similarly reproduce renogram in the actual clinical.

## P1-093

혈관 석회화 팬텀 모델에서 Blooming artifact에 의한 협착 정도 평가

박유진, 김정훈, 박지은, 안도현,

이도병, 이도석, 최현우, 조숙인, 이종민

경북대학교 의용생체공학과

In the present study, we developed a coronary arteriosclerosis calcification phantom model. Using this phantom model, depending on the degree of calcification was assessed the degree of luminal stenosis by Blooming artifact. As a result, the more the degree of calcification seems to increase the luminal diameter reduction. Therefore, the more calcification much progress tends stenosis of the lumen appears more exaggerated.

## P1-094

Breast Specific Gamma Imaging에서 유방 보형물이 영상에 미치는 영향에 관한 고찰

이주영<sup>1</sup>, 박훈희<sup>2</sup>, 이태수<sup>1</sup>

충북대학교 의용생체공학과<sup>1</sup>,

신구대학교 방사선과<sup>2</sup>

In this study, we confirmed the effect of



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breast implants in Breast Specific Gamma Imaging(BSGI). The self-developed phantom had a rectangular shape and  $230 \times 190 \times 80$  mm size. It included five spheres in central part, whose diameters were 10, 13, 17, 22, 28 mm. We made additional nine phantoms filled with 0.9 % sodium chloride, silicon and paraffin, whose thicknesses were 10, 20, 30 mm for each. In imaging results, the effect of phantom thickness was the highest in the phantoms filled with 0.9 % sodium chloride and those filled with silicon and paraffin followed ( $P < 0.005$ ). The effect of phantom types was the highest in the paraffin-filled phantom and the silicon and 0.9 % sodium chloride followed ( $P < 0.005$ ). These results are thought to be clinically helpful in the assessment of breast image quality in the BSGI test.

## P1-095

### DBS환자의 B1+rms 제한기준을 적용한 brain MRI 영상평가

연규진<sup>1,2</sup>, 장영애<sup>2</sup>, 이태수<sup>1</sup>  
충북대학교 의용생체공학과<sup>1</sup>,  
삼성서울병원 MRI검사실<sup>2</sup>

DBS manufacturing company notes a new guideline of DBS that limits the RF power,  $B1+rms \leq 2.0 \mu T$ . We evaluated the SNR, CNR and visibility about the five anatomical structures in the brain MRI images obtained using three protocols (Routine,  $SAR \leq 0.1$  W/kg and  $RMS \leq 2.0 \mu T$ ). CNR of RMS adjusted image in T2 and T1 is equivalent to routine sequence images. Therefore, the usefulness of DBS manufacturing company's new guideline was confirmed, comparing with conventional SAR standard on the aspect of improvement of image quality, reduction of

scan time and easy adjusting parameter.

## P1-096

### 다중 라벨 융합과 희소성 표현의 결합을 이용한 정중시상에서의 뇌량 분할

박길순, 곽기창, 이종민  
한양대학교 생체의공학과

Corpus Callosum (CC), which connects the two cerebral hemispheres, is the largest white matter structure of the human brain. Its structure features such as size and shape have been contributed to analyze neurological disease progression. Robust extraction of the features is associated on segmentation performance. In this paper, we introduced novel method for CC segmentation in midsagittal that combines sparse representation and multi-label fusion.

## P1-097

### 노드 스케일이 고려된 구조 네트워크 허브 추출 방법

권훈기, 최용호, 이종민  
한양대 의용생체공학과

The 'human connectome' concept has been proposed to argue that it significantly increase our understanding of how functional brain states emerge from their underlying structural substrate [1]. Graph theoretical analysis has been adopted in the neuroimaging study to investigate the characteristics of human brain networks at macroscale. In many network parameters, hub has been considered as one of the most important topological properties to interpret network as a complex system. Previous structural brain connectome studies have reported the network hub regions based on var-

ious nodal resolutions [2]. Since network hubs of the previous studies have been defined after restricting to a specific resolution, they might not capture the potential scale-dependent nature of a node's role in the network as a whole [2]. We hypothesized that brain network hub, fundamental brain network topological property, should be determined considering various nodal scales in a certain range. In this work, we proposed the methodological framework to test our hypothesis.

#### P1-098

##### 주파수 차원에서 뇌의 동적 기능적 연결성

박영훈, 이종민  
한양대학교 생체공학과

Brain show a dynamic integration and segregation in terms of the large-scale functional connectome. Therefore, functional resting-state connectivity is studied by dynamic method rather than static method. For dynamic study in frequency domain, many study uses traditional frequency range (0.01~0.027, 0.027~0.073 etc.). However, the frequency range is not derived from the BOLD signal and not considered the functional connectivity. So, we show the new frequency range derived from functional connectivity and compare the frequency range of other study.

#### P1-099

##### 고속 임피던스 영상시스템을 이용한 관류 영상화 기술의 개발

김영은<sup>1</sup>, 장극영<sup>2</sup>, 위현<sup>3</sup>, 오동인<sup>4</sup>, 우응제<sup>4</sup>  
<sup>1</sup>경희대학교 생체의과학과,

<sup>2</sup>경희대학교 생체의공학과,  
<sup>3</sup>경희대학교 임피던스영상신기술연구센터,  
<sup>4</sup>경희대학교 의학전문대학원

Recently, electrical impedance tomographic technique applied to the continuous respiration monitoring in the lung during the mechanical ventilation. If we estimated the respiratory function in the lung, we must measure the air distribution and blood perfusion inside the lung together. However, the conductivity change due to the blood circulation was too small and fast comparing to the one of air distribution, it was quit difficulty. We developed the fast impedance imaging system based on the FPGA (Field-programmable gate array) to monitoring the conductivity change of perfusion in the lung. The maximum acquisition speed was 100 frames/sec and SNR (signal-to-noise ratio) was 90 dB. We could produce the conductivity images of blood perfusion in the chest synchronized with electrocardiogram.

#### P1-100

##### 환자맞춤형 임피던스 영상화를 위한 능동형 분리전극 벨트 개발

박준환<sup>1</sup>, 정유정<sup>2</sup>, Ghazal Ayoub<sup>1</sup>,  
백상민<sup>3</sup>, 위현<sup>3</sup>, 오동인<sup>4</sup>, 우응제<sup>4</sup>

<sup>1</sup>경희대학교 생체의공학과,  
<sup>2</sup>경희대학교 생체의과학과,  
<sup>3</sup>경희대학교 임피던스영상신기술연구센터,  
<sup>4</sup>경희대학교 의학전문대학원

Recently, electrical impedance tomography (EIT) has been used in the clinic for real-time monitoring of respiration or perfusion in the lung. It requires patient specific model for image reconstruction and finding the exact position of measuring electrodes.

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In order to make a procedure to extract them easily, we developed the active measurement belt with custom-designed marker. We made the patient specific reconstruction model based on the information of electrode position using 3D depth camera. Since we adopted the compound electrode for separating current injection and voltage measurement and active measurement circuit in the belt, we could improve the spatial resolution and to reduce the shape deformation in the reconstruction images.

## P1-101

CT 기반 Tissue Label Map을 이용한 다기관  
Brain PET 연구에서의 PET Scanner 영상품질 평  
준화

문효정,<sup>1,2</sup> 오정수,<sup>1</sup> 김재승<sup>1</sup>

<sup>1</sup>울산대학교 의과대학 서울아산병원 핵의학과,

<sup>2</sup>울산대학교 대학원 의과학과

In order to reduce camera difference in multiple PET/CT scanners in K-ADNI study, we developed a new PET scanner harmonization method using CT-based tissue label map (CTM). We generated the CTM using best quality CT images of Hoffman 3D Brain Phantom. We determined the optimal harmonization kernel for smoothed CTM (between variable smoothing kernel sizes) exhibiting the highest correlation coefficient with PET. We found the similar results of harmonization factors making effective 8mm-resolution as found in ADNI study. Therefore, we suggest our proposed CTM method as a new reference frame for PET scanner harmonization.

## P1-102

폐 보호 기계환기를 위한 임피던스 기반 폐탄성 영  
상화 기술

장극영<sup>1</sup>, 위현<sup>2</sup>, 전기완<sup>3</sup>, 우응제<sup>4</sup>, 오동인<sup>4</sup>

<sup>1</sup>경희대학교 생체공학학과,

<sup>2</sup>경희대학교 임피던스영상신기술연구센터,

<sup>3</sup>국가수리과학연구소,

<sup>4</sup>경희대학교 의학전문대학원

Many patients have been applied to the mechanical ventilator in the intensive care unit or operating room. If too high or too low pressure applied to the each patients with different lung compliance, it could produce another injury in the lung. In this study, we used electrical impedance tomography(EIT) method to evaluate regional lung compliance by images. Multiple electrodes were attached around the thorax of a swine, and measured the position of each electrode using 3D camera. Based on the object specific model, we reconstructed impedance images on the multiple PEEP level. From the results, we could show the regional lung compliance images depending on the each PEEP level. This technique will be used for lung protective mechanical ventilation.

## P1-103

비강을 통한 염화망간 주입 후 이명유발 쥐와 정상  
쥐의 청각신경회로 기능영상 비교

장진희<sup>1</sup>, 장용민<sup>1,2,3</sup>

<sup>1</sup>경북대학교 의용생체공학과

<sup>2</sup>경북대학교 의학전문대학원 분자의학교실

<sup>3</sup>경북대학교병원 영상의학과

In this study, we report a new method of manganese enhanced magnetic resonance imaging (MEMRI) after nasal cavity manganese administration. Animal models of salic-

ylate-induced tinnitus indicate that tinnitus can be a perceptual consequence of altered spontaneous neural activity along the auditory pathway. Peripheral and/or central effects of salicylate can account for neuronal activity changes in salicylate-induced tinnitus. We explore  $Mn^{2+}$  uptake from nasal cavity into the functional auditory tract tracing. After manganese administration in rodent tinnitus model, T1-weighted MR images were obtained for up to 24, 48 hours with a 1.5 T MR imager.

#### P1-104

##### 가상모델 기반 순차적 악교정 수술 내비게이션 시스템

이상정<sup>1\*</sup>, 이상윤<sup>1</sup>, 유지용<sup>1</sup>, 강세룡<sup>1</sup>,  
이우진<sup>2</sup>, 이원진<sup>3</sup>

<sup>1</sup>서울대학교 융합과학기술대학원

융합과학부 방사선융합의생명전공

<sup>2</sup>서울대학교 의과대학 협동과정 방사선응용생명과학

<sup>3</sup>서울대학교 치의학대학원 영상치의학교실

An orthognathic surgery is performed for treating maxillofacial deformities related to the acquired and inherited faults. In conventional surgery, although the deformities and facial asymmetry were 3D issues, 2D medical imaging data was used for surgery plan. To overcome the challenges, an orthognathic surgery navigation system has been introduced, and consists of medical imaging from several imaging modalities, such as computed tomography (CT), ultrasound (US) and magnetic resonance imaging (MRI), surgical planning, transferring the planned data to the patient and intra-operative guidance. In the present study, the virtual surgery planning was performed using the patient's virtual models fused with

optically scanned images for reducing metal artifacts and enhancing resolution. The fused model provided surgery guidance to transfer the planned data to a patient.

#### P1-105

##### 맞춤형 위스콘신 카드테스트와 기능적 자기공명 영상을 이용한 유기용매의 노출과 뇌의 집행기능에 대한 영향

양무진<sup>1</sup>, 장경은<sup>1</sup>, 장용민<sup>1,2,3</sup>

<sup>1</sup>경북대학교 대학원 의용생체공학과

<sup>2</sup>경북대학교 의학전문대학원 분자의학교실

<sup>3</sup>경북대학교병원 영상의학과

It is widely known that deficits in cognitive function have been demonstrated among workers chronically exposed to organic solvents. And organic solvent exposure could induce functional abnormalities of distributed cortical networks in relation to executive function. And we used two modified version of the Wisconsin Card Sorting Test (WCST), differing in cognitive demand, and a high-level baseline (HLB). Our finding of higher activations medial temporal lobe at normal group. This region served as processor of declarative or long-term memory

#### P1-106

##### AFNI를 이용한 tasking state fMRI 처리 방법

이진성<sup>1</sup>, 최재찬<sup>2</sup>, 이종민<sup>1</sup>

<sup>1</sup>한양대학교 생체공학과

<sup>2</sup>원주 세브란스병원

Functional MRI(fMRI) can be applied to study the functional connectivity of the human brain. fluctuations in the blood deoxygenation level-dependent (BOLD) signal during tasking reflect activative region of

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brain. we present method to detect differences among event-related hemodynamic responses in functional MRI. we can calculate the deconvolution of a measurement 3D+time dataset with a specified input stimulus time series by 3dDeconvolve[2] in AFNI

## P1-107

### 웨이블릿을 이용한 4분할 의료영상 워터마킹 구현

이도석<sup>1</sup>, 김정훈<sup>2</sup>, 박지은<sup>1</sup>, 안도현<sup>1</sup>

이도병<sup>1</sup>, 이종민<sup>1,3</sup>

경북대학교 대학원 의용생체공학과<sup>1</sup>,

경북대학교 대학원 전자공학과<sup>2</sup>,

경북대학교 의학전문 대학원 영상의학교실<sup>3</sup>

In this study, the wavelet transform domain is proposed by the method of insertions using the information of image shape in the structure and the Radiology School of Medicine<sup>3</sup> spatial region.[1] A location of the watermark insertion is the candidate regions which are determined in sub-band having a high frequency. After the insertion, performing of the inverse wavelet transform(IDWT) creates the image which is a inserted watermark image. Using the proposed method, the PSNR (Peak Signal-to-Noise Ratio) could confirm the results of excellent invisibility by observing a inserted watermark image. Therefore, this study is considered to be applicable for copyright protection or ownership certification etc. in medical images requiring the best qualified image.

## P1-108

### 두개 내부 부피 측정법이 알츠하이머 질병 그룹 분석에 미치는 영향

김보현, 곽기창, 이종민

한양대학교 생체공학과

A variability between-subjects in regional volume is explained by differences in head size, measured by intracranial volume. Intracranial Volume (ICV), which is including brain, meninges, and CSF is an important covariate for brain analysis. Intracranial volume normalization is an important step to compensate the between-subject variability. There are several automatic methods for estimating intracranial volume and these methods have systematic differences. The purpose of this article is compare two methods commonly used to estimate intracranial volume and investigate the implications of intracranial volume from different methods in cortical thickness analysis in AD (Alzheimer's Disease) and NL (Normal) groups.

## P1-109

### 개선된 영상 정합 방법과 그룹 아틀라스를 사용한 확산 텐서 영상 분석방법 비교

최용호<sup>1</sup>, Collins Kwadwo Boahen<sup>1</sup>, 이종민<sup>1</sup>

한양대학교 생체공학과

Tract based spatial statistics(TBSS) has become a software for the analysis of diffusion MRI. Several researchers have pointed out the problems associated with TBSS pipeline. At the same time, efforts have been made to improve such limitations. We identified relative results of voxel based analysis depending on registration methods and atlas.



## P1-110

## 뇌영상을 이용한 알츠하이머성 치매 분류를 위한 희소성표현 기술

곽기창, 윤혁진, 김은경, 이종민  
한양대학교 의용생체공학과

In this paper, we proposed a sparse representation and dictionary learning algorithms applied to hippocampus using structural MRI and FDG-PET together to separate AD/MCI from normal control subjects. In this way, we expected high classification performance using patches that is compatible with selected regional information. We considered structural and function information of hippocampus together and applied sparse patch-based approach to reduce the feature dimension effectively and to make the feature more discriminative.

## P1-111

## 멀티 모달리티 영상을 이용한 좌우간 대뇌 피질의 두께 차이와 두뇌 연결성간의 관계에 대한 연구

이동균<sup>a</sup>, 박준성<sup>b</sup>, 서상원<sup>c</sup>, 이종민<sup>a</sup>  
a 한양대학교 의용생체공학과 CNA Lab  
b 삼성전자 Medical System Lab  
c 삼성서울병원 신경과

The functional and structural hemispheric asymmetry was reported by several neuro imaging studies. This hemispheric asymmetry is expected to be related by inter-hemispheric connectivity. In order to investigate the source of brain morphological asymmetry, we used different measurements of brain asymmetry and inter-hemispheric connectivity from the multi-modality images.

## P1-112

## Dye encapsulated polymeric nano-probes for in vitro and in vivo fluorescence imaging in entire UV-Vis-NIR wavelength range

H. Kim,<sup>1</sup> L. Oktavia,<sup>1</sup> S.J. Kim,<sup>2</sup>  
P.C.W. Lee,<sup>2</sup> M. Kwak<sup>1</sup>

<sup>1</sup>Department of Chemistry,  
Pukyong National University

<sup>2</sup>Department of Biomedical Sciences,  
University of Ulsan College of Medicine

We present a method to efficiently stabilize micelles of F127 by semi-interpenetrating networks (sIPN) formation. First, pentaerythritol tetraacrylate (PETA) loaded in the core was cross-linked to form sIPN resulting in stabilized particles. We characterized size and stability of the particles by fluorescence, UV-Vis spectroscopies, and dynamic light scattering. In addition, a number of chemical compositions and experimental conditions were tested to optimize sIPN formation of the polymer. Furthermore, it turned out that our probe nanoparticles are potential materials for cell and animal imaging.

## P1-113

## 영유아 방사선 촬영 보조기구의 개발과 흉부 X-ray 영상분석에 관한 연구

이도병<sup>1</sup>, 김정훈<sup>2</sup>, 안도현<sup>1</sup>, 박지은<sup>1</sup>,  
이도석<sup>1</sup>, 박유진<sup>1</sup>, 이종민<sup>1,3</sup>

경북대학교 의용생체공학과<sup>1</sup>, 경북대학교 전자공학과<sup>2</sup>,  
경북대학교의학전문대학원 영상의학교실<sup>3</sup>

Chest AP upright, Chest PA upright using Ancillary Device for Child & Infant Radiography(ADCI) had been taken infants and children of 240 participants from 6 months

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to 5 years old, the two specialists of department of radiology evaluated the scores of Chest AP upright, Chest PA upright using ADCI in comparison with Chest AP supine nor using ADCI by CEC Image Criteria. Evaluation result showed that the top score was 55.5 of Chest AP upright using ADCI, the second score was 54.8 Chest PA upright using ADCI and the lowest score was 52.7 of Chest AP supine nor using ADCI. As for the result which statistically showed the significant difference among the scores of categorized evaluation, Chest AP upright using ADCI has higher score than Chest AP supine not using ADCI in ① Performed at peak of inspiration, except for suspected foreign body aspiration: 4.87%, ④ Reproduction of the vascular pattern in central 2/3 of the lungs: 6.92%, ⑤ Reproduction of the trachea and the proximal bronchi: 12.9%, ⑥ Visually sharp reproduction of the diaphragm and costo-phrenic angles: 10%, ⑦ Reproduction of the spine and paraspinal structures and visualisation of the retrocardiac lung and the mediastinum: 3.65%. Chest PA upright has higher score than Chest AP supine not using ADCI in ④ 6.27%, ⑤ 9.67%, ⑥ 7.46%, ⑦ 4.45%. Therefore application of ADCI will be a proper method to beef up security, take a effective X-ray and produce a clear imaging information.

## P1-114

대뇌 형태 측정 기반 구조적 표현형의 네트워크에 대한 특성 비교

양진주, 권훈기, 이종민  
한양대학교 생체의공학과

In three morphometric based correlation

networks of cortical thickness, surface area, and gray matter volume, we examined directly describing their correlation patterns in view of interregional covariance. We calculated the characteristics of the correlation patterns using a Venn diagram concept across 314 normal subjects. We found that over 60% of all nonoverlapping correlation patterns emerged with divergent unique patterns, while there were 10% of all common edges in ipsilateral and homotopic regions among the three morphometric correlation networks. Our findings showed that correlation patterns of the network itself can provide complementary information when compared with network properties.

## P1-115

A Novel Computer-Aided Diagnosis System for Breast Cancer in Digital Mammograms via Deep Belief Network

M. A. Al-antari<sup>1</sup>, M. A. Al-masni<sup>1</sup>,  
S. U. Park<sup>1</sup>, J. H. Park<sup>1</sup>, Y. M. Kadah<sup>2</sup>,  
S. M. Han<sup>1</sup>, and T.-S. Kim<sup>1</sup>

<sup>1</sup>Department of Biomedical Engineering,  
Kyung Hee University  
<sup>2</sup>Department of Electrical and  
Computer Engineering  
King Abdulaziz University

In this study, we propose a novel Computer-aided diagnosis (CAD) system for breast cancer diagnosis via Deep Belief Network (DBN) that automatically detects breast mass regions and recognizes them as normal, benign, and malignant. We randomly extract four non-overlapped ROIs with a size of 32×32 pixels from a detected mass.



Our results demonstrate that the proposed DBN outperforms the conventional classifiers. This paper shows the feasibility of DBN based CAD system which could be used as a better choice in the field of breast cancer diagnosis.

### P1-116

#### 치료용 선형가속기를 이용한 X선 유도 음향 영상

박은영<sup>1</sup>, 김지수<sup>1</sup>, 정유한<sup>1</sup>, 김병철<sup>2</sup>,  
김중현<sup>2</sup>, 이철영<sup>2</sup>, 김인중<sup>2</sup>, 김철홍<sup>1</sup>

<sup>1</sup>포항공과대학교 창의융합공학과 및 전자전기공학과,  
<sup>2</sup>한국표준과학연구원 방사선표준센터

X-ray induced acoustic (XA) imaging is an integrated imaging modality which consists of a medical X-ray accelerator and an ultrasound (US) transducer. XA imaging has great potential to be utilized for monitoring X-ray dose distribution during radiation therapy. In this paper, a recently developed XA imaging system is introduced. The feasibility of the developed system is investigated by acquiring images of X-ray absorbing samples. Even though much work is needed to improve the image quality and to monitor X-ray dose distribution in biological tissue, the results in this paper encourage further studies.

### P1-117

#### 얼굴 N-back 과제 수행을 이용한 작업기억에 대한 기능적 자기공명영상 연구

양지웅<sup>1</sup>, 장용민<sup>1,2,3</sup>

<sup>1</sup>경북대학교 대학원 의용생체공학과

<sup>2</sup>경북대학교 의학전문대학원 분자의학교실

<sup>3</sup>경북대학교병원 영상의학과

Working memory is a key cognitive function in daylife[1]. The working memory can be shown in a number of areas like as shifting, updating, and inhibition and it has been demonstrated. our study's goal was to estimate the neural activity's dynamic changes involved in working memory with the facial N-back task, using fMRI. The main finding revealed by our study was that the working memory networks with the facial N-back task was shown to be significantly activated in face perception area and recruited more left-hemisphere areas. And there were more activated in high load condition at specific regions that was related to working memory network such as frontal and parietal brain area.

### P1-118

#### CT Angiography 영상에서 AAM 알고리즘을 이용한 대동맥 기부 추출

김태형, 윤수현, 허현무, 신기영, 문정환

성균관대학교 생명공학대학 바이오메카트로닉스학과

American Heart Association reported that heart-related disease such as aortic stenosis or coronary artery stenosis showed the highest occurrence rate which will cause heart attack. Before the surgical procedure, it is very important to determine the anatomical information of surgical target region to increase surgery output. For the assessment of anatomical structure of aortic root in CT angiography image is time consuming and show less reproducibility when expert segment aortic root manually. Therefore, we proposed automatic aortic root segmentation model by using Active Appearance model in CT angiography image and analyzed the segmented results

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with Region competition applied model.

## P1-119

Patient motion estimation and its correction in Computed Tomography

M. A. A. Hegazy, M. E. Eldib,  
Y. J. Mun, M. H. Cho, S. Y. Lee  
Dept. of Biomedical Engineering,  
Kyung Hee University

Computed tomography is one of the best medical imaging modalities in terms of resolution so it has many application that is used very fine resolution like Micro CT and dental CT. However, the resolution of CT image could be affected by many artifacts such motion artifact and to correct this motion artifact we should know the source of this motion. There are two expected source of motion during image acquisition patient motion and system motion. To correct the motion coming from the system and patient we should first estimate this motion. Motion detection could be Hardware-based detection or software-based detection. Hardware-based detection has a limitation in measurement resolution because it can detect motion in order of millimeters. However for dental CT and micro CT, we need to detect the motion of micrometers. So the best way is to detect this motion with software. In this work we implement a method to detect the motion of patient from the projection images by calculating the cross correlation between each sequence of image. This will give indication of the shift between each series of projection images so we can correct the amount of shift in projection domain.

## P1-120

Non-uniformity correction in photon-counting-detector-based micro-CT

M. E. Eldib, M. A. A. Hegazy,  
Y. J. Mun, Min H. Cho, Soo Yeol Lee  
Dept. of Biomedical Engineering  
Kyung Hee University

Due to miscalibration of detector elements and some manufacturer defects in photon counting detector, non-uniformities are produced causing stripe artifacts in sinogram domain which generate ring artifacts in the reconstructed CT images. We present a method for evaluating sensitivity of detector elements response based on the sensitivity difference between each two successive elements, after that we correct the non-uniformities in sinogram domain. The proposed method is applied on Shepp-Logan phantom for simulation, and also on experimental data using both Silicon (Si) and Cadmium Telluride (CdTe) photon counting detectors, and both of them showed a great suppression for both stripe artifacts in the sinogram domain and ring artifacts in the reconstructed CT images.

## P1-121

초음파영상 Speckle 제거를 위한 라플라시안 피라미드 기반 Total Variation Denoising 기법 개발

문주혜<sup>1</sup>, 오명은<sup>1</sup>, 임유나<sup>1</sup>, 태기식<sup>1</sup>, 최동혁<sup>1</sup>  
<sup>1</sup>건양대학교 의료공과대학 의공학부

Speckle noise reduction is an essential pre-processing step, whenever ultrasound imaging is used for medical imaging. Therefore, image despeckling is a very important task. A new speckle reduction method, i.e.,

Laplacian pyramid-based total variation denoising, is proposed for medical ultrasound imaging. With this method, speckle is removed by total variation denoising of bandpass ultrasound images in Laplacian pyramid domain. The performance of the proposed method has been compared with that of other speckle reduction methods, including the recently proposed speckle reducing anisotropic diffusion and directional smoothing. The proposed method could effectively preserve edges and detailed structures while thoroughly suppressing speckle. These preliminary results indicate that the proposed speckle reduction method could improve image quality and the visibility of small structures and fine details in medical ultrasound imaging. In simulation and phantom studies, an average gain of 4.65dB in contrast-to-noise ratio and gain of 14.11dB in signal-to-noise ratio.

#### P1-122

##### SegNet을 이용한 폐결핵 자동진단 프로그램 개발

안현수, 유예라, 이주희, 태기식, 최동혁  
건양대학교 의료공과대학 의공학부

SegNet is a novel deep architecture for semantic pixel wise image labelling, composed of a stack of encoders followed by a corresponding decoder stack which feeds into a soft-max classification layer. We tried the auto tuberculosis detection in chest radiographs using the SegNet, deep learning technique. SegNet has several attractive properties; (i) it only requires forward evaluation of a fully learnt function to obtain smooth label predictions, (ii) with increasing depth, a larger context is con-

sidered for pixel labelling which improves accuracy, and (iii) it is easy to be visualize the effect of feature activation(s) in the pixel label space at any depth. We applied SegNet to detection of tuberculosis on total 333 chest images. Our results were a sensitivity of 0.87 at a specificity of 0.70 and an accuracy of 0.8 on 250 train images and 83 test images using the SegNet method. Therefore, this method will be useful for auto CAD (computer-aided diagnosis) of tuberculosis detection.

#### P1-123

##### 광음향 단층 촬영에서 실시간 영상을 위한 빔형성 및 포락선 검파의 GPU 가속 영상 처리

이원지, 이명기  
부경대학교 의공학과

High-speed signal processing is essential for real-time display in medical imaging application. Photoacoustic tomography provides structural, functional, and molecular imaging with high resolution in non-invasive way. Especially, 3-D image reconstruction, functional imaging, and real-time display require fast signal processing. In this study, we provide a high-speed signal processing method using a graphic processing unit (GPU) to reconstruct a photoacoustic B-mode image for real-time display. In order to reconstruct the image beamforming and envelope detection were computed in parallel. Total GPU processing time was approximately 3.4 ms in average to process a frame of B-mode image with  $128 \text{ channels} \times 3200 \text{ samples}$ .

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P1-124

DT-MREIT 영상기법을 이용한 뇌의 비등방성 도전  
율 텐서 영상

최법경<sup>1</sup>, N. Katoch<sup>1</sup>, S. Z. K. Sajib<sup>2</sup>,

정우철<sup>2</sup>, 김형중<sup>2</sup>, 우응제<sup>3</sup>

<sup>1</sup>경희대학교 생체의공학과,

<sup>2</sup>경희대학교 임피던스영상신기술연구센터,

<sup>3</sup>경희대학교 의학전문대학원

Diffusion tensor-magnetic resonance electrical impedance tomography (DT-MREIT) is newly develop method to quantitative-ly visualize the anisotropic distribution of the electrical conductivity inside the biological tissues. At low frequency, the electrical conductivity of the biological tissues can be expressed as a product of mobility and concentration of ions in the extracellular space. From the water self-diffusion measurement, we obtain the directional information of water molecules which corresponds to the mobility of ions. The concentration information however, can be obtain as a position dependent scale factor from the magnetic flux density measurement. By combing these two information, we evaluate the anisotropic conductivity distribution inside the canine brain.

P1-125

사전 학습 방법을 이용한 뇌 자기공명영상의 측뇌실  
영역 분할

<sup>1</sup>홍진우, <sup>1</sup>윤익철

<sup>1</sup>대구가톨릭대학교 의공학과

Many clinical applications rely on a segmentation of MRI brain structures, especially on lateral ventricle, which enables us to describe how brain anatomy changes due to aging or disease. However, it requires

a robust segmentation method for a precise and quantitative analysis. In this study, we proposed a label fusion algorithm based on dictionary learning. This algorithm was learned from a priori gold standards and made segmentation result using combination of learned dictionary and label fusion. The proposed method showed a similar result to the others, but if more a priori gold standards, it could be expected to get better results.

P1-126

영상유전체학에서 유전자집합분석의 반복 신뢰도

우보영<sup>1</sup>, 이명은<sup>2,3</sup>, 김종효<sup>1,2,3</sup>

<sup>1</sup>서울대학교 융합과학기술대학원

<sup>2</sup>서울대학교병원 영상의학과

<sup>3</sup>차세대융합기술연구원

Radiogenomics represents an emerging interdisciplinary field that encompasses radiology and genomics, and thus requires a reliable gene analysis function as an indispensable component. GSEA (Gene Set Enrichment Analysis) is software which analyzes gene expression data and extracts gene sets that show statistically significant differences between samples of two different phenotypes, and is currently one of the most widely used gene analysis tools. This paper introduces gene set analysis, discusses how gene set analysis might be used in radiogenomics, and assesses the repeatability of GSEA through simple repeated experiment.

## P1-127

## 세포 이동의 간접 추정에 관한 영상신호처리 방법

김현우, 허정현, 이재훈, 조은일,  
이정직, 한지호, 임지현, 윤영로  
연세대학교 보건과학대학 의공학과

Handling cell image is critical area in molecular biology. We can obtain important information concerned of variety of bio research and application. Traditional cell image analysis and comparison work have been done manually by expert of this field. But this kind of work has disadvantage of wasting time and effort[1]. In this study, we suggest technique of cell movement by image processing. By applying suggested method, we are able to indirectly estimate cell movement.

## P1-128

## 혈관 유사 이용한 초음파 하지정맥류 팬텀에 관한 기초 연구

김미선\*, 김주영\*\*, 김재영\*\*, 노시철\*\*\*, 최흥호\*\*  
\*식품의약품안전평가원 첨단의료기기과  
\*\*인제대학교 의용공학부  
\*\*\*한국국제대학교 방사선학과

In this study, we observed a change of vessel mimicking material through the sonication by using a tissue mimicking varicose vein phantom that improved the repeatability and reproducibility. We measured the change of the inner diameter and the thickness of the material while changing the blood vessel sonication time and intensity by using the diagnostic ultrasound imaging. We were able to predict the changes in the tissue under varicose vein treatment. This study has been determined to be useful to

evaluate the effect of the ultrasonic therapy.

## P1-129

## 감쇠 프로파일 매칭 기법: 기도 벽 두께의 정밀 측정을 위한 알고리즘

양제파<sup>1</sup>, 진형민<sup>1</sup>, 김종효<sup>1,2,3</sup>  
1. 서울대학교 융합과학기술대학원  
방사선융합의생명전공,  
2. 서울대학교병원 영상의학과,  
3. 차세대융합기술연구원

Thickness of the small airway is an important biomarker for evaluation of pulmonary diseases, such as asthma, COPD, etc. We present a novel method, attenuation profile matching (APM) technique with adopting PSF of a commercial CT and various physical parameters. Our new method provided accurate determination the wall thickness of small airways as well as superior robustness to noise and reconstruction kernel variation.

## P1-130

## 특허분석을 이용한 연구개발전략에 대한 고찰 - 국내 MRI, PET를 중심으로

이만표\*\*, 신상훈\*\*, 최경현\*  
\*한양대학교 기술경영전문대학원  
\*\*한국보건산업진흥원

Development of new technologies is regarding to maximize the possibility for market dominance and to change the structure of the business and economic in the industry and nation. Technological capabilities are one of the important factors for dominating the market. So it would necessary to make an innovation



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and strategies. Korean MRI(Magnetic Resonance Image), PET(Positron Emission Tomography) market is a highly dependent on imports. Since 2015, issued patents related the MRI and PET are 1,203 in Korea. And the top 20 institutions issued 49.5% of the entire patents, and 52.9% of them are filed by university and research institute. Under current status of market and patents in Korea, it is closer in research and development steps than in making product by aspect of R&D. So it is good for technology transfer to venture or other companies can commercialize in the future.

## P1-131

유방 밀도 확률 함수와 Chan-Vese 레벨-셋 알고리즘을 결합한 유방밀도 자동 측정 방법

안철균<sup>1</sup>, 김종효<sup>1,2,3</sup>

<sup>1</sup>서울대학교 융합과학기술대학원 융합과학부

방사선융합의생명전공,

<sup>2</sup>서울대학교 차세대융합기술연구원

의료 IT융합기술 연구센터,

<sup>3</sup>서울대학교병원 영상의학과

Breast density has been widely known as a strong indicator for breast cancer risk. However, measurements of breast density still rely on a qualitative judgment of radiologists. This study presents an automatic mammography breast density estimation method based on combination of a mammogram density probability function and a Chan-Vese level set algorithm. Of the total of 397 mammograms, 297 mammograms were randomly selected as a training set and the rest 100 mammograms were used for a test set. Breast density of the test set was automatically measured by the proposed method. The correlation coefficient

between automatically measured breast density by the proposed method and manually measured density by three experts was 0.90.

## P1-132

휴지 기능성 MRI를 이용한 수면장애 환자의 연결성 분석

원지혜<sup>1</sup>, 박현진<sup>2,3</sup>

1) 성균관대학교 전자전기컴퓨터공학과

2) 뇌 과학 이미징 연구단, 기초과학연구원

3) 성균관대학교 전자전기공학부

Sleep is an important factor for improving physical and emotional conditions. The quality of sleep is related to emotional and memory functions. The purpose of this study was to identify differences of brain connectivity between sleep disorder patients and normal subject groups using a connectivity parameter derived from resting-state functional magnetic resonance imaging (fMRI). The results might provide new insights into the relationships between sleep and emotional and memory functions of the brain.

## P1-133

독립성분석과 연결성분석을 통한 THC군과 정상군의 뇌 연결망의 차이

조환호<sup>1</sup>, 김종훈<sup>1</sup>, 박현진<sup>2,3</sup>

1) 성균관대학교 전자전기컴퓨터공학과

2) 뇌 과학 이미징 연구단, 기초과학연구원

3) 성균관대학교 전자전기공학부

Delta-9-Tetrahydrocannabinol (THC), the major component of cannabis, produces behaviors and cognitive deficits, and it causes alteration in brain functional con-



nectivity. In this paper, we explored difference in brain functional connectivity between THC-used group and normal control groups using resting functional magnetic resonance image from Human Connectome Project database. Group independent component analysis (ICA) was used to find functionally similar activated regions and each independent component was compared with known Resting State Networks to identify significant independent components. To measure group differences, each group's betweenness centrality were calculated. As a result, we found that sensorimotor network showed significant difference between THC-used group and normal control groups.

#### P1-134

##### 임플란트 수술 네비게이션 시스템을 위한 두 상용화 광학 추적 장치 비교

유지용<sup>1</sup>, 이우진<sup>2</sup>, 우상윤<sup>1</sup>,  
강세룡<sup>1</sup>, 이상정<sup>1</sup>, 이원진<sup>3</sup>

<sup>1</sup>서울대학교 융합과학기술대학원 방사선융합의생명전공

<sup>2</sup>서울대학교 의과대학 협동과정 방사선응용생명과학

<sup>3</sup>서울대학교 치과대학 구강악안면방사선학교실

Accuracy and precision in oral and maxillofacial surgery than other surgery in aesthetic and functional part of the patient is considered more important. Recently, surgical navigation system has been developed for this purpose, as surgical navigation system is used, there are many commercialized optical tracking device. In this article, two commercialized optical tracking devices used in implant surgery were compared with each other regarding accuracy and precision. We evaluated accuracy and precision measuring fiducial registration

error(FRE), target registration error(TRE) and fiducial localization error(FLE).

#### P1-135

##### 영상 유전학을 기반의 파킨슨병과 정상 대조군 분류

김만수<sup>1</sup>, 박현진<sup>2,3</sup>

1) 성균관대학교 전자전기컴퓨터공학과

2) 뇌 과학 이미징 연구단, 기초과학연구원

3) 성균관대학교 전자전기공학부

Parkinson's disease (PD) is a common neurodegenerative disorder characterized rigidity. The hallmark of PD is known as loss of dopaminergic neurons in the substantia nigra and striatum. Recently, researchers attempted to use imaging techniques as intermediate phenotype to identify genetic risk factors, known as imaging genetics. In this study, we apply the imaging genetics model to classify between PD and normal control (NC). Four brain regions showed significant degree centrality difference between PD and NC. Many genetic risk factors were identified using the degree centrality of these regions as intermediate phenotype. Finally, we accomplished 72% of accuracy to classify between PD and NC based on imaging genetics model.

#### P1-136

##### 다양한 안저 영상에서의 망막 혈관 두께 측정의 연관성 연구

김현, 서종모

서울대학교 공과대학 전기정보공학부,

서울대학교병원 의생명연구소

Retinal vessel evaluation using medical images can be an important tool for

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analyzing disease progression of not only the retina itself but also systemic disease such as diabetes mellitus and hypertension. The usage of fundus images of the retina has been popular among scientists for many years until the advent of scanning laser ophthalmoscopy(SLO) and optical coherence tomography(OCT). This paper describes and compares the three types of retinal imaging technique frequently used to analyze retinal vessel calibers.

## P1-137

### 엔트로피 최소화를 이용한 듀얼에너지 CT 잡음 저감

이우진<sup>1</sup>, 강세룡<sup>2</sup>, 우상윤<sup>2</sup>, 이상정<sup>2</sup>, 유지용<sup>2</sup>, 이원진<sup>3</sup>

<sup>1</sup>서울대학교 의과대학 협동과정 방사선응용생명과학

<sup>2</sup>서울대학교 융합과학기술대학원 방사선융합의생명전공

<sup>3</sup>서울대학교 치과대학 구강악안면방사선학교실

Increased noise is a general concern for dual-energy material decomposition. In this study, we develop an image-domain noise suppression method for dual-energy CT by incorporating an entropy minimization algorithm. Pixels of decomposed images are first linearly transformed into 2D clusters of data points. An optimal axis is identified in the 2D space via numerical search such that the projection of data clusters onto the axis has minimum entropy. Noise suppression is performed on each image pixel by estimating the center-of-mass values of each data cluster along the direction perpendicular to the projection axis. Our method effectively suppresses variations of dual-energy CT for quantitative use.

## P1-138

### 알츠하이머 환자의 뇌 피각 영역에서의 뇌 네트워크 변화 분석

손성진<sup>1</sup>, 이승학<sup>1</sup>, 박현진<sup>2,3</sup>

1) 성균관대학교 전자전기컴퓨터공학과

2) 뇌 과학 이미징 연구단, 기초과학연구원

3) 성균관대학교 전자전기공학부

Putamen atrophy is commonly observed in Alzheimer's disease (AD). Brain network analysis allows researchers to explore regional dysfunction which might be caused by atrophy. In this study, we acquired structural and resting-state functional MRI of normal control (NC), mild cognitive impairment (MCI) and AD. Brain network analysis using graph theoretical approach was adopted. The volume of putamen was reduced as AD progressed. Betweenness centrality, a network parameter, also changed in putamen. We found that dysfunction of putamen is related to the volume atrophy caused by AD.

## P1-139

### Hough 변환을 이용한 동공 반사 측정에 관한 연구

왕재환, 서종모

서울대학교 공과대학 전기정보공학부,

서울대학교병원 의생명연구소

As an efficient, highly objective clinical examination, pupil response is widely used for the detection of accommodative response of the eye and the early detection of neuro-ophthalmologic disorders. This paper dedicated to the study improving the detection accuracy of using Hough transformation on anterior segment movie clip.

## P1-140

## Resting-state functional MRI 연결성을 이용하여 나이에 따른 주의력 결핍 및 과잉 행동 장애 환자와 정상 그룹간 비교

홍지수<sup>1</sup>, 박현진<sup>2,3</sup>

- 1) 성균관대학교 전자전기컴퓨터공학과
- 2) 뇌 과학 이미징 연구단, 기초과학연구원
- 3) 성균관대학교 전자전기공학부

Attention-Deficit/Hyperactivity disorder (ADHD) is one of the most common behavioral disorders showing abnormalities in attention, cognition and motor control. Previous studies found that these symptoms are related to inferior temporal cortex. In this study, we assessed group-wise differences using a network parameter obtained from connectivity analysis of resting-state functional magnetic resonance imaging between normal and ADHD subjects. Our results showed that the connectivity patterns of each groups were significantly different.

## P1-141

## 금속 음영 감소를 위한 통계적 추출 기법

조태식, 헤가지, 신영권, 손원범, 조민형, 이수열  
경희대학교 생체의공학과

Since the introduction of CT decades ago, CT has widened its application in clinical imaging owing to its superb spatial resolution. However, CT still suffers from metal artifacts when the patient has metal devices or implants. We introduce a statistical metal artifact reduction (MAR) method for dental imaging. We performed experimental imaging of dental phantoms that have dental filling and metal implants. The experimental results has shown great

reduction of metal artifacts.

## P1-142

## 광열치료를 위한 후코이단-황화구리 나노입자

장비안<sup>1,2</sup>, Panchanathan Manivasagan<sup>2</sup>,Santha Moorthy<sup>2</sup>, Junghwan Oh<sup>1,2,3</sup><sup>1</sup>부경대학교 의생명기계전기융합공학협동과정<sup>2</sup>부경대학교 해양융복합 MIBC 사업단<sup>3</sup>해양과학 MIBT 융복합 센터 (BK21Plus)

Copper sulfide nanoparticles (CuS NPs) coated with fucoidan were synthesized and evaluated to prove the potential as a photothermal agent for cancer therapy. The fucoidan-coated copper sulfide nanoparticles were characterized by UV-vis spectroscopy, XRD, FTIR, EDS and TEM. The Copper sulfide nanoparticles were spherical in shape with an average size of 15 nm. Fucoidan-coated copper sulfide nanoparticles exhibited low cytotoxicity against human breast cancer (MDA-MB-231) cells. This study suggests that fucoidan-coated copper sulfide nanoparticles may have the potential as a photothermal agent in the near future.

## P1-143

## A cost-effective advantage of photoacoustic microscopy with laser diode excitation

Van Tu Nguyen,<sup>1</sup> 오정환<sup>2,3</sup><sup>1</sup>부경대학교 의생명융합공학과,<sup>2</sup>부경대학교 의공학과, <sup>3</sup>해양과학 MIBT 융복합 센터

Photoacoustic microscopy (PAM) has great potential for biological tissue imaging in terms of the high spatial resolution, image

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contrast, and depth penetration. But the use of PAM system hindered by its cumbrously and highly-priced solid state laser source. We try to use the low cost laser diode (LD) which operated at wavelength of 905 nm with power output of 130W for photoacoustic imaging. The acoustic signal was picked up by the commercial focused transducer with frequency of 10 Mhz. Scanning across the phantom which is made of silicone tubes filled with poly-pyrrole nanoparticles, earnings a 2D image. The lateral resolution of this PAM system can be measured approximately 0.7  $\mu\text{m}$  by imaging carbon fibers. In addition, the 2D photoacoustic images have been reconstructed by MATLAB to get clear visualization of phantom. The results indicated that the designed PAM could be useful for development of cost effective biological tissue imaging tool.

## P1-144

### 레이저 발생 초음파 트랜스듀서에 의한 충격파의 특성

范晓峰<sup>1</sup>, 강현욱<sup>1</sup>, 하강렬<sup>2</sup>,  
김무준<sup>2</sup>, 김정순<sup>3</sup>, 오정환<sup>1</sup>

<sup>1</sup>부경대학교 의공학과,

<sup>2</sup>부경대학교 물리학과,

<sup>3</sup>동명대학교미디어 학과

On photoacoustic effect, a laser generated ultrasound transducer (LGUT) made of carbon and elastomeric materials can radiate a very short and strong ultrasound pulse waves into water. In this study, the characteristics of the waves from the transducers made by coating carbon nanotube (CNTs) and polydimethylsiloxane (PDMS) on the substrates of poly-

methylmethacrylate (PMMA) were investigated. The three different thickness of CNTs layers (0.3, 0.7, 1.4  $\mu\text{m}$ ) with 9.0  $\mu\text{m}$ -thick PDMS layer and the PDMS layers (4.5, 9.0, 13.5  $\mu\text{m}$ ) with 0.7  $\mu\text{m}$ -thick CNT layer, respectively, were fabricated and examined. There were not significant differences among the measured waves, and all of them have the blast wave-like unique waveforms which could be fitted well by Friedlander equation. The amplitude of the shockwaves attenuated rapidly with -3.45 dB/cm and the propagation speed was about 1495 m/s in 25 °C water.

## P1-145

### 광용적맥파에서의 실시간 호흡수 추정을 위한 향상된 방법

김호담, 임창환

한양대학교 일반대학원 생체공학과

Since respiratory rate (RR) is one of essential biomarkers in many clinical and healthcare applications, estimation of RR from photoplethysmography (PPG) has attracted increased attention from healthcare industry. In this study, we proposed a new method to estimate respiratory rate from PPG using adaptive IIR notch filter, which can effectively estimate a frequency of a signal. Simulation studies showed that our proposed method can estimate RR more quickly (20 seconds) and more precisely (1.96 breaths/min) than existing methods.

## P1-146

### 근전도 센서와 관성센서를 이용한 수화 인식

김성중<sup>1</sup>, 이한수<sup>1</sup>, 김영호<sup>1,2</sup>

<sup>1</sup>연세대학교 보건과학대학 의공학부

<sup>2</sup>연세대학교 대학원 의공학과,  
연세대학교 의료공학연구소

In this study, pattern recognition analysis with feature vector extraction algorithm was applied to distinguish American Sign Language with an armband sensor(8-channel EMG sensors and one IMU). The validation test was carried out with ten people, by stacking 10, 20 and 30 training samples for each letter. Results showed that the recognition accuracy was over 97% with 20 training samples. The present study would be very useful to help the deaf communicate well with the hearing people.

#### P1-147

##### 산광형 레이저 기구를 이용한 기도협착 동물 모델 개발

이형신<sup>1</sup>, 김성원<sup>1</sup>, 이강대<sup>1</sup>,  
옥철호<sup>2</sup>, 강현욱<sup>3</sup>, 오정환<sup>3</sup>

<sup>1</sup>고신대학교 복음병원 이비인후과학교실

<sup>2</sup>고신대학교 복음병원 내과학교실

<sup>3</sup>부경대학교 의공학과

We developed a diffusing laser device with a 1-cm 'active segment' and 360-degree laser functionality to induce tracheal stenosis in an animal model. The diffusing laser device was inserted transorally under bronchoscopic view, and the diffusion laser (10W) was delivered to the tracheal mucosa 2-3 cm below the level of the vocal cords. The laser was administered for five seconds to those in group A (n=7) and for seven seconds to those in group B (n=7). The extent of stenosis in group B (90~98%) was significantly larger than that in group A (75~92%) (p=0.004). Rabbits in group B showed significantly poorer survival (p=0.001).

#### P1-148

##### 호흡기류를 이용한 수면호흡장애 환자의 수면/각성 분류

박종욱<sup>1</sup>, 정필수<sup>1</sup>, 최호선<sup>2</sup>, 이경중<sup>1</sup>

<sup>1</sup>연세대학교 의공학과, <sup>2</sup>대원대학교 간호학과

This study proposes the feasibility for automatic classification of sleep/wakefulness using respiratory signal in patients with sleep-disordered breathing (SDB). We extracted the features for classifying sleep/wakefulness based on time-domain, frequency-domain and non-linear analysis. And then, we conducted the independent two-sample t-test and calculated Mahalanobis Distance (MD) between the two categories. As a results,  $SD_{LEN}$  (MD = 0.84,  $p < 0.01$ ),  $P_{HF}$  (MD = 0.81,  $p < 0.01$ ),  $SD_{AMP}$  (MD = 0.76,  $p = 0.031$ ) and  $MEAN_{AMP}$  (MD = 0.75,  $p < 0.027$ ) were selected as optimal feature. We classified sleep/wakefulness based on support vector machine (SVM). The classification results showed mean of sensitivity (Sen.), specificity (Spe.) and accuracy (Acc.) of 96.7%, 67.2% and 85.8% respectively. These results are comparable to those of previous studies. Therefore, this method has the potential to automatically classify sleep/wakefulness only using nasal flow signal.

#### P1-149

##### 교정 치아 이동 경로 추적을 위한 지그 기반의 스캐닝 시스템

<sup>1</sup>이재철, <sup>1,2</sup>박현국, <sup>3</sup>김경아, <sup>3</sup>박기호,

<sup>1,2</sup>최삼진, <sup>3</sup>박영국

<sup>1</sup>경희대학교 의과대학 의공학교실,

<sup>2</sup>최소침습정밀표적치료연구센터,

<sup>3</sup>경희대학교 치과대학 교정학교실

A new procedure for measuring precise



# POSTER I

orthodontic tooth movement through three-dimensional coordinates of the brackets based on the zig and scanner is proposed in this study. The optic scanning-optimized zigs were designed with types of patient's brackets and applicated to the patient. A three-dimensional shape of the customized zig array was acquired using white-light scanner. The obtained three-dimensional scan data were converted into solid model using three-dimensional CAD software and three-dimensional coordinates of the bracket was acquired. The amount and pattern of the tooth movement through calculating changes in bracket coordinates between two different time points were confirmed quantitatively. Therefore, the orthodontist can recognize the path of teeth before treating the orthodontic appliance to the patient.

## P1-150

### 체외막산소화장치와 결합된 인체순환 시스템에 대한 전산 모델

신동아<sup>1</sup>, 박지흠<sup>1</sup>, 이정찬<sup>2,3</sup>, 김희찬<sup>2,3</sup>

<sup>1</sup>서울대학교 공과대학 바이오엔지니어링 협동과정

<sup>2</sup>서울대학교 의학연구원 의용생체공학연구소

<sup>3</sup>서울대학교 의과대학 의공학교실

Extracorporeal membrane oxygenator (ECMO) has been used for patients suffering from cardiac or respiratory failure or the both to support blood circulation. However, recent study have shown that ECMO support can deteriorate left ventricular performance of the patient with excessive blood flow generated, suggesting that optimal flow rate for each patient may exist to provide the best hemodynamic effects. Accordingly, we developed a

computational model that integrates human circulatory system with ECMO performance to evaluate such hemodynamic effects under different physiological conditions. The simulation results show that cardiac output (CO) decreases during veno-arterial (VA) ECMO support compared to normal condition, changing pressure volume curve accordingly, which well matches to clinical data. By applying various physiological and pathological characteristic of patients to our computational model for further study, we may able to suggest patient-specific optimal flow rate by providing an essential ECMO simulation tool.

## P1-151

### 미세 유체칩 상의 Podocyte와 HUVEC의 배양을 통한 Glomerulus 모델

옥경은, 박도연, 이상훈

고려대학교 바이오융합공학과

고려대학교 KU-KIST 융합대학원 NBIT

고려대학교 보건과학대학 바이오의공학부

Kidney is a complex organ removing waste products of metabolism and regulating homeostasis. Because drug induced nephrotoxicity is often observed during drug development, new drugs and therapies developed for kidney need to be tested. Kidney-on-a-chip is a suitable in vitro model for drug screening because it reproduces similar aspect to in vivo microenvironment. However, existing in vitro models are focused on using proximal tubule cells growing in 2D monolayers. Herein we have developed a 3-layer microfluidic chip by combining polydimethyl siloxane (PDMS) microfluidic channels and a porous membrane substrate to culture the



podocyte and HUVEC.

#### P1-152

##### 음파변환기 거리에 따른 초음파를 이용한 피부 약물전달에 대한연구

송길수, 신운철, 차오름, 김진호, 서종범, 김한성  
연세대학교 보건과학대학 의공학과

The most important mechanism of transdermal drug delivery by using the sonophoresis is cavitation. Through the acoustic pressure of ultrasound transducer, there are two types of cavitation : stable or inertial. And they vary depending on the acoustic pressure of ultrasound transducer. Two different conditions were set up, one which stable cavitation is likely to occur and the other inertial cavitation would occur. In vitro experiment took place in the two independent conditions, using porcine skin. As a result, when sonicated 12mm above the skin with 1.3W/cm in intensity, the amount of drug transmitted through the skin was twice as much, compared to a natural diffusion condition.

#### P1-153

##### 초소형 곤충 모사 시각 기관 설계의 현황과 미래

서민원<sup>1</sup>, 김현<sup>1</sup>, 구교인<sup>2</sup>, 서종모<sup>1,3</sup>

<sup>1</sup>서울대학교 공과대학 전기공학부,

<sup>2</sup>울산대학교 공과대학 전기공학부,

<sup>3</sup>서울대학교병원 의생명연구소

This paper is to discuss about visual system of a small military unmanned aerial vehicle. This visual system of UAV should have three important aspects, wide angle view, high dynamic range and high resolution. The results about these functionality of

a recent study are reviewed. For the wide angle view, micro lens array is fabricated. And For the high dynamic range, neuromorphic image sensor, ATIS sensor is developed. High resolution image sensor is already developed, but for the integration of lens array and image sensor, nanowire image sensor fabrication method has to be developed.

#### P1-154

##### 사이클 운동시 대퇴 피부 온도와 중심부 온도를 이용한 생체 피로 지수 비교

고명준, 심수영, 주광민, 박광석  
서울대학교 바이오엔지니어링 협동과정

Physiological Strain Index (PSI) can be crucial to hard working personnel. Firefighters and soldiers report many cases of heat strokes or heat injuries. Physiological Strain Index is calculated using one's core temperature and heart rate. PSI have values range from 0 to 10, 10 being the most severely harmful to one's body. Normally, PSI 7.5 is the point whether the person is at risk or not risk. When PSI exceed 7.5, one personnel could be in the risk of heat stroke or heat injury. Calculating PSI from core body temperature is cumbersome. One need to swallow temperature sensing pills and fluid intake could mask core temperature for certain period of time. To overcome this problem, Thigh Skin temperature was used instead of core body temperature. This study shows how PSI calculated from thigh skin temperature can be similar to PSI calculated from core body temperature.

# POSTER I

P1-155

적혈구 막과 포도당 수송체 단백질이 고정화된  
포도당 센싱 전극 개발

김인수, 윤대성  
고려대학교 바이오융합공학과

Blood glucose monitoring has formidable importance to diabetes patients. However, it is almost impossible to measure the exact glucose concentration by commonly used electrodes coated with polymeric filter that is not enough to block interfering molecules (i.e., ascorbic acid and uric acid), which have similar and smaller size of glucose. In this regard, glucose specific filter is needed for accurate measurement of glucose concentration. In this paper, we developed glucose sensing electrode functionalized with red blood cell membrane incorporating glucose transporter-1, which can exclusively transports glucose into electrode without nonspecific molecules.

2016년도 제51회

대한의용생체공학회 춘계학술대회

# POSTER II

08:00-09:00 (미래관 4층)

- Medical Nano and Microtechnology
- Neural Engineering
- Orthopedic and Rehabilitation Engineering
- Tissue Engineering and Biomaterials
- U-Health, e-Health.m-Health Technology



# POSTER II

P2-001

## 캘빈 프로브 현미경을 이용한 아밀로이드 베타 섬유의 전기적 특성 규명

이원석<sup>1</sup>, 이형빈<sup>1</sup>, 이상우<sup>1</sup>, 윤대성<sup>2</sup>

<sup>1</sup>연세대학교 의공학과

<sup>2</sup>고려대학교 바이오의공학과

Aggregation of amyloid- $\beta$  (A $\beta$ ) fibrils is highly related with neurodegenerative diseases (i.e., Alzheimer's diseases). It had been reported that A $\beta$  fibrils which electrostatically interacted with cell membrane could lead to cell death in brain. However, electrical properties of amyloid fibrils have not been fully elucidated at molecular level. In this paper, we synthesized A $\beta_{42}$  fibrils in vitro and investigated their structural information by using Atomic force microscopy. In addition, we measured the surface potential of A $\beta_{42}$  fibrils using Kelvin probe force microscopy. These results provide an important clue to understanding the biophysical properties which can help not only to prevent the diseases but also to develop the treatment of amyloidogenic aggregates.

P2-002

## 전기유전영동집게와 산화철 나노입자를 이용한 암세포 특성분석에 관한 연구

오은설, 고관휘, 이현, 배장열, 이재홍

연세대학교 의공학부

Dielectrophoretic tweezers are developed and verified to measure Biophysical/Biochemical properties of living things. Iron oxide nanoparticles can be designed for specific targeting to cancer cells, and we hypothesized the iron oxide nanoparticles could change the electrical properties such

as permittivity and conductivity of cells. In this study, we demonstrate some evidences of that the iron oxide nanoparticles can play roles as cancer cells markers and separate cancer cells among normal cells via dielectrophoretic tweezers.

P2-003

## 디스크 나노입자를 이용한 약물전달 시스템

배장열, 이현, 오은설, 이재홍

연세대학교 보건과학대학 의공학부

Most nanoparticles are prepared by either emulsion or nano-precipitation. While those methods are efficient to yield many nanoparticles within simple steps, it has a limitation to control the shape of nanoparticles precisely which can affect reticuloendothelial system(RES) significantly. Here, we demonstrate 500x200 discoidal polymeric nanoconstructs(DPNs) as a drug delivery carrier. To demonstrate the performance of DPNs, they have multiple payloads, polyethylene glycol(PEG), lipid-Rhodamine B dye(RhB) and salinomycin which is 100 times more effective than paclitaxel to kill breast cancer stem cells in mice. In this study, we characterized properties of DPNs as a therapeutics agent including size, encapsulation efficiency(EE), and cell experiments.

P2-004

## 암 전이 림프절 치료를 향상시키기 위한 나 노입자 연구

임지영, 전옥화, 김병지, 김현구, 박지호

KAIST 바이오및뇌공학과

Lymph node acts as an important

## POSTER II

physiological site for cancer metastasis. Cancer cells preferentially metastasize into regional lymph nodes and subsequently metastasize into distant organs in the body. In this study, negatively charged phosphatidylglycerol liposomes (PG liposomes) were used as a vehicle to deliver anticancer drug efficiently to tumor-draining lymph nodes. PG liposomes showed higher loading efficiency of cisplatin and uptake to tumor cells, macrophages, and dendritic cells in draining lymph node via its enhanced lymphatic delivery. Consequently, PG liposomes can be applied to lymph node metastasis treatment in the future study.

### P2-005

#### 표적 광역학 치료 및 약물 전달을 위한 다공성 실리카 나노입자

정석현, 박상효, 이재홍  
연세대학교 의공학부

Photodynamic therapy (PDT) is a non-invasive medication appropriate to treat tissue lesions with several blood vessels. PDT using nanoparticles is particularly considered as a promising approach to treat malignant tumor selectively while minimizing damage to surrounding healthy tissue. For this purpose, in this study, we report mesoporous silica nanoparticles (MSN) coated with hyaluronic acid (HA) which specifically interact with CD44 receptors that are overexpressed on various cancer cells. The MSN also include chlorin e6 (Ce6) used as a photosensitizer and doxorubicine (Dox) as a chemotherapy drug. Therefore, the HA modified MSN with Ce6 and Dox is enable to target and treat tumor cells at the same time with the external laser sources.

This study demonstrates major properties of this nanoparticle including morphology, hydrodynamic diameter, and cytotoxicity. The HA modified MSN with Ce6 is being developed for in vivo cancer diagnosis and therapy.

### P2-006

#### 유전영동기술을 이용한 생화학적 특성분석 응용연구

박인수, 이상우  
연세대학교 의공학과

The dielectrophoretic (DEP) technique has been widely applied in clinical diagnosis, drug delivery, cell manipulation, immunoassay, etc. This technique enables to manipulate various type of biological materials such as DNA/RNA, protein, cancer cell and bacteria. In this study, we reports our biochemical applications using dielectrophoretic techniques; dielectrophoretic force spectroscopy for characterization of biochemical bonds and quantitative analysis of cellular response to biochemical reactions using dielectrophoretic techniques in micro-fluidic device. This applications of determining biomaterial properties could be very useful for the simultaneous examination from molecule to cell level as it can be easily and cost-effectively implemented within a micro-fluidic device.

### P2-007

#### Modular in Vivo Delivery of CpG-Incorporated Lipid-DNA Nanoparticles for Spleen DC Activation

H. Park,<sup>1</sup> J. Jin,<sup>2</sup> M. Kwak<sup>1</sup>



We introduce a versatile carrier system based on DNA nanoparticles (NPs). Incorporation of lipid-modified nucleobases to DNA strands enables formation of micelles in uniform size. In a single self-assembly step the micelles can be equipped with immune adjuvant (CpG) and fluorescent probe through Watson-Crick base-pairing. With the NPs we have investigated effect of the CpG concentration in immunostimulation. We observed dose dependent activation of TLR-9 resulting in DC maturation in vivo.

#### P2-008

##### 전기유전영동 힘에 따른 미세입자들의 강성도 특성화

최승엽, 김민형, 고관휘, 박인수,  
손명구, 이재홍, 이세영, 이상우  
<sup>1</sup>연세대학교 의공학과

Characterization of the stiffness of multiple particles trapped by tweezers-based force spectroscopy is a key step in building simple, high-throughput, and robust systems that can become bioanalytical tools in order to investigate the molecular interactions in a biological process, but the technology to characterize it in a given environment simultaneously is still lacking. We characterized the stiffness of multiple particles trapped by dielectrophoretic (DEP) tweezers inside a microfluidic device. In this characterization, we introduced the solution containing the carboxylated polystyrene particles in the reservoir, resulting in the existence of electrical repulsion between the particles and the surface. We also developed a method to measure the thermal fluctuations of the trapped multiple particles with DEP tweezers by varying the heights

of the particles in the given environment at the same time. This study not only provides a simple and high-throughput method to measure the trap stiffness of multiple particles inside a microfluidic device using DEP tweezers but also inspires the application of the trapped multiple particles to investigate the dynamics in molecular interactions.

#### P2-009

##### 유체 역학 시뮬레이션을 통한 특정 세포 농축용 필터의 개발

장요창<sup>1,3</sup>, 문희성<sup>2</sup>, 허만승<sup>2,3</sup>, 오진호<sup>2,3</sup>, 이규성<sup>1,3</sup>

<sup>1</sup>성균관대학교 삼성융합의과학원 의료기기산업학과

<sup>2</sup>삼성전자 종합기술원 생명과학연구소

<sup>3</sup>삼성서울병원 의공학연구센터

Autologous therapy requires large numbers of healthy, viable leukocytes (WBCs), which in turn requires large amounts of whole blood to be enriched in a short period of time. However, conventional WBC enrichment methods involve significant manual handling, which is prone to error and contamination, making them difficult to use clinically. In this study, we have devised a novel membrane filter based upon fluid dynamics simulation to maximize its filtering capacity, while minimizing deleterious effects due to cracking, leading to catastrophic failure. Cell recovery (LNCaP: 98%, Jurkat: 83%) and viability (LNCaP: 96%, Jurkat: 92%) was assessed to confirm the filtering capacity of the novel membrane filter, and the filter was then used to directly filter large amounts of whole blood (~10mL) in 15 minutes or less, showing that it would be suitable to be used in clinical settings.

## POSTER II

P2-010

### TNF- $\alpha$ 에 의한 HUVEC의 기계적 특성 변화 분석

김대경, 한수정, 이세영  
연세대학교 의공학부

Recently, Atomic force microscope (AFM) is used to measure the mechanical properties of a variety of nano/micro structure including living cell. In particular, it is useful to measure change of the mechanical properties in the single cell level according to the environmental change. Force-distance curve of the human umbilical vein endothelial cell (HUVEC) can be obtained by using a spherical particle mounted on V-shape cantilever. While the approaching curve provides the elastic property of cell through Hertz model, the retracting curve gives the information about the viscoelastic properties of cells by using Kelvin body model. We measured the mechanical properties of HUVEC treated with TNF- $\alpha$  to see the biophysical response, and observed structural changes in the cell.

P2-011

### 연속적인 화학적 반응법을 이용한 금과 은 나노 입자의 표면증강라만산란 종이 칩의 비교

김완선<sup>1</sup>, 최삼진<sup>1,2</sup>, 박현국<sup>1,2</sup>  
<sup>1</sup>경희대학교 일반대학원 생체의과학과  
<sup>2</sup>경희대학교 의과대학 의공학교실

We introduce a facile, rapid, low-cost, highly reproducible, and equipment-free synthesizable fabrication method of gold nanoparticle (AuNP) and silver nanoparticle (AgNP) on the paper substrate using the successive ionic layer absorption and reaction (SILAR) method. Surface

enhanced Raman spectrum (SERS) effect, generated by plasmonic AgNPs and AuNPs deposited directly on paper through the SILAR approach allowing to control the size of nanoparticle or the thickness of film through multiple repetition of the chemical reactions were investigated and compared. The interesting advantage of this approach is to require no external equipment for synthesis of the nanoparticles. The potential of gold- and silver-based sensors was evaluated through human cervical fluid for clinical diagnosis of human papillomavirus (HPV) infection and three indistinguishable keratoconjunctivitis in the initial stage.

P2-012

### 원심미세유체역학 기반의 삼차원 스페로이드 형성

박지흠<sup>1</sup>, 이기훈<sup>2</sup>, 박중열<sup>2</sup>, 이정찬<sup>3,4</sup>, 김희찬<sup>3,4</sup>  
<sup>1</sup>서울대학교 공과대학 바이오엔지니어링 협동과정  
<sup>2</sup>중앙대학교 기계공학과  
<sup>3</sup>서울대학교 의학연구원 의용생체공학연구소  
<sup>4</sup>서울대학교 의과대학 의공학교실

Three dimensional (3D) spheroid culture technique is particularly important in drug discovery and cancer research as they are known to represent in-vivo environment much better than 2D monolayers. However, conventional ways to generate 3D spheroids have limitations in controlling size and shape to create homogeneous spheroids while achieving high levels of productivity. In this study, we propose a novel method for 3D multicellular spheroid culture using centrifugal microfluidic techniques. Centrifugal force allows cell suspensions loaded at the center of the rotating platform to evenly distribute toward micro-wells

placed at the outer edge, improving size consistency of the spheroids created at each well and continuous hypergravity condition improves shape consistency as well.

## P2-013

### 엑소좀의 라만신호 분류를 통한 폐암 세포 구분법

박재나, 황미연, 최연호  
고려대 바이오융합공학과  
고려대 바이오의공학부

Exosome is a membrane vesicle studied as an indicator of cancer. Exosome has unique composition of membrane proteins resulting in distinctive Raman spectrum. These Raman spectrums thus is a fingerprint of each lung cell derived exosome. In this study, we propose a lung cancer cell classification method by recognizing the patterns of Raman spectrums of exosome by principal component analysis (PCA). We were able to classify H522, H1299 cell derived exosome from alveolar cell derived exosome.

## P2-014

### 마이크로 인젝션 시스템을 이용한 펌프 부피의 용액을 정량적으로 주입하기 위한 실험적 이론 설계

유제원<sup>1</sup>, 권효성<sup>1</sup>, 박항수<sup>2</sup>, 홍성희<sup>2,3</sup>, 최연호<sup>1,4</sup>  
<sup>1</sup>고려대학교 바이오융합공학과  
<sup>2</sup>고려대학교 의생명융합과학과  
<sup>3</sup>고려대학교 바이오시스템의과학부  
<sup>4</sup>고려대학교 바이오의공학부

Injection has been widely used as an effective delivering method, because delivered volume can be easily controlled.

According to the advancement of fabrication technology, injector size is reduced from cm to nm. Therefore, applied model is also smaller from an animal to a cell. In small scale, however, the measurement and the theoretical prediction of injected volume is challengeable, because inertial forces are sharply decreased. In this paper, we observed the empirical injected volume result in femtoscale. Based on these results, we suggest theoretical equation for injection volume prediction. This technique would be applied to the field of cell engineering.

## P2-015

### 표면 플라즈몬 포획 기반의 자가 조립 핫 스팟을 통한 분자 탐지

심온, 홍순우, 권효성, 최연호  
고려대학교 바이오융합공학과

Since surface-enhanced Raman spectroscopy (SERS) can enhance weak Raman signal from molecules, it has been spotlighted. Although SERS can detect molecules with label-free and sensitively, its enhancement factor depends on the substrate design. Here, we converged plasmonic trapping with conventional SERS. This is troubleshooting for expensive cost to build substrates and high time efforts. We could trap gold nano particles (GNPs) onto gold nano bowtie pattern and fabricate self-aligned hot-spots. As trapped GNPs triggered shortening of nano structure's gap distance, it makes more enhanced signal on the site. We also conducted numerical analysis for electric field distribution and trapping force.

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P2-016

### 동맥류 치료용 생체흡수성 폴리머를 코팅한 혈관스텐트에 관한 연구

이도희<sup>1</sup>, 이준희<sup>2</sup>, 박찬희<sup>#</sup>, 김철생<sup>#</sup>  
전북대학교 바이오테크놀로지 공학과

We propose a new biodegradable nanofiber stent coating method. This method is fast, cost-effective, and adaptable. Since the stent is coated with nanofibers, it blocks and seals the aneurysm immediately. It is also cost-effective compared to the stent-assisted coiling method because it only needs one operation. Nanofiber coated stents do not rely on thrombosis to be effective, so they allow for additional treatment in the occurrence of recurrence. The use of biodegradable polymers to make the nanofiber coating means that the coating will degrade with the healing of the aneurysm. In this study, we were able to confirm the manner in which the blood flowed into the aneurysm through PIV in vitro testing. We were also able to confirm the effectiveness of this new stent coating through animal testing in vivo.

P2-017

### 플라즈몬 바이오센서를 위한 크기와 물질 조성에 따른 나노입자 배열 제작

홍민기<sup>1</sup>, 신현구<sup>2</sup>, 최연호<sup>1,2</sup>  
고려대학교 바이오의공학부<sup>1</sup>  
고려대학교 바이오융합공학과<sup>2</sup>

Controlling scattering profiles of metal nanoparticles array is critical issue in surface plasmon resonance based biosensor fields. Here, we demonstrated the self-assembly fabrication method with nanosphere lithography and thermal annealing. In first,

closed-packed monolayer of polystyrene (PS) particles were patterned on a substrate by drop-coating, and then 10 to 50 nm metal film were deposited on the substrate. After removal of the PS particles, the substrate were annealing at over 400 °C. Finally, we could fabricate the hexagonal plasmonic nanoparticle array, and the structural and optical properties depend on metal thickness and composition of metal film. We expected that these nanoparticle array can applied to detecting the secretion and real-time monitoring of a living cell.

P2-018

### 알렌드로네이트가 결합된 금 나노입자를 이용한 골 흡수 방지

이동현, 권일근  
경희대학교 일반대학원 치의학과  
경희대학교 치의학전문대학원 치과재료학교실

The goal of this study was to improve bone-tissue regeneration by using targeted gold nanoparticles (GNPs). We fabricated a functionalized GNPs conjugated with alendronate (ALD). Subsequently, the ALD, GNPs, and ALD conjugated GNPs (GNPs-ALD) were used to investigate their inhibitory effects on bone marrow-derived macrophages (BMMs) differentiation, and these were applied to ovariectomy (OVX)-induced osteoporotic mice. The in-vitro study indicated that the GNPs, ALD and GNPs-ALD suppressed osteoclast formation, and the mice treated GNPs-ALD had higher bone density as compared to other groups. The results from these tests indicated that GNPs-ALD can be useful agents for preventing and treating osteoporosis.

## P2-019

세포 spheroid 생성용 3D goblet 마이크로 웰  
김성환, 박중열  
중앙대학교 기계공학부

For spheroid cell culture, concave microwell array has been used. The 3D concave shape has advantages including uniform-sized spheroid formation. Keeping such benefits, some studies developed concave microwell-based co-culture systems using microfluidic technology. However, in such co-culture systems, the spheroids were exposed to unwanted flow and shear stress. Here, we proposed a novel spheroid co-culture system where interaction occurs by diffusion not convective flow. In our system, the microwell has goblet-shape which consists of two parts; hemispherical microwell and connected hole filled with agarose gel. We hope this new microwell system can be used for studying cancer cell metastasis and immune mechanism.

## P2-020

전기방사를 통한 키토산-카페익산/폴리카프로  
락톤 나노/마이크로 멤브레인 제작

오건우<sup>1,2</sup>, 제재영<sup>3</sup>, 김영목<sup>4</sup>, 정원교<sup>1,2</sup>

<sup>1</sup>부경대학교 의공학과 및 BK21 plus  
해양MIBT융복합사업단

<sup>2</sup>부경대학교 해양융복합바이오닉스 MIBC 연구단

<sup>3</sup>부경대학교 과학기술융합전문대학원  
해양바이오융합과학전공

<sup>4</sup>부경대학교 식품공학과

In the present study, we designed composite nano/microfiber mats consisting of poly ( $\epsilon$ -caprolactone) (PCL), chitosan (CH), or chitosan-caffeic acid conjugate (CCA) fabricated by an electrospinning technique

for wound dressing application. The PCL/CCA composite shows significantly higher initial cell attachment and cell proliferation than the PCL and PCL/CH composites, and a high anti-microbial effect was observed compared to the PCL and PCL/CH composites. Based on these results, the CCA is demonstrated to be good supplemental bioactive agent for wound dressing applications and skin tissue engineering.

## P2-021

Preparation of Chitosan coated  
Magnetic-Liposome Nanoparticles for  
pH and Temperature Responsive Drug  
Delivery Applications

Thi Tuong Vy Phan,<sup>1</sup>

Madhappan Santha Moorthy,<sup>1</sup> 오정환<sup>1,2</sup>

<sup>1</sup>해양융복합바이오닉스 MIBC,

<sup>2</sup>부경대학교 의공학과

The current study reports the development and characterization of a chitosan coated magnetic-liposomes as a potential carrier for drug delivery. The advantages of the magnetic nanoparticles in drug delivery applications that can be transported through the vascular system and can be concentrated at a particular point of the body by the external magnetic field. Liposomes are well known for drug delivery for long times. However, liposomes as well as magnetic nanoparticles are prone to adhere to each other and fuse to form aggregation and also the short circulation after intravenous administration of liposomes limit their development in the application. The magnetic-liposomes with iron oxide nanoparticles and thermosensitive



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liposomes (composed of DPPC/Chol) were prepared by reverse-phase evaporation. We used chitosan which has many interesting characteristics such as: pH sensitive, biocompatibility, biodegradability, low toxicity, and low immunogenicity to coat the magnetic liposome in order to increase the stability of liposomes and prevent the magnetic liposomes from the aggregation. The loaded drug molecules can be released from the chitosan coated magnetic liposome nanoparticles by pH stimuli and external magnetic hyperthermia stimuli to the target tumor sites. Long-term storage of chitosan-coated magnetic liposomes showed that chitosan coating significantly improved the stability of magnetic liposome. In conclusion, pH and temperature sensitive chitosan-coated magnetic liposomes were synthesized successfully and can be a promising for tumor-targeted drug delivery.

### P2-022

Synthesis of  $\text{Fe}_3\text{O}_4@\text{SiO}_2@\text{PolyGlycidol}$  Functionalized Nanoparticles for pH and Magnetic Stimuli-Responsive Drug Delivery and Fluorescence Imaging Applications.

M. Santha Moorthy<sup>1</sup>, Yunok Oh<sup>1</sup>,

R. Thenmozhi<sup>2</sup>, J. Bian<sup>1</sup>, Junghwan Oh<sup>1,2</sup>

<sup>1</sup>Marine-Integrated Bionics Research Center,  
Pukyong National University

<sup>2</sup>Department of Biomedical Engineering and  
Center for Marine-Integrated Biotechnology  
(BK21 Plus), Pukyong National University

Nanoparticles offer a range of potential applications based on their unique characteristics. In particular, magnetic nanomaterials represent one of the most exciting prospects in current

nanotechnology. Magnetic and fluorescent inorganic nanoparticles are of particular importance due to their broad range of potential applications. By focusing this point, we have designed and synthesized a highly fluorescent, magnetic  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  nanoparticles by attaching the fluorescein (FITC) fluorophore. To further improve their biocompatibility, the silica-coated  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  nanoparticles were further functionalized with polyglycidol functional groups to obtain the final  $\text{Fe}_3\text{O}_4@\text{SiO}_2@\text{Polyglycidol}$  nanoparticles. The resulted materials were characterized using XRD, FTIR, SEM, TEM, DLS and TGA analysis. The  $\text{Fe}_3\text{O}_4@\text{SiO}_2@\text{Polyglycidol}$  nanoparticles were used for loading anticancer drug and pH and hyperthermia induced drug release applications.

### P2-023

In vitro evaluation of paclitaxel-loaded chitosan oligosaccharide capped gold nanoparticles as a novel carrier for anticancer drug delivery

Panchanthan Manivasagan<sup>1</sup>, Subramaniyan

Bharathiraja<sup>1</sup>, and Junghwan Oh<sup>1,2</sup>

<sup>1</sup>Marine-Integrated Bionics Research Center,  
Pukyong National University

<sup>2</sup>Department of Biomedical Engineering and  
Center for Marine-Integrated Biotechnology  
(BK21 Plus), Pukyong National University

Polymer nanoparticles have emerged as potential drug carriers for anticancer agents. Biocompatible gold nanoparticles (AuNPs) were synthesized using chitosan oligosaccharide (COS) as reducing and stabilizing agent and subsequently loaded with paclitaxel (PTX) to demonstrate



their use for drug delivery of MDA-MB-231 human breast cancer cells. The biosynthesized chitosan oligosaccharide capped gold nanoparticles (COS AuNPs) characterized using X-ray diffraction (XRD) analysis, fourier transform infrared spectroscopy (FTIR), field emission scanning electron microscopy (FESEM), high resolution transmission electron microscopy (HRTEM), energy dispersive X-ray spectroscopy (EDX), dynamic light scattering (DLS) and zeta potential (ZP). The COS AuNPs were spherical in shape with an average particle size of  $55.11 \pm 3.94$  nm. The paclitaxel-loaded chitosan oligosaccharide capped gold nanoparticles (PTX-COS AuNPs) showed sustained and pH-dependent drug release profiles. The PTX-COS AuNPs exhibited strong cytotoxic effect against MDA-MB-231 cells through induction of apoptosis with enhanced ROS generation altered MMP level. These results revealed that promising potential of PTX-COS AuNPs as drug delivery and cancer therapy in the near future.

## P2-024

Doxorubicin-loaded fucoidan-stabilized gold nanoparticles as a novel carrier for anticancer drug delivery

Panchanthan Manivasagan<sup>1</sup> and

Junghwan Oh<sup>1,2</sup>

<sup>1</sup> Marine-Integrated Bionics Research Center,  
Pukyong National University

<sup>2</sup> Department of Biomedical Engineering and  
Center for Marine-Integrated Biotechnology  
(BK21 Plus), Pukyong National University

Polymer nanoparticles are emerging as a useful tool for a wide variety of

biomedical applications such as drug delivery and imaging. Recent advances in bionanotechnology have contributed to the development of multifunctional nanoparticles as representative nanomedicine. The present study involves the doxorubicin-loaded fucoidan-stabilized gold nanoparticles as a novel carrier for anticancer drug delivery. Gold nanoparticles were biosynthesized using fucoidan as a reducing and stabilizing agent. The fucoidan-stabilized gold nanoparticles synthesis was determined by UV-visible spectrum and it was further characterized by X-ray diffraction analysis, Fourier transform infrared spectroscopy, field emission scanning electron microscopy, high resolution transmission electron microscopy, energy dispersive X-ray spectroscopy and dynamic light scattering. The release of doxorubicin from doxorubicin-loaded fucoidan-stabilized gold nanoparticles was higher in acidic pH (4.5) as compared to neutral pH (7.4). The in vitro cytotoxic effect of doxorubicin from doxorubicin-loaded fucoidan-stabilized gold nanoparticles (DOX-Fu AuNPs) exhibited strong cytotoxic effect against MDA-MB-231 cells. These results revealed that promising potential of doxorubicin-loaded fucoidan-stabilized gold nanoparticles as novel carrier for drug delivery of cancer cells.

## P2-025

Design of Core-Shell  $\text{Fe}_3\text{O}_4$ @  
Mesoporous Organosilica Nanocarrier  
for pH and Hyperthermia Stimuli-  
Responsive Controlled Drug Delivery in  
Cancer Therapy

M. Santha Moorthy,<sup>1</sup> P. Manivasagam,<sup>1</sup>

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S. Bharathiraja,<sup>1</sup> Phan Vy,<sup>2</sup> Junghwan Oh<sup>1,2</sup>

<sup>1</sup>Marine-Integrated Bionics Research Center,  
Pukyong National University

<sup>2</sup>Department of Biomedical Engineering and  
Center for Marine-Integrated Biotechnology  
(BK21 Plus), Pukyong National University

Among numerous drug delivery systems tested, mesoporous silica nanoparticles (MSNs) stand out to be a promising candidate in drug delivery applications. In particular, mesoporous silica nanoparticles (MSNs) are widely used as a delivery reagent because silica possesses favorable chemical properties, thermal stability, and biocompatibility. Herein, we have designed of core-shell  $\text{Fe}_3\text{O}_4$ @Mesoporous organosilicas for pH and hyperthermia stimuli-responsive controlled drug delivery in cancer therapy.

## P2-026

Synthesis of Core-Shell  $\text{Fe}_3\text{O}_4$ @  
 $\text{SiO}_2$ @HAp Nanoparticles for pH  
and Temperature Responsive Drug  
Delivery Applications in Cancer  
therapy.

R. Thenmozhi<sup>1,2</sup>, Santha Moorthy<sup>3</sup> and  
Junghwan Oh<sup>1,2,3</sup>

<sup>1</sup>Center of Marine-Integrated  
Biomedical Technology (BK21 Plus),  
Pukyong National University

<sup>2</sup> Interdisciplinary Program of Marine-Bio,  
Electrical & Mechanical Engineering,  
Pukyong National University

<sup>3</sup>Marine-Integrated Bionics Research Center,  
Pukyong National University

We synthesized a novel core-shell  $\text{Fe}_3\text{O}_4$ @  
hydroxyapatite nanoparticle as an efficient  
nanocarrier for anti-cancer drug delivery

application. The synthesized drug carrier system play a vital role in rendering the drug release in pH and temperature stimuli conditions. Dynamic Light Scattering data revealed the synthesized iron nanoparticle size around 35–55nm. The designed drug carrier system shows good biocompatibility and therefore useful as a carrier vehicle for loading and releasing anti-cancer drugs in cancer therapy.

## P2-027

디클로페낙 제어 전달을 위한 이식형 마이크로  
칩

이승호<sup>1</sup>, 지한비<sup>2</sup>, 최영빈<sup>1, 2, 3</sup>

<sup>1</sup>서울대학교 의학연구원 의용생체공학연구소

<sup>2</sup>서울대학교 바이오엔지니어링 협동과정

<sup>3</sup>서울대학교 의과대학 의공학교실

We prepared an implantable micro-chip enabled for controlled delivery of diclofenac sodium (DS). The micro-chip was made of poly(methyl methacrylate), where a pair of micro-channels and micro-wells was embedded to serve as a drug diffusion barrier and a reservoir, respectively. As we adjusted the length and cross-sectional area of the channel, the drug release profiles could be accurately tailored, following the Fick's 1<sup>st</sup> law of diffusion. Thus, by properly combining multiple pairs of micro-wells and channels of different geometry, a single microchip could release the drug in a zero-order pattern. The microchip herein also demonstrated continuous, long-term exposure of the drug in vivo.

## P2-028

## 약물주입경로 오류방지를 위한 주사기-카테터 간 어댑터 시스템

조용찬<sup>1</sup>, 이승호<sup>2</sup>, 남동연<sup>1</sup>, 조양현<sup>3</sup>, 최영빈<sup>1,2,4</sup><sup>1</sup>서울대학교 바이오엔지니어링 협동과정<sup>2</sup>서울대학교 의학연구원 의용생체공학연구소<sup>3</sup>성균관대학교 의과대학 흉부외과<sup>4</sup>서울대학교 의과대학 의공학교실

Wrong-route errors with medication are administrations of drug to an undesired patient, or nonintended site in a patient. These can result in patients' death in serious cases. As a protective modality, we suggest a "lock and key" adapter system installed between a catheter and syringe, which allows connectivity only when the drug in a syringe and profiles of patient match. Syringe adapter was shaped to be a key with patterned ridges, and catheter adapter was shaped to be a lock with patterned grooves. We envision that clinicians can realize the wrong route errors by perceiving the mismatching between the adapters.

## P2-029

## 경두개직류전류자극을 통한 정상상태시각유발 전위 조절

김의진, 임창환

한양대학교 생체공학과

Steady state visual evoked potential (SSVEP) is a one of the most widely used EEG signals because the brain-computer interface (BCI) systems based on SSVEP have high accuracy and information transfer rate even with low or no training procedures. However, some participants cannot generate SSVEP responses strong enough to be used for SSVEP-based BCI systems. In this paper, we have investigated

whether 20-min anodal transcranial direct current stimulation (tDCS) can enhance the representative SSVEP features for BCI.

## P2-030

## 웨이블릿과 DPW를 이용한 개선된 안구전도 기반 눈글 인식 시스템

장원두, 임창환

한양대학교 생체공학과

'Eye-writing' is a technique to draw patterns by moving a person's gaze, which is a promising tool for various HCI applications. This paper proposes a novel method to improve conventional EOG-based 'eye-writing' systems, by employing wavelet coefficients and dynamic positional warping. The proposed method dramatically increased the mean accuracy from 87.4% to 97.8%, where the worst accuracy among the participants was just 89.9%.

## P2-031

## 말초 신경신호의 활동전위 분류

추준욱

한국기계연구원 대구융합기술연구센터

In neuro-prosthetic hand, restoring sensory feedback is necessary to improve grasping and manipulation functions. As a preliminary study, it was attempted to decode sensory information by muscle proprioceptors and skin exteroceptors. During passive movements and mechanical stimuli, muscle and cutaneous afferent signals were recorded from the rat sciatic nerve, and a spike sorting was performed to isolate individual neuronal unit. The proprioceptive units were classified as

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muscle spindle afferents or Golgi tendon organ afferents, and the exteroceptive units were categorized as slow adapting afferents or fast adapting afferents.

### P2-032

#### 효과적인 심부 피질 자극을 위한 경두개 직류전 기 자극 전극 배치법

이상준, 이찬희, 임창환  
한양대학교 생체공학과

Transcranial direct current stimulation (tDCS) delivers weak current to the cortex to modulate neuronal excitability using electrodes attached on the scalp. The degree of modulation is depending on the magnitude of current density which is mainly determined by the placement of electrodes. We investigate the optimal montage via two finite element models for stimulating three different targets located at nonsuperficial cortical regions.

### P2-033

#### 회전 음원을 이용하는 안구전도 기반의 새로운 이진 의사소통 패러다임

김도연, 한창희, 임창환  
한양대학교 생체공학과

Recently, brain-computer interface (BCI) studies have focused on developing various BCI paradigms to assist communication of patients with locked-in syndrome. The performance of previous paradigms is slowly improving but has not fulfilled two primary goals: high reliability and universal usability. Here we present a new EOG-based binary communication paradigm using sound rotation, which does not require

training nor voluntary eye movements. The hypothesis was the proposed paradigm would detect a user's decision between binary options, two different-frequency songs, in real-time. Six healthy subjects were participated, and their left and right horizontal EOG signals were measured. An average accuracy was 90%.

### P2-034

#### 뇌종양 환자 치료를 위한 두개골 이식용 약물주 입장치 기술개발

김영태<sup>1</sup>, 서종현<sup>1</sup>, 김광기<sup>1</sup>, 유현<sup>2</sup>  
국립암센터 융합기술연구부 의공학연구과<sup>1</sup>  
국립암센터 신경외과<sup>2</sup>

Brain cancer patients need regular injection of drug into the ventricles or tumor cavities for several months or about one year. Ommaya reservoir has been mainly used in leptomeningeal carcinomatosis. However, it is not easy to find exact location to inject drug as it is easily deformed under skin of scalp after being implanted since it is made of soft polymeric materials. There have also been related complications reported. The chemoport for lung cancer is capable of repeated injection and long-time use as it is made of hard materials and easy to find where the port is on the skin surface. Thus, brain chemoport was designed and clinically tested to see its usability and long-time use compared with the Ommaya reservoir.

### P2-035

#### EEG-tDCS 결합 시스템을 이용한 개인별 머리 내부 전도도 추정

이찬희, 이상준, 임창환  
한양대학교 전기생체공학부 생체공학전공

In this paper, we propose a method to estimate electric conductivity inside head using combined electroencephalography (EEG)-transcranial direct current stimulation (tDCS) system. Sinusoidal electric current was injected to tDCS electrodes, and EEG electrodes collected electric potential, simultaneously. Potential distribution was calculated using a finite element (FE) model which consists of brain, cerebrospinal fluid, skull and scalp. Electric conductivities were parameters of optimization. As an optimization algorithm, evolutionary strategy (ES) minimized the difference between calculated and measured potentials. For each calculation of FE method, electric conductivities were varied and tested by ES. Our suggested method could estimate individual conductivity inside head.

#### P2-036

##### 파킨슨 환자의 진전 증상 모니터링 및 평가를 위한 SVM 모델

전효선<sup>1</sup>, 이홍지<sup>1</sup>, 김상경<sup>1</sup>, 김한별<sup>1</sup>,  
박혜영<sup>2</sup>, 이웅우<sup>2</sup>, 전범석<sup>2</sup>, 박광석<sup>3</sup>

1 서울대학교 협동과정 바이오엔지니어링 전공

2 서울대학교 의과대학 신경과

3 서울대학교 의과대학 의공학과

The purpose of this study is to construct a classifier, SVM model, for monitoring and quantification of Parkinsonian tremor. We measured the tremor at the middle finger and the wrist using a wearable device, consist of accelerometer and gyroscope. Eight features were extracted from acceleration of the finger. SVM model was constructed with several feature among 8 features and then, the model

with the best performance was selected. The performance of SVM was accuracy 83.33%, sensitivity 80%, and specificity 85.71%. This result shows that the wearable device with this SVM model may have a potential for monitoring and quantification for the Parkinsonian tremor.

#### P2-037

##### 다공성 금 나노구조체를 이용한 신경전극 성능 향상

김용희, 김국화, 박종길, 정상돈  
한국전자통신연구원, 시냅스 소자 창의연구실

Ag:Au alloy was electro-co-deposited on bi-layer lift-off resist sputter-deposition passivated Au MEA followed by chemical etching of Ag to form porous Au structure. The impedance value of the nanoporous Au-modified MEA is  $15.4 \pm 0.55 \text{ k}\Omega$  at 1 kHz. The charge injection limit of the nanoporous Au-modified electrode estimated from voltage transient measurement is ca. 1 mC/cm<sup>2</sup>, which is comparable to roughened platinum and carbon nanotube electrode. The charge injection capability of the nanoporous Au-modified MEA was confirmed by observing stimulus-induced spikes at above 0.2 V. The nanoporous Au-modified MEA showed mechanical durability upon ultrasonic treatment up to an hour.

#### P2-038

##### 운동피질자극에 의해 유도된 뒷다리와 꼬리 움직임 관찰

이유진<sup>1</sup>, 이지원<sup>1</sup>, 이에나<sup>1</sup>, 조윤경<sup>1</sup>,  
도진경<sup>1</sup>, 박찬웅<sup>2</sup>, 전상범<sup>1,3</sup>  
<sup>1</sup>이화여자대학교 전자공학과



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<sup>2</sup>서강대학교 물리학과  
<sup>3</sup>이화여자대학교 뇌인지과학과

The movement of tail and hindlimb can be induced by electrical stimulation on the corresponding motor areas of rat brain cortex. The knowledge for neuromodulation in brain motor cortex can be valuable for motor neural prostheses as well as basic neuroscience studies. In this study, electrical stimulation was applied on the rat primary motor cortex processing tail and hindlimb movements. The correlation of rat hindlimb and tail movement is carefully investigated. Because of tail's contribution to rat movement, this study can be the fundamental of animal behavioral experiments.

## P2-039

### 금 나노입자가 신경 세포에 미치는 독성 분석

김순영<sup>1</sup>, 황서영<sup>1</sup>, 정혜선<sup>1</sup>, 장자윤<sup>1</sup>, 전상범<sup>1,2</sup>

<sup>1</sup>이화여자대학교 전자공학과

<sup>2</sup>이화여자대학교 뇌인지과학과

Recently, for various purposes such as bioimaging, drug delivery, and neuromodulation, researches utilizing nanoparticles are being conducted. Previously, there have been investigations to assess toxicity of nanoparticles upon various types of cells. In this study, neurotoxicity of gold nanoparticles are analyzed by observing cultured hippocampal neurons seeded with gold nanorods (59 nm and 146 nm in length). The effects are different depending on the size and the concentration of the particles. Intriguingly, severe toxicity was observed with the larger size and heavier concentration rates. This study is expected to serve as a

foundation experiment for further research on the cytotoxicity of gold nanoparticles.

## P2-040

### DMD 를 이용한 광열패턴 자극 시스템 개발 및 검증

정현준, 남윤기

KAIST 바이오 및 뇌공학과

Photothermalneuralstimulationhasattracted attentions due to its high spatiotemporal resolution with minimal invasiveness and genetic free characteristics. Recently our group developed neural suppression technique using NIR laser and Gold NanoRods. However further studies are necessary to characterize the effect of photothermal stimulation on neural suppression and system for patterned photothermal neural inhibition is required. In this paper, we developed patterned NIR illumination system for area-specific photothermal neural inhibition using digitally micro-mirror device. We could illuminate specific NIR pattern on the sample surface and measured laser power density available for each objective lens.

## P2-041

### 동물 행동 제어를 위한 유선 제어기의 설계 및 제작

심신용, 박정환, 김성준

서울대학교 전기정보공학부

Recently, to control animal behavior, a fully implantable micro-current stimulator is constructed. Prior to implantation of the device for stimulation, exact positioning of the stimulation site is essential. Much more,



the feasibility of electrical stimulation on behavior control at that site should be also determined. In this paper, a wired controller for animal behavior is developed using FPGA and current stimulator ASIC. The controller is designed to modulate stimulation parameters such as pulse rate, duration, and amplitude of biphasic current. Stimulation pulses are successfully generated as preset parameters.

#### P2-042

Development of LCP (Liquid Crystal Polymer) based Cuff Electrode and its Application to Peripheral Nerve Stimulation

Jungmin Seo<sup>1</sup>, Jee Hye Wee<sup>2</sup>, Jeong-Hoan Park<sup>1</sup>, Pona Park<sup>2</sup>, Jeong-Whun Kim<sup>2</sup>, and Sung June Kim<sup>1</sup>

<sup>1</sup> Department of Electrical and Computer Engineering, Seoul National University

<sup>2</sup> Department of Otorhinolaryngology, Seoul National University Hospital College of Medicine

A liquid crystal polymer (LCP) based cuff electrode was designed and fabricated. The cuff electrode consists of two Au metal sites and an LCP substrate. The LCP substrate is biocompatible and flexible. The fabricated cuff electrode was evaluated through in vitro and in vivo tests. Charge storage capacity (CSC) and impedance were measured in the phosphate buffer solution. Subsequently, the cuff electrode was installed around the hypoglossal nerve of rabbit to observe the effect of in vivo stimulation. The C-arm fluoroscopy was utilized to observe broadening of the upper airway of the subject while the electrode was percutaneously connected to the

pulse generator which provides a pulsed current with adjustable parameters. The evaluated CSC and the impedance at 1 kHz were  $0.35\text{mC/cm}^2$  and  $0.418 \angle -55.78^\circ \text{k}\Omega$ , respectively. The upper airway broadening was observed with the stimulation current with level, rate, and duration for  $41.0 \mu\text{A}$ ,  $0.635 \text{ kHz}$ , and  $0.375 \text{ ms}$ , respectively.

#### P2-043

정규화 전이 엔트로피 알고리즘을 이용하여 관찰한 이소플루란 마취 중 쥐 뇌파 연결성의 변화

배재영<sup>1)</sup>, 조동래<sup>1)</sup>, 이보름<sup>1)</sup>, 김재관<sup>1)</sup>

광주과학기술원 <sup>1)</sup>의생명공학과

Electroencephalography (EEG) is generally used as a surrogate parameter to observe the effect of anesthetic agents. Currently, Bispectral index (BIS) is a popular method for monitoring the depth of anesthesia by analyzing EEG. However, for non GABAergic agents, pediatric and cerebropathic patients, BIS cannot be applied due to their neurophysiologic differences. Thus, we have investigated other method to evaluate the depth of anesthesia. In this study, we applied a normalized transfer entropy algorithm to analyze the EEG connectivity of brain. We expect that it could be used to compensate the drawbacks of the Bispectral index method.

#### P2-044

CPLD를 이용한 프로그래머블 신경자극기 개발

박영상, 문동준, 송인호, 문진희,

유성근, 김진원, 이승아, 정하철,

봉선우, 안진우, 이상훈

오송첨단의료산업진흥재단

첨단의료기기개발지원센터 제품개발부 첨단융합팀

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The aim of this study is to develop neuro-stimulator generating various stimulation pulse waveforms by programming. The developed neuro-stimulator in this study consists of micro controller unit(MCU), complex programmable logic device(CPLD), digital to analog converter(DAC), charge pump, and biphasic circuit. We could implemented that width and amplitude of stimulation pulse waveforms were controlled 1 us and 13 mV step size, respectively. The develop neuro-stimulator could generate up to 9.8 V biphasic pulse. The frequency range of stimulation pulse waveforms could controlled 10 ~2 kHz.

P2-045

이식형 액정폴리머 기반 대뇌 피질 자극 장치

안승희<sup>1</sup>, 윤승현<sup>1</sup>, 신재우<sup>2</sup>, 공찬호<sup>2</sup>,

정현호<sup>2</sup>, 장진우<sup>2</sup>, 김성준<sup>1</sup>

<sup>1</sup>서울대학교 전기·정보공학부

<sup>2</sup>연세대학교 의과대학 신경외과

An implantable neurostimulator using liquid crystal polymer is suggested. This device is targeting hind limb area of cerebral motor cortex in pain model rat. The stimulator contains 4-channel planar electrode and monolithic package with size of about 15 mm diameter. The electrode was fabricated with MEMS process and the electric circuit module was packaged with conformal deformation and thermal pressing of liquid crystal polymer

P2-046

동물행동제어를 위한 무선중계기의 설계

윤승현, 박정환, 정준수, 김성준

서울대학교 공과대학 전기정보공학부

A wireless transceiver meant to be mounted on the animal was designed to solve the problems caused by the cables in electrical stimulation. The purpose of the transceiver is delivering control data from user to the implanted system. ZigBee protocol which has the advantage of low power consumption was selected for user-to-transceiver communication. Inductive coupled link was used to communicate between the transceiver and the implanted system. In the circuit, RF module with a microprocessor was used to implement ZigBee protocol and class-e amp was used for inductive coupled link. Designed transceiver had compatibility with other implantable system.

P2-047

이전 엔트로피를 이용한 뇌파 기반의 마취심도 자동 분류

함진실<sup>1</sup>, 조동래<sup>1</sup>, 김성현<sup>1</sup>, 최동혁<sup>1</sup>,

김재관<sup>1</sup>, 김형일<sup>1</sup>, 이보름<sup>1</sup>

<sup>1</sup>광주과학기술원 융합기술원 의생명공학과

In general, anesthesia is commonly performed in order to treat and operate without pain. Especially, general anesthesia causes loss of consciousness (LOC). Because of LOC, one of the serious problems can happen: awareness. Therefore, it is necessary to decide depth of anesthesia (DOA). The DOA can be determined through analysis of electroencephalogram (EEG). Furthermore, machine learning has been utilized in medical field to classify diagnoses automatically. In this study, we applied transfer entropy (TE) to EEG data for feature extraction and used multiclass support vector machine to classify those

features for the depth of anesthesia (DOA) automatically.

## P2-048

### 아연 농도에 따른 신경세포의 활성화 변화

정혜선<sup>1</sup>, 황서영<sup>1</sup>, 김순영<sup>1</sup>, 유현지<sup>1</sup>, 전상범<sup>1,2</sup>

<sup>1</sup>이화여자대학교 전자공학과

<sup>2</sup>이화여자대학교 뇌인지과학과

Zinc is an essential trace element for mammalian cells and used as a neurotransmitter or modulator in the central nervous system. However, exposure of central neurons to high concentrated  $Zn^{2+}$  leads to neuronal death. In this study, we observed the alteration of neuronal activity in accordance with the change of zinc concentration on the hippocampal neurons cultured on microelectrode arrays (MEAs). Depending on the zinc concentration, the different phenomenon has been found. When the measurement was held by electrical method, the action potential activity increased at low concentrations of zinc and decreased at high concentration.

## P2-049

### MUA 방법을 이용한 감정을 유발하는 사진 자극과 중간 사진 자극에 의한 사건관련전위 관찰

여동훈, 차광수, 최정우, 김경환

In this study, we observed the difference of event-related potential (ERP) when affective or neutral pictures are presented using mass univariate analysis (MUA). We observed late positive components 400ms after stimulus via permutation test method. Our results are in agreement with other conventional ERP research on emotion

processing, and show that MUA method does not only include conventional results of statistical significance, but also gives us wealthy information on the data analyzed.

## P2-050

### 렘수면행동장애 환자의 공간적 시각자극 제시 시 신경활동 변화

차광수<sup>1</sup>, 최정우<sup>1</sup>, 이병욱<sup>2</sup>, 구선아<sup>2</sup>, 김태준<sup>2</sup>,

선우준상<sup>2</sup>, 변정익<sup>2</sup>, 정기영<sup>2</sup>, 김경환<sup>1</sup>

<sup>1</sup>연세대학교 의공학과

<sup>2</sup>서울대학교 의과대학 신경과

We investigated that the alteration of brain activities in patients with REM sleep behavior sleep disorder (RBD) during a visuospatial attention task by observing enhancement of the neural activities. At early period, significantly altered P200 component and theta-band power were observed in RBD patients at posterior area. Our results support that RBD patients have cognitive dysfunction, which was associated with visuospatial attention.

## P2-051

### 영화 시청 시 피부전도반응의 정점을 기준으로 각성도에 따른 뇌파의 스펙트럼 파워 비교

서부경, 최종두, 최정우, 김현, 김경환

연세대학교 의공학과

In this study, we compared spectrum power of event-related electroencephalograms (EEGs) among different arousal levels during watching movies using time-frequency analysis. EEGs where 1s before/after the peak of skin conductance response (SCR) were analyzed. Both before and after the peak, significant differences were observed

## POSTER II

in beta-band at central regions. In addition, through 1s after the peak, temporal alpha-band power was significantly increased in low arousal level.

### P2-052

#### 시각세포의 효율적 자극을 위한 광다이오드 기반 인공망막 자극기 설계

박정환, 심신용, 김성준  
서울대학교 전기·정보공학부

A photodiode-based current stimulator IC is designed that uses contour as visual information. We compared the output current of adjacent photo-diodes to extract the contour. The circuit structure uses less the number of stimulation channels than those using light intensity based current stimulation, thus achieving low power consumption and efficient stimulation. We describe the circuit, layout, and simulation results.

### P2-053

#### 렘수면활동장애 환자의 렘수면 중 뇌기능적 연결성

허성진<sup>1</sup>, 정민희<sup>1</sup>, 차광수<sup>1</sup>, 최정우<sup>1</sup>,  
이병욱<sup>2</sup>, 구선아<sup>2</sup>, 김태준<sup>2</sup>, 선우준상<sup>2</sup>,  
변정익<sup>2</sup>, 정기영<sup>2</sup>, 김경환<sup>1</sup>  
<sup>1</sup>연세대학교 의공학과  
<sup>2</sup>서울대학교 의과대학 신경과

In this study, we compared brain functional connectivity during REM sleep between patients with REM sleep behavior disorder(RBD) and healthy control using sleep electroencephalogram(EEG). Weighted phase lag index(WPLI) was analyzed to observe interregional functional

connectivity. Delta-band functional connectivity was significantly strong at the central region in RBD patients.

### P2-054

#### 뉴로시네마틱스: 뇌파를 이용한 영화 평가지표 개발

차호승, 장원두, 신영석, 장동표, 임창환  
한양대학교 생체공학과

Neurocinematics, which measures brain activities of audiences and predict audience's response, was suggested as a branch of neuromarketing. To date, fMRI has been usually utilized for the neurocinematics, but several issues need to be addressed for its practical application. First, audiences should get inside the fMRI and watch films in unnatural environment. Second, use of fMRI needs high cost. Lastly, fMRI might not obtain brain activities in reaction to fast-changing scenes due to its low temporal resolution. To circumvent this, we introduced two EEG-based "brain" indices named "empathy index" and "reactivity index" that indicate empathy and reactivity of audiences, respectively, in our previous work. In this study, we validated the two indices by applying new EEG data collected during screening of a Korean movie ("The Insider") in theater, and confirmed that the results of two indices were consistent with our previous study, demonstrating the "brain" indices may be used as promising "brain" indices for neurocinematics.

### P2-055

#### 성 범죄자의 다중감각 치료에 대한 뇌파 활성도 변화

김지은<sup>1</sup>, 송채빈<sup>1</sup>, 송원영<sup>2</sup>, 태기식<sup>1</sup>

<sup>1</sup>건양대학교 의공학부,  
건양대학교 심리상담치료학과

Sex addict is an addiction that accompanies mental anxiety, psychological and physical dependence. Sex addicts feel the psychological emptiness. Also, they want to make their presence through sexual adventures and seem sexually obsessed. Therefore, this study is to evaluate the brain activity changes related to sexual addiction by utilizing the developed multi-sensory after 4-weeks sex offender treatment program. We analyzed the EEG activity changes in the subjects and regions of brain. As a result, the theta wave increased after treatment than before. The absolute alpha waves should increase but relative alpha waves showed a decrease. Also overall brain activity decreases when subjects are stable state. The rest brain waves showed no significant differences or decreased. The findings not only provide a neurobiological explanation in sex addicts, but also have clinical implications for a prevention and treatment.

## P2-056

### 촉각 신경신호로부터 감각자극 인식을 위한 미분류 활동전위 특징에 관한 연구

한성민<sup>1,2</sup>, 추준욱<sup>3</sup>, 박종웅<sup>2</sup>, 윤인찬<sup>1</sup>

<sup>1</sup>KIST 의공학 연구소

<sup>2</sup>고려대학교 의과학과

<sup>3</sup>KIMM 대구융합기술연구센터

In functional electrical stimulations, sensory feedback based closed-loop control can be useful for restoring lost function in patients with paralysis. In this study, we propose a novel unsorted spike-based feature based pattern recognition method. The tactile

afferent signals were recorded from a multichannel microelectrode on the dorsal root ganglion, and multilayer perceptron classifier was used to detect sensory event.

## P2-057

### 관성센서 신호를 이용한 레보도파에 의해 유도된 이상운동증 검출

김상경<sup>1</sup>, 김한별<sup>1</sup>, 전범석<sup>2</sup>, 박광석<sup>3</sup>

<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링 전공

<sup>2</sup>서울대학교병원 신경과

<sup>3</sup>서울대학교 의과대학 의공학교실

Levodopa induced dyskinesia(LID) is side effect of levodopa which is normally used as medication for Parkinson's disease. The aim of this study is to analyze characteristics for LID and normal movements. Five patients with LID and five healthy subjects participated in this study. Dyskinetic movements were measured by inertial sensors which were attached at wrists, ankles and waist while subjects were asked to stand with eye opened and with eye closed, to sit on a chair, and to walk along the corridor for sixty seconds. The ratios of powers of 0.3-4Hz and 4-10Hz were significantly higher in the LID than in the control during standing with eye closed. Mean and standard deviation of trace in the central axis were significantly different between LID and controls. Therefore, it could be possible to detect and monitor LID by using combination of power and trace.



## POSTER II

P2-058

고속순환전압전류법에서 신경전달물질 검출민감도 향상을 위한 waveform control 기술

강유민, 신호진, 오윤배, 박천호,  
M. DeWaele, 장동표  
한양대학교 생체공학과

Fast Scan Cyclic Voltammetry(FSCV) is conventional method to measure the concentration of neurotransmitters in Vivo or Vitro. Conventional FSCV have a sensing limit in low level concentration. To increase the sensitivity, modify the waveform to make voltammogram flat, and amplify the region where the peak current arising. In this paper, we describe the method of control the waveform to make voltammogram flat.

P2-059

초음파 촉각 자극을 위한 파라미터 최적화 연구

최정봉<sup>1</sup>, 조경원<sup>1</sup>, 김인영<sup>2</sup>, 장동표<sup>1</sup>  
<sup>1</sup>한양대학교 의생명공학전문대학원  
<sup>2</sup>한양대학교 의공학교실

There are various receptor types or free nerve endings underneath skin. Human tactile sensation is basically a combination of these receptors. Focused ultrasound have been reported as a new tool for evoking tactile sensation in skin, but it's underlying mechanism is unknown. In this study, therefore, we aim to find optimized ultrasound parameters for stimulating mechanoreceptors in skin, based on subject's experience and neural response from animal. We configured the database of human subject's report and spiking patterns associated with stimulation parameters (frequency, duration, and so on), and setup the basic principles and resources for the

development of tactile display in the future.

P2-060

주파수 민감도 저하가 청성유발 전위 검사에 미치는 영향

황종호, 이준창, 고여명, 김용환, 남경원, 김인영  
한양대학교 생체의공학과

Hearing loss patients characteristics are lowed hearing threshold, lowed frequency selectivity and etc. Those reasons make difficult to hear the sound. So, hearing diagnosis is important to hearing loss patients. Generally, PTA (pure tone audiometry) or ASSR (auditory steady state response) test are used to hearing loss diagnosis. However, PTA and ASSR test are diagnosis of hearing threshold. It is difficult to diagnosis about frequency selectivity by using PTA or ASSR test. In this study focused on the effect of lowed frequency sensitivity on ASSR in hearing simulation test.

P2-061

이식형 리드전극 제작용 나선형 미세 금속선 와인더 개발

김진원, 송인호, 문진희, 유성근,  
이승아, 정하철, 문동준, 봉선우,  
안진우, 박영상, 이상훈  
오송첨단의료산업진흥재단  
첨단의료기기개발지원센터 제품개발부 첨단융합팀

Implantable medical devices such as deep brain stimulation and pacemaker involve the lead electrode with helically coiled micro metal wires. Well arrangement of a large number of micro metal wires improves the facility and the quality of lead electrode



fabrication. Uniformly and closely coiled metal wires play a role as a guidance of stylet that enhances the straight ahead motion of lead electrode. Here, we report the development of a winder for helically coiled micro lead wire fabrication. This winder can eliminate the excessive tension as a cause of wire cutting and modify the diameter and/or the pitch of helically coiled lead wire.

#### P2-062

##### 중추신경기록과 자극을 위한 PDMS-패럴린 복합 미세전극열 제작

이우람<sup>1</sup> 임창균<sup>1</sup> 김준민<sup>1,2</sup> 고진수<sup>3</sup> 서종모<sup>1,4</sup>

<sup>1</sup>서울대학교 전기정보공학부

<sup>2</sup>서울대치과병원 치의생명연구원

<sup>3</sup>한림대학교 의과대학 생리학교실

<sup>4</sup>서울대학교 의과대학 안과학교실

In this paper, we report on a PDMS-parylene hybrid electrode array for the recording and the stimulation of the central nervous system. The electrode contains 10 electrode sites with 50um of the diameter. Two different biocompatible polymers were as substrate materials to utilize their superior property. To enhance signal to noise ratio, electrode pads were designed as a protruded shape instead of commonly used sunken configuration.

#### P2-063

##### 초음파를 이용한 영장류 뇌 자극을 위한 사전 연구

차오름, 송길수, 김진호, 신운철, 서종범

연세대학교 의공학과

When a brain is sonicated with noninvasive

ultrasound, the size of the focus change and the energy of acoustic wave decreases. Generally acoustic energy attenuates the most as it travels through the skull. Pre-study on an ultrasound beam that has passed through a monkey's skull has been conducted.

#### P2-064

##### 인덕티브 링크를 이용한 이식체와의 통신에 있어서의 피드백 고찰

김채빈, 엄경식, 권태목, 정준수, 김성준

서울대학교 전기·정보공학부

Inductive link is widely used in transcutaneous communication to the implanted medical devices. To achieve position tolerance of the link for stable communication, feedback topology is often utilized. In this article, feedback topology is considered and analyzed.

#### P2-065

##### 쥐 후각 망울에서 취기제 응답의 스펙트럼 분석

임창균<sup>1,2</sup>, 고진수<sup>2,3</sup>, 이우람<sup>1</sup>,

김준민<sup>1,4</sup>, 서종모<sup>1</sup>, 신형철<sup>2</sup>

<sup>1</sup>서울대학교 공과대학 전기정보공학부,

<sup>2</sup>한림대학교 의과대학 생리학교실,

<sup>3</sup>연세대학교 의과대학 신경외과학교실,

<sup>4</sup>서울대치과병원 치의생명연구원

Olfaction is an important sense for survival and breeding in mammals. Therefore, various studies have tried to reveal its underlying mechanism. Previously, we showed that it is possible to discriminate odorants from spike activities in rat olfactory bulb. However, there are some limitation in long-term signal acquisition due to electrode

## POSTER II

movement and immune response. In contrast, electrocorticography (ECoG) can provide long-term stable recording. In this study, we applied the continuous wavelet transform technique to extract odorant information from ECoG signals recorded on the surface of the main olfactory bulb. We show that different odorant presentations elicit different increase in beta oscillation. Further, this result suggests that ECoG signals can be used for odor discrimination with long-term stability.

### P2-066

#### 측두엽 뇌파를 활용한 뇌-컴퓨터 접속 시스템 개발 가능성 타진

최수인<sup>1</sup>, 최가영<sup>1</sup>, 임창환<sup>2</sup>, 황한정<sup>1</sup>

<sup>1</sup>금오공과대학교 메디컬IT융합공학과

<sup>2</sup>한양대학교 전기생체공학부 생체공학전공

The aim of this study was to investigate whether temporal EEG can be used for developing a brain-computer interface (BCI) system. Three subjects took part in the experiment in which EEG data was measured while the subjects closed and opened the eyes. The power spectral analysis was applied to the EEG data in order to observe changes in EEG alpha activity (8-12 Hz). Alpha power significantly increased when the subjects closed the eyes for most EEG channels. In particular, the signal-to-noise ratio of temporal EEG was comparable to that of EEG signals measured from parietal, central, and frontal areas. We are currently investigating the reliability of temporal EEG to develop a BCI system by analyzing EEG data measured during mental arithmetic, and will present related results in the conference.

### P2-067

#### 동기화된 신경신호 패턴 분석을 위한 스미스-워터만 알고리즘 적용 방법 연구

이형섭, 남윤기

KAIST 바이오및뇌공학과

Synchronized network burst(SNB) is one of the most remarkable activity, which can be measured with microelectrode array(MEA). Many researchers have tried to investigate SNB patterns since recent decades, but they are difficult to analyze because of jittering in spike timing. In this study, we introduced sequence alignment technique, which has been used for DNA, RNA or protein, to SNB pattern comparison. We expect that the developed method can be used to characterize spike patterns in developing neural networks.

### P2-068

#### 고령자의 기립형 휠체어 최적 탑승 위치

유제성, 조민, 최은경, 안순재,

김종만, 정영재, 김성중, 김영호

연세대학교 대학원 의공학과,

연세대학교 의료공학연구원

In the study, biomechanical analysis was performed to determine an optimal riding position for the standing wheelchair. Ten elderly volunteers were participated in this study. Using a brake-type dynamometer and the 3D motion capture system, joint moments and total energy expenditure were calculated. A tall subject showed the smallest total energy expenditure on the highest seat position, whereas short subjects showed the smallest total energy expenditure on the center seat position. Both groups showed the smallest total energy expenditure 3.6~3.8% backward from a center seat position proportional to

the height.

## P2-069

### 고령자의 연령과 균형성 평가 변인 간의 상관관계 도출

서정우<sup>1</sup>, 김대혁<sup>1</sup>, 양승태<sup>1</sup>,  
강동원<sup>2</sup>, 최진승<sup>1,2</sup>, 탁계래<sup>1,2</sup>

<sup>1</sup>건국대학교 의료생명대학 의학공학부,

<sup>2</sup>BK21플러스의공학실용기술연구소

The purpose of this study was to find the relationship between balance test variables and aging. The Timed-Up Go (TUG) test is a widely used clinical protocol to evaluate balance and mobility. Eighty subjects (age:  $76.4 \pm 5.8$ ) participated in TUG test with six inertia sensors (APDM). Results showed that the total duration, gait stride length %stature, & meter, gait range of motion shank & knee, turn to sit duration & peak turn velocity variables were correlated with age. It means that the variables related with aging should be considered when evaluate the balance and mobility in elderly.

## P2-070

### 사이클 페달링 시 페달 힘을 이용한 무릎부상방지 인덱스 연구

김대혁<sup>1</sup>, 서정우<sup>1</sup>, 양승태<sup>1</sup>,  
강동원<sup>2</sup>, 최진승<sup>1,2</sup>, 탁계래<sup>1,2</sup>

<sup>1</sup>건국대학교 의료생명대학 의학공학부,

<sup>2</sup>BK21플러스의공학실용기술연구소

The study proposed a knee injury prevention index (the ratio of the vertical force to the horizontal force acting on the pedal) by comparing a vertical alignment of the lower limbs. Seven male subjects participated in two minutes, 60 rpm cycle pedaling tests

with the same load and cadence. Results showed that the range of motion of the knee trajectory in the frontal plane was decreased and the proposed index was also decreased after vertical alignment. It could be concluded that the proposed index be used as the injury prevention of the lower limbs.

## P2-071

### Mechanomyography를 이용한 대퇴사두근 피로 분석

신이수, 조민, 최은경, 정영재,  
김종만, 안순재, 유제성, 김영호  
연세대학교 대학원 의공학과,  
연세대학교 의료공학연구원

Fatigue analysis of quadriceps femoris muscle using the convex hull algorithm based on the mechanomyography was performed in this study. Twenty-five male volunteers participated in the experiment. The subjects performed the knee flexion/extension exercises on the isokinetic dynamometer to measure joint torques during the maximal isometric contraction. MMG sensor was placed on the right rectus femoris muscle. MMG signals were measured during knee extension movements until exhaustion. The results showed that decreases in hull area or volume of MMG signal were strongly related with the fatigue due to the reductions in motor unit firing rate and the influence of increases in muscle thickness.

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P2-072

### 보행 중 인가한 진동자극 특성에 따른 수직 지면 반발력의 변화

곽기영<sup>1</sup>, 김희균<sup>1</sup>, 김동욱<sup>2,3</sup>

<sup>1</sup>전북대학교 대학원 헬스케어공학과

<sup>2</sup>전북대학교 바이오메디컬공학부

<sup>3</sup>전북대학교 고령친화복지기기연구센터

The purpose of this study was to investigate the changes of vertical ground reaction force (VGRF) according to vibration stimulation characteristic during gait. For this, vibration perception threshold was measured. And then vibration was applied based on measured results during gait. To analyze changes of VGRF, a 3-D motion analysis system was used. We analyzed 1<sup>st</sup> peak and 2<sup>nd</sup> peak of VGRF. As a results, the changes of 1<sup>st</sup> peak and 2<sup>nd</sup> peak due to stimulation of the perception threshold intensity (100%) was differed to those at none-stimulation. And the changes of 1<sup>st</sup> peak and 2<sup>nd</sup> peak due to stimulation of the perception threshold intensity (100%) was similar to those at the perception threshold intensity (100%). And the change of VGRF peaks differed depending on vibration frequency.

P2-073

### 진동 자극 특성에 따른 하퇴의 근력과 근반응시 간 변화에 관한 연구

김희균<sup>1</sup>, 곽기영<sup>1</sup>, 김동욱<sup>2,3</sup>

<sup>1</sup>전북대학교 대학원 헬스케어공학과

<sup>2</sup>전북대학교 공과대학 바이오메디컬공학부

<sup>3</sup>전북대학교 고령친화복지기기연구센터

In this study, the lower leg along the vibration stimulation characteristics was investigated change of muscle strength and muscle reaction time. In order to stimulate

the lower leg muscle, vibration stimulation was applied to the tibialis anterior tendon and Achilles tendon. Using the EMG measurement and analysis system for MVC and PMT analysis. The result of the MVC and PMT analysis showed that the muscle strength and muscle reaction time differed by the frequency and intensity of vibration. As a result, applying the vibration stimulation characteristics to lower leg tendon was a positive effect on the lower leg muscle, this means could contribute to improvement of gait performance and stability.

P2-074

### 수술 방법에 따른 전방십자인대의 터널 확장의 차이 비교

김훈영<sup>1</sup>, 이도경<sup>1</sup>, 왕준호

성균관대학교 삼성융합의과학원

일반대학원 의료기기산업학과

To compare femoral tunnel widening between the trans-portal (TP) and outside-in (OI) surgical techniques after anatomic double-bundle (DB) anterior cruciate ligament (ACL) reconstruction. Tunnel widening was evaluated by the change of center of tunnel and the change of cross section area in immediate post op and post op 1yr follow up. Our study showed that tunnel center was statistically significant shift to anterior and distally anatomically in both technique. Tunnel widening was larger in outside-in technique groups than trans-portal technique groups in AM bundle with statistically borderline significance.

P2-075

### 스파크 방지를 위한 고주파 자극기 핸들부 개발

강승호<sup>1</sup>, 권용찬<sup>1</sup>, 이인광<sup>1</sup>,  
안진우<sup>2</sup>, 문진희<sup>2</sup>, 김국한<sup>1</sup>  
(주)대성마리프 의공학연구소<sup>1</sup>  
오송첨단의료산업진흥재단 첨단의료기기개발지원센터<sup>2</sup>

In this study we developed the parts of handle that could prevent a spark and improve useability by improving high frequency stimulator structurally. We made a sample according to design and, thereby, verified that output of high frequency at the stimulator in accordance with control on/off action worked normally and also was stable.

## P2-076

### 하지 재활훈련에서 사용되는 족부압력 측정 센서시스템의 개발

최정현<sup>1</sup>, 최현주<sup>1</sup>, 변정섭<sup>1</sup>,  
서재용<sup>2</sup>, 박상일<sup>2</sup>, 황화식<sup>2</sup>  
<sup>1</sup>(재)김해시 차세대 의생명융합산업지원센터  
<sup>2</sup>(주)광원메디텍

It is important to train muscle strength using a tilting table to recover the lower extremity function of hemiplegia patients. Foot deformity and poor posture in rehabilitation training can reduce the effectiveness of rehabilitation training. In this study, we developed a sensor system that can measure the foot pressure of a trainer for the load control of the lower extremity during lower-limb rehabilitation training. It could improve the effectiveness of it.

## P2-077

### FEA를 이용한 정원창 구동 이식형 인공중이용 벨로우즈 진동체 구현

조유진<sup>1</sup>, 신동호<sup>2</sup>, 우승탁<sup>2</sup>, 문하준<sup>2</sup>,

공호준<sup>2</sup>, 정의성<sup>3</sup>, 성기웅<sup>4</sup>, 김명남<sup>5</sup>, 조진호<sup>2,6</sup>  
<sup>1</sup>경북대학교 대학원 의용생체공학과,  
<sup>2</sup>경북대학교 대학원 전자공학부,  
<sup>3</sup>대구경북첨단의료산업진흥재단,  
<sup>4</sup>경북대학교병원 의공학과,  
<sup>5</sup>경북대학교 의학전문대학원 의공학교실  
<sup>6</sup>경북대학교 IT 대학 전자공학부

In this study, a new bellows transducer has been proposed for RW-drive-middle-ear hearing aids, as it has excellent output and is easy to implant. The proposed transducer consists of three coils, a three-pole magnet, and a miniaturized bellows. The structure of bellows can be designed by means of mechanical vibrational characteristics using the FEA. Based on FEA results, the transducer has implemented. To verify the usefulness of transducer, vibrational characteristics of transducer was measured using the LDV and compared vibrational characteristics between the transducer and normal human temporal bone stapes (ASTM F2504). As a result of experiment, vibration magnitude of the transducer was on average 20dB higher than that of ASTM in whole frequency. Thus, it is expected that the proposed bellows transducer can be applied to RW stimulation.

## P2-078

### 열전자 소자를 포함한 고주파 자극기의 열전달 수치해석

안진우<sup>1</sup>, 김국한<sup>2</sup>, 문진희<sup>1</sup>, 송인호<sup>1</sup>,  
유성근<sup>1</sup>, 이승아<sup>1</sup>, 정하철<sup>1</sup>, 문동준<sup>1</sup>,  
봉선우<sup>1</sup>, 박영상<sup>1</sup>, 이상훈<sup>1</sup>  
오송첨단의료산업진흥재단  
첨단의료기기개발지원센터 제품개발부<sup>1</sup>  
(주)대성마리프 의공학연구소<sup>2</sup>

RF(radiofrequency) stimulator is used



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to reduce musculoskeletal pain induced deep heat using radiofrequency current in human body. We numerically investigated heat transfer analysis of human body under the influence of deep heat and cool stimulation by applying RF current and using thermoelectric device. Using COMSOL multiphysics, the model can be solved by coupling Maxwell equation, Navie-Stokes equation and Energy equation. Our analysis shows that temperature distributions of human body and RF stimulator.

### P2-079

#### 정상인을 대상으로 한 보행 보조차가 보행에 미치는 생체역학적 영향

조유라<sup>1</sup>, 최세린<sup>1</sup>, 이동현<sup>1</sup>, 이현주<sup>2</sup>, 태기식<sup>1</sup>  
<sup>1</sup>건양대학교 의공학부, <sup>2</sup>건양대학교 물리치료학과

The aim of this study is to investigate the biomechanical effects and the activities of the lower-limbs muscle on walking of a four-wheeled walker (rollator) in healthy subjects(n=10). The walking pattern with and without rollator was analyzed using a three-dimensional motion analysis system. The surface electromyography was used to measure the muscle activity of the pelvic limb muscle(rectus femoris, tibialis anterior, biceps femoris, gastrocnemius). During rollator-walking the ankle and knee joints were less dorsiflexed/flexed and the ROM of the hip was reduced than during normal-walking. Rollator-walking reduces pelvic limb muscle activity.

### P2-080

#### 연하장애 보조진단을 위한 무선 모니터링 시스템 개발

김선주<sup>1</sup>, 조혜정<sup>1</sup>, 차태현<sup>2</sup>, 이현주<sup>3</sup>, 최동혁<sup>1</sup>, 태기식<sup>1</sup>

<sup>1</sup>건양대학교 의료공과대학 의공학부

<sup>2</sup>건양대학교 의과대학 학부 작업치료학과

<sup>3</sup>건양대학교 의과대학 물리치료학과

Dysphagia, or disordered swallowing is having a difficulty swallowing food or drink. It can be seen in patients undergoing treatment for stroke, parkinson's disease and neurodegenerative illnesses. The methods currently used for diagnosis are VFSS(video fluoro swallowing study), or laryngendoscope. These methods, however, are time-consuming, costly and invasive. Swallowing accelerometry is inexpensive, noninvasive. IMU sensor measured the neck's vibration and provided signals using the Visual Studio C++ . This method will be useful for evaluation of dysphagia.

### P2-081

#### 추간체유합보형재의 허가 및 기술문서 작성을 위한 가이드라인 개발 연구

김형식, 송하림, 유시형, 이창형, 박창원  
식품의약품안전처 식품의약품안전평가원  
의료제품연구부 의료기기연구과

The market size of Spinal cage and the number of their approvals by Ministry of Food and Drug Safety (MFDS) has increased with a trend of increasing aging population. Therefore, it needs to develop the technical document guideline for Spinal cage. The draft of guideline was developed by investigating of the standards (ISO, KS, ASTM, and etc.), approved technical documents and Medical Device Standards, followed by consulting the ad hoc expert committee. We developed the guidelines suitable to global harmonization and domestic requirement including test methods and information with



appropriate examples.

## P2-082

### 경추의 해부학적 구조를 고려한 경추용 후방 고정 시스템 설계 최적화

박광민<sup>1</sup>, 양재웅<sup>1</sup>, 윤진상<sup>2</sup>, 정승조<sup>2</sup>, 정태곤<sup>1</sup>

<sup>1</sup>오송첨단의료산업진흥재단 첨단의료기기개발지원센터

<sup>2</sup>(주)지에스메디칼 기업부설연구소

The object of this study was to investigate the design optimization of posterior cervical fixation system with anatomic structure in cervical spine. For measuring their anatomical size, based model was obtained on CT image from Korean adult male by Mimics. The thickness of occipital bone was measured with 4.1~22.7mm, pedicle length and diameter of vertebral body (C3~37) were 27.9~33.8mm and 8.8~11mm, respectively. Thus, we could be considered to develop implants size that the occipital bone screw has to be 4~23mm with anatomical aspect while the cervical pedicle screw has corresponded with average size of conventional implant.

## P2-083

### 경추용 인공 추간판의 베어링 재료에 따른 마모 특성

정용훈<sup>1</sup>, 양재웅<sup>1</sup>, 이수원<sup>1</sup>, 우수현<sup>2</sup>, 정태곤<sup>1</sup>

<sup>1</sup>오송첨단의료산업진흥재단 첨단의료기기개발지원센터

<sup>2</sup>(주)메디씨이 기술연구소

Cervical total disc replacement (CTDR) is used in the management of degenerative disc disease to preserve spinal movement and prevent adjacent disc overload and subsequent degeneration. To assure the expected life time with implantation of

CTDR, inert materials have to possess to resist creep and degenerate wear debris. In this study, we have the object to comparatively evaluate the feasibility of PEEK on PEEK and UHMWPE on UHMWPE as a bearing material for use in CTDR with defined in the ISO standard 18192-1.

## P2-084

### 완전 이식형 보청기용 SAR ADC의 설계 및 구현

김종훈<sup>1</sup>, 박영식<sup>2</sup>, 최원석<sup>2</sup>, 임형규<sup>3</sup>,  
성기웅<sup>4</sup>, 이정현<sup>5</sup>, 김명남<sup>5</sup>, 조진호<sup>6</sup>

<sup>1</sup>경북대학교 대학원 의용생체공학과,

<sup>2</sup>경북대학교 대학원 전자공학부,

<sup>3</sup>경북대학교 의공학연구소,

<sup>4</sup>경북대학교병원 의공학과,

<sup>5</sup>경북대학교 의학전문대학원 의공학교실,

<sup>6</sup>경북대학교 IT대학 전자공학부

In this paper, we proposed 16-bit 32 kHz successive approximation register analog-to-digital converter (SAR ADC) of low power and small size for fully implantable hearing aid. The design of low power and small size is achieved by R-2R resistor array, power control switch, and offset rejection techniques. As a result of simulation, the digital code compared with sampled input signal and reference voltage is confirmed. Also, the circuit verification was performed by LVS (layout versus schematic) and DRC (design rule check). The SAR ADC is implemented in a SMIC 180 nm CMOS technology. The power consumption of designed SAR ADC is 50μW, and the area occupies 152.1 μm × 124.9 μm.

## POSTER II

P2-085

경추용 인공디스크 PEEK 인레이의 마모시험을 위한 운동 파라미터 상관관계 분석

양재웅<sup>1</sup>, 정용훈<sup>1</sup>, 우수현<sup>2</sup>, 정태곤<sup>1</sup>

<sup>1</sup>오송첨단의료산업진흥재단 첨단의료기기개발지원센터

<sup>2</sup>(주)메디씨이 기술연구소

Cervical total disc replacement (CTDR) is a constructive non-fusion technology that can preserve motion and avoid excessive stress. Wear simulation is adopted to estimate life time of inlay bearing in CTDR, wear rate has been calculated with weight decrement of inlay materials based on ISO 18192-1 regulation. While running wear simulation, there are few kind of parameters such as displacement, torque, and etc. except weight change, we needed to find out more details with analysis of parameters from wear simulation. In this study, we are going to investigate the correlation of wear simulation parameters of PEEK CTDR for biomechanical stability.

P2-086

해부학적인 발목 관절-가동범위 특성을 고려한 발목근육훈련기 개발: 신뢰도 검증연구

이휘영, 조상우, 구도훈, 김호진

국립재활원

We developed the ankle muscle trainer (AMT) that is able to measure ankle ROM (Range of Motion). The aim of this study was to verify a reliability of AMT. 8 elderly subjects were participated in the experiment. We measured ankle ROM of sagittal plane and frontal plane using AMT and VICON at same time. In the results of intra-class correlation coefficient, ankle ROM of AMT is in agreement with the VICON results. Therefore, AMT be able to

use in ankle rehabilitation of stroke with disabilities.

P2-087

표면 근전도를 이용한 한국 숫자지화 인식의 연구

박종준, 권춘기, 강현주

순천향대학교

This work describes recognition of Korean natural numbers from finger gestures by using surface electromyograph (sEMG). To this end, minimal electrode positions on forearm muscles are selected to consider finger movements to make gestures for Korean natural numbers from zero to five in this work: flexor digitorum superficialis, flexor pollicis longus, extensor digitorum, abductor pollicis longus. To extract features for classification procedure, Mean Absolute Value (MAV) is used due to its simple implementation. The k-Nearest Neighborhood (k-NN) is employed as classification algorithm since it has been shown to provide good classification performance. The results in this work show potential use for recognition of Korean natural numbers from sEMG based finger gestures.

P2-088

슬관절 전방변위를 이용한 보행의도 파악

양길태<sup>1</sup>, 강승록<sup>2</sup>, 이현종<sup>3</sup>, 김일송<sup>4</sup>, 심한수<sup>4</sup>, 김근우<sup>4</sup>, 홍철운<sup>2</sup>, 권대균<sup>2</sup>

<sup>1</sup>전북대학교 헬스케어공학과,

<sup>2</sup>전북대학교 바이오메디컬공학부,

<sup>3</sup>국립재활원 재활보조기술연구과,

<sup>4</sup>(주)이지무브

본 연구는 슬관절의 전방변위만으로 보행의도를 파악하고자 한다. 보행의도 파악은 슬관절의 변위를 측정하기 위한 변위센서만을 사용하였으며, 피험자의 보행의도는 피험자의 보행시작, 보행 중, 보행 종료를 파악하는 것이 목적이다. 본 연구에서는 슬관절의 움직임의 변화를(보행시작, 보행 중, 보행 종료) 3가지의 영역으로 구분하였으며, 보행의도 파악을 위한 변수로 560ms의 시간과, 양쪽 슬관절의 거리차는 5cm를 기준으로 하였다. 본 연구 결과, 전동보행 보조기의 보행의도 파악은 슬관절 전방변위의 변화만으로도 효과적임을 확인하였다.

#### P2-089

##### 경추추간공협착증 동물모델을 이용한 증세 정량화 방법 연구: 예비실험

이혜경<sup>1</sup>, 양인철<sup>2,4</sup>, 천권수<sup>3</sup>, 권지연<sup>1</sup>,  
김성민<sup>1,2</sup>, 강호철<sup>2,4</sup>, 조도상<sup>5</sup>  
동국대학교 의료기기산업학과<sup>1</sup>  
동국대학교 의생명공학과<sup>2</sup>  
베일러 의과대학 소아과<sup>3</sup>  
(주)솔메딕스 기업부설연구소<sup>4</sup>  
이화여자대학교 의과대학 신경외과<sup>5</sup>

In this paper, we investigated the effectiveness of Cervical Foraminal Dilator(cFD) measuring the change of animal's locomotion and activity level by the motion capture camera system and computerized analysis, and verify its quantification method. We used a canine model with experimentally induced cervical foraminal stenosis, and the results of the group surgically treated by cFD were compared with that of the group without the surgical treatment. Our hypothesis is that a group getting treatment surgery with cFD would show more superior locomotion and activity recovery level.

#### P2-090

##### 모바일 기반 상지 재활운동 시 세타감마 동조현상 분석

임현미, 구정훈  
계명대학교 의과대학 의용공학과

Objective: In this study, we developed mobile-based upper limb rehabilitation system and conducted preliminary experiment for evaluation of the effect on brain function at motor cortex. Method: The rehabilitation app was based on Brunnstrom stage and designed to lead accurate movement of upper limb. And the movement detecting module was developed and used. Experiment: 8-channel EEGs were recorded from 13 healthy volunteers (age:  $23 \pm 1.87$  years) from two conditions (Mobile-rehab: elbow flexion-extension exercise with mobile-rehab, Rehab-alone: elbow flexion-extension exercise with observation of block screen). The TGC (theta-phase gamma-amplitude coupling) data were analyzed. Discussion: The TGC at motor cortex area were higher in Mobile-rehab condition compared than Rehab-alone ( $t=3.390$ ,  $df=12$ ,  $p<0.005$ ). This finding supports the mobile-based rehabilitation would be helpful to revitalize reconstruction of motor cortex.

#### P2-091

##### 양기능 근육의 근전도 분석을 위한 원형 전극 배열의 6채널 근전도 시스템

채유선<sup>1,2</sup>, 송강일<sup>1,3</sup>, 박종웅<sup>2</sup>, 윤인찬<sup>1</sup>  
한국과학기술연구원 의공학연구소<sup>1</sup>,  
고려대학교 의과대학 정형외과교실<sup>2</sup>,  
연세대학교 전기전자공학과<sup>3</sup>

The surface electromyography (sEMG) records action potentials from different

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muscle fibers according to electrode orientation. There are limitations that it offers inaccurate information of sEMG signal over changing muscle fiber direction and recruited motor unit when body movement was performed such as rotation and flexion for that reason. The purpose of this study was to acquire sEMG signal of biceps brachii using 6-channel circular sEMG sensor which has different orientations for each channel during dual task included flexion/extension and pronation/supination.

### P2-092

#### 신체 조건에 따른 효과적인 스쿼트 자세 분석

이용석<sup>1</sup>, 김도빈<sup>1</sup>, 김수빈<sup>1</sup>, 박준혁<sup>2</sup>,  
김예현<sup>2</sup>, 주효성<sup>1</sup>, 우민정<sup>2</sup>, 우지환<sup>1</sup>  
울산대학교 의공학과<sup>1</sup>,  
울산대학교 스포츠과학과<sup>2</sup>

Because of the risk of knee injury, it is important and recommended to perform squat exercise correctly. But there is no squat guideline that considers the physical factor difference. In this study, we examined the relationship between physical factors and squat depth to give squat depth guideline based on physical factors. Four men with no previous lower limb surgeries were participated to experiment that measure physical factors and proper squat depth. Then we assessed the correlation of physical factors with the proper squat depth. The result shows that the proper squat depth can be expected by using physical factors.

### P2-093

#### 개발단계에서 의료기기의 예비생물학적 안전성 평가

김상동, 전경수, 김단비, 민한솔,  
김준식<sup>1</sup>, 유래형<sup>1</sup>, 안상현<sup>1</sup>, 김충용<sup>1</sup>  
대구경북첨단의료산업진흥재단 실험동물센터

Submissions for approval of medical devices require that biocompatibility assessment be conducted to assure safety of the device or material. Safety data can be obtained by testing according to certain prescribed or recommended guidelines, including guidance documents developed by the International Organization for Standardization (ISO) documents 10993 (Biological Evaluation of Medical Device). This standard defines devices in terms of their invasiveness and duration of patient contact, and subsequently determines what level of safety testing manufacturers need to successfully complete prior to putting their product on the market. Usually, manufactures of medical device have been conducted safety test by accredited laboratory accreditation for approval of medical device. Not addressing these reason can be costly when retesting or device redesign becomes necessary. Therefore, preliminary safety monitoring system of medical devices at a development stage in DGMIF-LAC provide a comprehensive review and reporting system for consideration of retesting, redesign and component materials of medical devices. We performed cytotoxicity test, acute systemic toxicity test, hemocompatibility test and intracutaneous reactivity test for preliminary safety monitoring. The ultimate goal of DGMIF-LAC is to establish a research cluster which leads to the commercialization of the prototypes and authorization of medical device.

## P2-094

## 교모세포종의 세포-기질 간 접착 능력 분석을 위한 생체 구조 모사 플랫폼의 활용

심우광, 차정화, 김필남, 최철희, 최경선  
KAIST 바이오 및 뇌공학과

Glioblastoma Multiforme (GBM) is the most malignant brain tumor in adults, highly infiltrative and difficult to cure. After infiltration of glioblastoma cells in brain tissue, cells settle down by adhering to around substrates for growing. Therefore, cell-substrate adhesion is one of important feature to be focused. In this article, we applied In vitro Biomimetic Platform as adhesion assay tool for analyzing cell-substrate adhesion ability of glioblastoma. This study suggested it can be simple image-based method for analyzing cell-substrate adhesion ability.

## P2-095

## 세포자극 용 균일펄스전자기장 발생 장치 개발

김태형<sup>1</sup>, 천송이<sup>2</sup>, 김동혁<sup>2</sup>, 문치웅<sup>2</sup>  
인제대학교 융합의과학과<sup>1</sup>,  
인제대학교 의용공학부, u-HARC<sup>2</sup>

In this study, the intensity of magnetic fields and stimulus period with a stimulus were modulated, and PEMP exposure system applying uniform magnetic fields to the stimulus range was developed for quantitative access. The probe for cell stimulation should be developed to generate uniform magnetic fields in the cell specimen. For checking the distribution characteristics of magnetic fields, computer simulation was conducted. The PEMF exposure system was designed to control both duty ratio from 1 to 100% in the frequency range of

1~100Hz and magnetic field output from 100 to 400mT.

## P2-096

## 수핵충진용임플란트의 성능평가 시험항목 및 시험방법 마련을 위한 연구

류지혜, 이희성, 이창형, 유시형,  
김은교, 이세은, 김선영, 박창원  
식품의약품안전처 식품의약품안전평가원  
의료제품연구부 의료기기연구과

As the world is becoming an aging society, the incident rate for degenerative lumbar disc diseases has been increasing. Nucleus pulposus implant, which can maintain permanent hydration condition and pressure by absorbing fluids of the human body to overcome such defects, is emerging as other replacement. Analysis of testing items and methods which are nationally and internationally recognized standards including ISO were performed to draw testing items and methods to evaluate the physical and mechanical characteristics. And such items & methods were also verified by testing.

## P2-097

## 심근세포 분화 조건 탐색용 2D 플랫폼 제작

고은민<sup>1</sup>, 김동민<sup>1</sup>, 고웅현<sup>1</sup>, 조영빈<sup>1</sup>, 손민정<sup>1</sup>, 신현정<sup>1</sup>  
<sup>1</sup>한국과학기술원 기계공학과

Current medical procedures to treat cardiovascular disease, which is one of the most fatal diseases, have many disadvantages and limits. Currently, many studies focus on in vitro tissue development to elucidate differentiation factors. In this study, we developed a platform to employ



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multiple stimulants including biochemical factors, uniaxial topology, and electric field (EF) stimulation. We successfully induced cellular elongation and differentiation using the micro-contact printing method, and verified that EF stimulation promoted cardiac maturation based on the traction force microscopy analysis. Our integrated multi-stimulation platform is expected to create optimal conditions for better differentiation of cardiomyocytes.

P2-098

### 바이오잉크 응용을 위한 젤라틴 기반 하이드로 젤 합성 및 평가

김지선<sup>1,2</sup>, 홍소영<sup>1</sup>, 황창모<sup>1,2</sup>

<sup>1</sup>서울아산병원 아산생명과학연구원 의공학연구소

<sup>2</sup>울산대학교 의과대학 대학원 의공학전공

The bioink for 3D tissue printing should have short gelling time, high cell compatibility and easy handling for preparation. In this study, tyramine branched gelatin based hydrogel was synthesized using EDC/NHS as coupling reaction. Synthesized gelatin based hydrogel showed short gelling time, which is feasible for in situ cross-linking for 3D bioprinting application. Three different types of gelatin hydrogels were synthesized and assessed. In vitro study demonstrates that in situ gel-forming hydrogels with different mechanical strengths had influence on cellular attachment and proliferation. As a results, this study suggests that by changing the tyramine concentration of gelatin based hydrogels, we could control biochemical properties and cellular behavior.

P2-099

### 재생의학적 장기재생을 위한 돼지 폐의 탈세포화 연구

강은영<sup>1</sup>, 유하나<sup>1,2</sup>, 이정훈<sup>1</sup>, 문지은<sup>3</sup>, 황창모<sup>1,4</sup>

<sup>1</sup>서울 아산병원 의공학 연구소

<sup>2</sup>한국과학기술원 의과학학제전공

<sup>3</sup>차의과대학 의학과

<sup>4</sup>울산대학교 의과대학 대학원 의공학전공

Human-sized acellular lung scaffolds provide a unique opportunity for ex vivo tissue engineering. In this study, optimization of porcine lung decellularization was tried for the purpose of human sized lung application. Conventional decellularization protocol depends on manual process for perfusion solution change, with pumps and partly gravity driven flow. This method resulted prolongation of decellurization time for each step, and precise control of decellularization condition was hampered. Here, we developed an automated system that can control perfusion time for stepwise control of each decellularization solution supply. By using a controlled valve system, time required for whole lung decellularization was greatly reduced. Acellular lung scaffolds were produced from native porcine lungs using a 1% sodium dodecyl sulfate in 3 days. After washing steps, we treated with ethylenediaminetetracetic acid(EDTA) and DNase for 1 day. Decellularized lung extracellular matrix scaffolds were checked via histological staining with hematoxylin-eosin and 4,6-diamidino-2-phenylindole. Residual cells in each group of decellularization condition were confirmed with histological staining images. The work presented herein describes an improved decellularization results, as well as reduced fluid volume consumption and processing times as compared to previously reported protocols.



## P2-100

## 폴리머 기반 신경보철 기기의 장기간 안정성 및 내구성 확보를 위한 공정 방법 개발 및 검증

권태목, 김진호, 김성준  
서울대학교 공과대학 전기정보공학부

Polymer-based neural implants have gained interest due to its flexibility and feasibility of micro-fabrication. However, delamination in polymer-based neural implants is one of the most critical parts in relation to their long-term reliability. To overcome reliability issue, the metal-polymer adhesion can be modified by mechanical methods on roughness and interlocking. In this study, we aim to fabricate micro metal patterns interlocked with polymer to enhance adhesion in metal-polymer interface using a dual photolithography process and electroplating, and evaluate the effect of the patterns through peel tests.

## P2-101

## 세포/조직 배양 과정 비침습적 연속 모니터링용 임피던스 영상 시스템을 위한 마이크로 배열전극의 개발

김광우<sup>1</sup>, 김태산<sup>1</sup>, 박재성<sup>2</sup>,  
이은아<sup>2</sup>, 오동인<sup>3</sup>, 김성현<sup>4</sup>  
<sup>1</sup>경희대학교 생체의공학과,  
<sup>2</sup>경희대학교 임피던스영상신기술연구센터  
<sup>3</sup>경희대학교 의학전문대학원,  
<sup>4</sup>서울대학교 화학부

Since most of evaluating methods for the status of cell/tissue during the culture period is invasive optical techniques, it requires destroying the samples containing cell and tissue for analysis. We proposed the electrical impedance imaging method to monitor the cell and tissue culture without the damage of cells. In order to measure

the multiple impedance for imaging the cell/tissue culture chamber, flexible micro-scale electrode array is needed combined with image reconstruction method. In this study, we designed the flexible microelectrode array and implemented it with biocompatible materials and affordable to check micro-scale conductivity.

## P2-102

## 창상치유용 EGCG가 담지된 PLGA 입자의 크기 조절 기술개발

우안루<sup>1</sup>, 신지원<sup>2</sup>, 강윤경<sup>2</sup>, 반훈영<sup>2</sup>,  
구서린<sup>1</sup>, 김미진<sup>2</sup>, 김지은<sup>2</sup>, 이은진<sup>2</sup>, 신정욱<sup>1,2,3</sup>  
<sup>1</sup>인제대학교 융합의과학  
<sup>2</sup>인제대학교 의용공학과  
<sup>3</sup>인제대학교 심혈관 대사질환센터/  
고령자 라이프 리디자인 연구소/  
u-향노화헬스케어연구소

Epigallocatechin-3-gallate(EGCG), a potent anti-inflammatory molecule, has been reported to enhance wound healing. Nanoparticle pharmaceutical carriers have advantages for drug delivery. Here, we tried to develop PLGA-nanoparticles as drug-delivery-system for wound healing and test their biocompatibility. In this preliminary study, PLGA-particles with different sizes were made and their biocompatibility was tested on human dermal fibroblasts. Then loading and releasing efficiency of EGCG-loaded-particles were examined. As a result, uniform PLGA-nanoparticles with diameters of 200nm or 2000nm were made. The smaller size nanoparticle showed a better compatibility on fibroblast. EGCG was successfully loaded and about 60% was released within 48h. Future study will be done about the anti-inflammation effects of

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this EGCG-loaded-nanoparticle on wound healing model in vitro and in vivo.

### P2-103

#### 플라즈마 처리를 통한 텅스텐과 Parylene의 접착력 향상

이상훈<sup>1</sup>, 문진희<sup>1</sup>, 송인호<sup>1</sup>, 유성근<sup>1</sup>,  
김진원<sup>1</sup>, 이승아<sup>1</sup>, 문동준<sup>1</sup>, 정하철<sup>1</sup>,  
안진우<sup>1</sup>, 봉선우<sup>1</sup>, 박영상<sup>1</sup>

<sup>1</sup>오송첨단의료산업진흥재단  
첨단의료기기개발지원센터 제품개발부 첨단융합팀

In this Study, metal-microelectrodes for neural recordings using Parylene without promoter(A-174 Silane) are Fabrication method. Parylene is a polymer well-known for its inertness and chemical resistance, conformal coating, but it has Poor adhesion to the metal. In general, the A-174 silane is used most frequently to modify substrate surfaces and improve parylene adhesion. the A-174 silane is inappropriate to use to bio-medical device because it has a toxicity. In order to improve parylene adhesion, plasma treatment used of RF(13.56MHz) source in oxygen, argon. plasma treatment was effective to reduce contact angles dramatically. Adhesion test results in the case of oxygen is shown 3B and argon is shown 4B. Conclusively, a plasma treatment with argon is more recommendable when the hydrophilic surface of tungsten is required.

### P2-104

The effect of substrate stiffness on the differentiation of MSCs into tendon and ligament fibroblasts

H.Y. Ban<sup>1</sup>, J.W. Shin<sup>1</sup>, Y.K. Kang<sup>1</sup>, S.H. Park<sup>1</sup>,

Y.M. Kim<sup>1</sup>, Y.R. Wu<sup>2</sup>, S.R. Gu<sup>2</sup>,

M.J Kim<sup>1</sup>, J.W. Shin<sup>1,2,3</sup>

<sup>1</sup>Department of Biomedical Engineering,  
Inje University,

<sup>2</sup>Department of Health Science and  
Technology, Inje University

<sup>3</sup>Cardiovascular and Metabolic  
Disease Center/Institute of  
Aged Life Redesign/UHARC

In tissue engineering for tendon and ligament (T/L) regeneration, the modulation of physical environments including fibrous structure and cyclic stretch is known to affect the differentiation of stem cells toward T/L lineages. However, the effect of substrate stiffness has not been reported yet. Here, we evaluated the differentiation of MSCs into T/L fibroblasts under BMP-12 treatment on three types of substrates; stiff, soft PDMS membranes, and culture plate. As a result, gene expression patterns in PDMS groups were not significantly different from each other, but distinctly different from plate group. The related marker in early phase was expressed in MSCs on PDMS membranes while mature marker was highly upregulated on plate.

### P2-105

#### 인도사이아닌그린을 이용한 중간엽 줄기세포 표지법 및 광음향 신호 측정

유진명, K. K. Hlaing, 오정환, 남승윤  
부경대학교 의공학과

Stem cell therapy has a huge potential to enhance the recovery of damaged tissues and organs. However, during the stem cell therapies, the implanted stem cells are difficult to be detected and observed to assess the therapeutic effects. Noninvasive

monitoring of stem cell viability is essential to estimate efficacy of stem cell therapy. In this study, indocyanine green, approved by FDA and clinically applicable, was used to label stem cells for tracking of photoacoustic signals. The photoacoustic signals were monitored before and after the cell death caused by injection of sodium hydroxide. The results show feasibility of noninvasive detection of stem cell viability during therapeutic procedures.

#### P2-106

유방암의 치료진단을 위한 독소루비신이 결합된 다기능성  $\text{CoFe}_2\text{O}_4$  자기 나노입자의 특성 연구

오윤옥,<sup>1</sup> Nhat Quang Bui,<sup>1,2,3</sup> 오정환,<sup>1,2,3,4</sup>

<sup>1</sup>부경대학교 해양융복합 MIBC 사업단,

<sup>2</sup>부경대학교 의생명기계전기융합공학협동과정,

<sup>3</sup>해양과학 MIBT 융복합 센터 (BK21 Plus),

<sup>4</sup>부경대학교 의공학과

Magnetic nanoparticles (MNPs) have been investigated as a potential hyperthermia agent for a wide biomedical application. Drug combined MNPs have recently attracted as a useful tool for the hyperthermia with chemotherapy in therapeutic application. In this study, multifunctional doxorubicin (Dox) loaded  $\text{CoFe}_2\text{O}_4$  nanoparticles were demonstrated as a dual modality for hyperthermia and anti-cancer treatment and imaged by photoacoustic imaging for the diagnosis. Dox-loaded  $\text{CoFe}_2\text{O}_4$  nanoparticles were highly internalized into breast cancer cells and visualized using Prussian blue stain. The release of Dox from Dox-loaded  $\text{CoFe}_2\text{O}_4$  nanoparticles was higher in acidic environment compared to neutral environment and enhanced

by hyperthermia treatment. Dox-loaded magnetic nanoparticles induced a higher apoptosis ratio than free Dox onto breast cancer cells and showed a high performance of cancer treatment combined with magnetic hyperthermia in vitro. Furthermore, the optical image of Dox-loaded  $\text{CoFe}_2\text{O}_4$  nanoparticles labeled cancer cells was demonstrated as a PAT modality. As a result, Dox-loaded  $\text{CoFe}_2\text{O}_4$  nanoparticles can provide excellent possibility of nonionizing and noninvasive diagnostic capability.

#### P2-107

조직공학용 시스테인 기반 합성물

B. Lowe, 남승윤

부경대학교 의공학과

The recapitulation of the extra cellular using functional biomaterial properties is an aspect of regenerative scaffold designs. To effectuate this, we developed a 3D nanocomposite compose of chitosan, nano-hydroxyapatite, gelatin and cysteine using a freeze-drying method. The nanocomposite is solid in nature and revealed a suitable microenvironment suitable for cell growth. The functional properties of the biomaterials present in the nanocomposite have distinct cellular responses. Also, the addition of cysteine, an assessor of the extracellular matrix, aims at further strengthening the mimicry nature of the nanocomposite for targeted cell behavior such as proliferation and differentiation.

#### P2-108

플로로탄닌으로 코팅된 폴리카프로락톤 필름의 유착방지효과

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오건우, 정원교  
부경대학교 의공학과 및  
BK21 plus 해양MIBT융복합사업단  
부경대학교 해양융복합바이오닉스 MIBC 연구단

The purpose of the present study was to fabricate phlorotannin-coated PCL film for using postsurgical adhesion prevention. PCL film was coated by phlorotannin solution (1, 3 and 5 wt%) and then mechanical characterization of fabricated films were investigated through FT-IR and universal testing machine. Furthermore, cytotoxicity and anti-inflammation of film were investigated by using the MTT assay and nitric oxide production assay. The results show that phlorotannin-coated PCL film did not cytotoxicity and significantly inhibited the nitric oxide production. The results of this study suggested that phlorotannin-coated PCL film is potentially useful as a bioactive ingredient in anti-adhesive barrier.

### P2-109

Melt-plotting system을 이용한 어류뼈 유래  
기능성 소재 융합형 골조직 의료재생공학용 3  
차원 세포담체 제작 및 특성 연구

허성영, 고석천, 정원교  
부경대학교 의공학과 및  
BK21 plus 해양MIBT융복합사업단  
해양융복합바이오닉스 MIBC 연구단

We designed scaffolds consisting of biodegradable polymer (poly-caprolactone (PCL)) and bioactive substance containing calcium and phosphate from fish bone fabricated by three axis plotting system for bone tissue regeneration. The effect of fish bone derived bioactive substance (FBBS)/PCL scaffolds (1 and 3%) on

various mechanical properties and characteristics including the morphology image, FT-IR analysis, and tensile properties were investigated. Moreover, the in vitro biocompatibilities of the FBBS/PCL scaffolds were examined using MC3T3-E1 pre-osteoblast. At the results, the FBBS/PCL scaffolds showed high cell proliferation, mineralization and mRNA expression of osteogenic markers were observed compared to the PCL scaffold.

### P2-110

피부 조직 재생을 위한 어류 콜라겐/알긴산 나  
트륨/키토올리고당 세포담체 제작

허성영, 정민선, 고석천, 정원교  
부경대학교 의공학과 및  
BK21 plus 해양MIBT융복합사업단  
해양융복합바이오닉스 MIBC 연구단

An emerging paradigm in wound healing techniques is that a tissue-engineered skin substitute offers an alternative approach to create functional skin tissue. Here we developed a fish collagen/alginate (FCA) sponge scaffold that was functionalized by different molecular weights of chitooligosaccharides (COSs) with the use of 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide-hydrochloride as a cross-linking agent. The 160-260  $\mu$ m pore size and over 90% porosity and COS's MW driven swelling and retention capacity, tensile property and in vitro biodegradation behavior guaranteed the FCA/COS-scaffolds for skin tissue engineering application. These properties suggest that the FCA/COS1-scaffold is a superior candidate that can be used for skin tissue-regeneration.

## P2-111

Structure and characterization of Sodium alginate/gelatin from Paralichthys olivaceus porous scaffolds merged with fucoidan for potential neural engineering applications

H. H. Park,

V. T. Nguyen and W. K. Jung

Department of Biomedical Engineering, and

Center for Marine-Integrated Biomedical

Technology (BK21 Plus)

Pukyong National University

Marine-Integrated Bionics Research Center,

Pukyong National University

Bases on the requirement of the key in neural tissue engineering are to develop materials with little or no effect to neuroinflammation. We have developed a method to create porous scaffolds by added fucoidan (Fu) into sodium-alginate (Sa)/gelatin (G) (SaGFu). For mechanical characterization such as stress/strain and swelling-test were measured. Cell culture tests, carried out using gelatin 2.0% (SaG2Fu) and 4.0% (SaG4Fu) showed a good cell proliferation. SaG4Fu also inhibited the activation and translocation of p65 NF- $\kappa$ B protein levels. These results provide insights into the diverse biological effects and open new opportunity for the applications of SaGFus in neuroscience.

## P2-112

광열 치료와 PAT 이미징을 위한 다기능성 제제로서의 약물이 결합된 카본 나노튜브의 특성 연구

오윤옥,<sup>1</sup> Nhat Quang Bui,<sup>1,2,3</sup> 서한수,<sup>2</sup> 오정환<sup>1,2,3,4</sup>

<sup>1</sup>부경대학교 해양융복합 MIBC 사업단,

<sup>2</sup>부경대학교 의생명기계전기융합공학협동과정,

<sup>3</sup> 해양과학 MIBT 융복합 센터 (BK21 Plus),

<sup>4</sup> 부경대학교 의공학과

SWNTs exhibit a higher NIR light absorbance with an 808 nm laser, which can be efficiently utilized to Photothermal therapy (PTT) for breast cancer. SWNTs can be also developed with strong optical absorbance in the near-infrared (NIR) region for molecular imaging as well as PTT of cancer therapy. Moreover, Dox, anti-cancer drug, can be easily conjugated on the surface of SWNTs through  $\pi - \pi$  interactions at lower pH range. And therapeutic efficacy of Dox-conjugated SWNTs (SWNT-Dox) were more improved combined with drug delivery and PTT for breast cancer. In this study, we demonstrated Dox-conjugated SWNTs as a novel cancer theranostic agent, for PAT image-guiding Photothermal therapy (PTT) and drug delivery.

## P2-113

친점액성 PEG 코팅된 녹내장 치료용 메조포러스 실리카 입자 개발

고송아<sup>1</sup>, 김세나<sup>1</sup>, 광지민<sup>1</sup>, 이승호<sup>2</sup>,

허범강<sup>1</sup>, 최영빈<sup>1, 2, 3</sup>

<sup>1</sup>서울대학교 공과대학 바이오엔지니어링 협동과정

<sup>2</sup>서울대학교 의학연구원 의용생체공학연구소

<sup>3</sup>서울대학교 의과대학 의공학교실

Eye drop formulation for glaucoma drug is limited in very short drug residence time at the preocular space, hence very low drug bioavailability. To resolve this, we proposed polyethylene glycol (PEG)-coated mesoporous silica as carriers of a glaucoma drug, brimonidine. The amine-functionalized mesoporous silica (AMS) was fabricated via anionic surfactant-mediated synthesis method (S-N+ ~I- mechanism),



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which were coated with PEG (M.W. 6000) to allow a mucoadhesive effect. We evaluated their in vitro drug release profile in pH 7.4 PBS. After a burst release of 33% on the first 20 min, the drug was slowly released for 8 hours. In vivo experiments were conducted with the PEGcoated AMS, where after their topical application to the rabbit eye, we measured the change in intraocular pressure (IOP) to examine the efficacy of brimonidine. Our findings showed that the period of lowered IOP was about 14 h after the administration, which is more than twice longer than that with a commercial brimonidine eye drop, Alphagan P (6h).

### P2-114

#### 폐쇄성 수면무호흡증 환자의 무호흡-저호흡 지수 예측

정다운<sup>1</sup>, 최재원<sup>2</sup>, 이유진<sup>2</sup>, 정도연<sup>2</sup>, 박광석<sup>3</sup>

<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링전공

<sup>2</sup>서울대학교병원 수면의학센터

<sup>3</sup>서울대학교 의과대학 의공학교실

Predicting obstructive sleep apnea is useful to separate low risk obstructive sleep apnea patients from high risk ones who need formal polysomnography and active therapeutic intervention. We devised new predictors of apnea-hypopnea index by assessing the autonomic dysfunction in obstructive sleep apnea patients. The simple predictors, extracted from the electrocardiographic recording, exhibited a noteworthy apnea-hypopnea index predictability.

### P2-115

#### 최대운동 후 진동슬링장비를 활용한 회복이 심박수 및 혈중젖산 분석

오주환, 권대규, 강승록, 노두영, 민진영

전북대학교 헬스케어공학과,

전북대학교 바이오메디컬 공학부,

(주) 소닉월드

physiological by-products of lactate occurred metabolic disorders, muscle contractile function and decreased muscle fatigue. Sling exercise and whole body vibration could improve cardiovascular function and muscle strengthening through the neuromuscular control and functional stability of local muscles. The experiment was performed for determining the heart rate and blood lactate recovery rates under different treatment conditions. As a result, the active recovery with WBV treatment is generally the most effective way to restore the heart rate and fatigue factors for maintaining their stable levels after maximal exercise.

### P2-116

#### 다채널 심전도 시스템에서 접촉 채널 자동 검출 방법

이홍지<sup>1</sup>, 이원규<sup>1</sup>, 윤희남<sup>1</sup>, 박광석<sup>2</sup>

<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링전공

<sup>2</sup>서울대학교 의과대학 의공학교실

In previous study, we developed an unconstrained 12-channel ECG measurement system. The main reason why the system was composed of multi-channels was to be strong in external noise by selecting the channels with high-quality ECG signals. Autocorrelation function, power spectrum ratio, kurtosis, and the mean and standard deviation of detected peaks in signals were used to determine automatically the electrodes in contact with the body among 12 electrodes. Our



algorithm detected the contacted channels with an average sensitivity of 97.62%, specificity of 99.87%, PPV of 99.24%, NPV of 99.59%, accuracy of 99.54%.

## P2-117

### 모바일 연동 환자 모니터링에서의 주요 장애물 - 규제, 표준, 임상 시험 -

김성재

SAIHST 의료기기산업학과

With a quick growth of the mobile health-care market, there are also increasing interests in challenges embedded in the market such as regulations, standards and clinical trials. To meet the increasing interests, US and EU the authorities have made guidance and a road-map, and the authorities in Korea have also done so. In the growing mobile healthcare industry, the largest market is the patient monitoring service. Therefore, it is important to review major challenges faced by companies providing the patient monitoring service. In this paper, we discuss key challenges to the provision of the patient monitoring service.

## P2-118

### 무선 3색 LED 광 출력 장치 프로토타입

김경원<sup>1</sup>, 이미소<sup>1</sup>, 유문호<sup>2</sup>, 안혜자<sup>1</sup>,  
오한영<sup>3</sup>, 김남균<sup>3</sup>, 박경준<sup>2,3</sup>

<sup>1</sup>전북대학교 헬스케어공학과,

<sup>2</sup>전북대학교 바이오메디컬공학부,

<sup>3</sup>㈜칼라세븐

Color therapy is a method of alternative medicines that uses various spectrums of visible light. It has drawn great results on clinical treatment from lifestyle disease to

cancer. This study presents a prototype development of a wireless three-color LED device. The prototype is composed of a MCU based on Arduino, a power supply circuit for LED emitting, and a Bluetooth module. A Windows-based host application is implemented to verify the functional feasibility. The accuracy of LED brightness is tested for every 10 % of PWM value.

## P2-119

### A pH Monitoring Algorithm using EGFET Platform

K.H. Lee<sup>1</sup>, D.K. Lee<sup>1</sup>, J.S. Yoon<sup>1</sup>,

K.S. Jeong<sup>1</sup>, B.S. Kwak<sup>1</sup> and O.W. Kwon<sup>1</sup>

<sup>1</sup> Daegu Research Center for Medical Devices

and Rehab Engineering,

Korea Institute of Machinery & Materials

This paper describes a disposable pH monitoring sensor using the extended-gate field-effect transistor(EGFET). Conventional ion-sensitive FET(ISFET) requires the post-fabrication for replacing the gate electrode with a chemically sensitive membrane in MOSFET. The proposed sensor, which composed of commercial MOSFETs, measures accurately pH values with novel monitoring algorithm. First, the sensor finds the pH value approximately by adjusting the voltage applied to the reference electrodes. Second, the sensor determines accurately minimal changes of pH value through the amplifier on a fixed reference voltage. Therefore, we can detect the pH value with a wide dynamic range and a good resolution.

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P2-120

### 샘플링율이 맥박변이도 시간영역 분석에 미치는 영향 분석

양윤라\*, 강성탁\*\*, 노동근\*\*, 최민주\*\*, 신항식\*\*

\*전남대학교 의공학협동과정

\*\*전남대학교 의공학과

We investigated the effect of sampling frequency to the pulse rate variability (PRV) on time domain. We analyzed AVNN, SDNN, SDSD, RMSSD, NN50 and pNN50 with 10 Hz, 25 Hz, 50 Hz, 100 Hz, 250 Hz, 500 Hz, 1,000 Hz and 5,000 Hz down-sampled photoplethysmogram with 10 kHz sampled signal. Then, we compared the result of down-sampled signal with the result of heart rate variability of 10 kHz-sampled electrocardiogram. Result shows that every variable of PRV is significant when sampling frequency is 25 Hz or higher. However, every variable except on AVNN are not significant at 10 Hz sampling frequency.

P2-121

### 헬스케어 분야에서의 개방형 혁신 플랫폼 구축

정혜임

성균관대학교 의료기기산업학과

The open innovation has been defined by Chesbrough: “open innovation is a paradigm that assumes firms can and should use external ideas and internal ideas.” The objectives of this study were (1) to apply open innovation in hospital to develop the doctor’s idea and (2) to develop the method of communicating between doctors and developers using the application. For applying this concept, a survey of doctors has been conducted in Korea and Systematic

Review was implemented. Two factors are “communication” and “participation”. This study presented the concept of platform for opening up open innovation processes.

P2-122

### 스트립형 힘센서 기반 무구속 호흡 측정 시스템

박수지\*, 김훈\*\*, 신항식\*\*\*

\*전남대학교 바이오전자메디컬공학협동과정

\*\*전남대학교 기계설계공학부

\*\*\*전남대학교 의공학과

The purpose of this research is to evaluate the strip-type on-bed respiration monitoring system. We developed piezo-resistive strip force sensor, acquisition system and signal processing algorithm to extract respiration. Developed system was tested with 9 subjects, and respiration rate was controlled to 0.2 Hz and 0.25 Hz. Result shows that 99.6%, 99.2% and 98.5% of extracted respiration rate have the time difference less than 1s, 0.5s and 0.2s, respectively.

P2-123

### ISO 15197:2013 국제기준규격에 따른 개인용 혈당측정 시스템의 적혈구용적률 간섭영향 평가

이승노<sup>1</sup>, 정윤아<sup>1</sup>, 이창형<sup>1</sup>, 박창원<sup>1</sup>, 홍성화<sup>2</sup>

<sup>1</sup>식품의약품안전처 식품의약품안전평가원

의료제품연구부 의료기기연구과

<sup>2</sup>식품의약품안전처 식품의약품안전평가원

의료제품연구부

Point-of-care testing glucose monitoring systems are widely used, important tools for determining the blood glucose levels of people with diabetes, patients in intensive

care units, pregnant women, and newborn infants. However, a number of studies have concluded that a change in hematocrit(Hct) levels can seriously affect the accuracy of glucose measurements. In this study, We have evaluated the hematocrit interference of eight glucose monitoring systems which can report the hematocrit level test results. This was followed by an evaluation of performance according to the international organization for standardization(ISO) 15197:2013 based on bias with respect to the reference method. The result of hematocrit interference demonstrated that a decrease in Hct levels increases glucose concentrations, whereas an increase in Hct levels reduces glucose concentrations.

#### P2-124

##### 휴대용 초음파영상진단기기 평가기술 개발 연구

이정주, 이창형, 강민재, 구윤정, 박창원  
식품의약품안전처 식품의약품안전평가원  
의료기기연구과

This research is intended to study and develop the safety and performance evaluation items of portable ultrasound diagnostic device to prepare guidelines. In this research, we have conducted investigation and analysis on principles and configuration of the device, status of research and development, relevant domestic and international standards, and status of approval. The test items, test criteria and test methods developed through investigation and analysis are verified using two portable ultrasound diagnostic devices on the market. The guidelines prepared by this research to evaluate the safety

and performance of portable ultrasound diagnostic device is expected to propose its differences from traditional ultrasound diagnostic devices and to support the approval and review process as well as to contribute to promoting national health and strengthening the industrial competitiveness of domestic medical devices by verifying the quality of devices applied with new technologies.

#### P2-125

##### 선호 및 비선호색의 색채자극에 따른 수면유도 변화

이선진<sup>1</sup>, 김동욱<sup>2,3</sup>

<sup>1</sup>전북대학교 대학원 헬스케어공학과

<sup>2</sup>전북대학교 공과대학 바이오메디컬공학부

<sup>3</sup>전북대학교 고령친화복지기기연구센터

Sleep was affected by various factors. Especially, modern man who lives in the development of the technology had a high frequency to experience sleep disturbance and sleeping difficulty due to stress. However, sleep environment was most vulnerable state. Considering that people spend most of time of the day in the house by sleep, lighting of indoor environment and changes of color were significant. Thus, this study investigated sleep induction changes according to the color stimulation of preferred and non-preferred color. Sleep was decided by Electroencephalogram (EEG). Using LED, Color stimulation of preferred and non-preferred color was presented. Consequently, time of sleep induction had difference according to color stimulation of preferred and non-preferred color. Because preferred color invigorated parasympathetic, color stimulation of

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preferred color induced sleep. The result of this study may be used as basic data of research that investigate the effect of color on human and as setting of sleep environment.

### P2-126

**모바일 헬스케어의 5가지 주요 장애물: 규제, 표준, 정책, 보안, 임상시험**

김철희<sup>1</sup>, 김성재<sup>1</sup>, 김진률<sup>2</sup>, 유규하<sup>3</sup>, 홍성화<sup>4</sup>

<sup>1</sup>성균관대학교 삼성융합의과학원 의료기기산업학과.

<sup>2</sup>삼성서울병원 난청연구실,

<sup>3</sup>삼성서울병원 의과학교수실

<sup>4</sup>삼성창원병원 이비인후과

A global population aging due to the development of medical technology and low birth-rate trend leads a dramatic rise of healthcare cost. In addition, according to the improvement in a quality of life and interest in health, the importance of prevention and management of the disease is increasing. mHealth is in the spotlight as a way to reduce the cost of healthcare and enhance the quality of healthcare service. However, there are several hurdles blocking the activation of mHealth. We summarized the five major hurdles preventing the activation of mHealth and presented possible partial responses.

### P2-127

**기계 학습을 이용한 심박 변이성 기반의 졸음 감지 시스템**

김영주, 박철수

광운대학교 컴퓨터공학과

The interest in the technological development of detecting drowsiness in

various situations has been increasing due to several reasons. This includes crucial safety issues while driving and also the eager to maintain the state of awakesness during working hours. While previous studies on drowsiness evaluation use various heart rate variability (HRV) parameters, this article focuses on which HRV parameters to be used specifically, when applying machine learning techniques. The k-means algorithm, which is an unsupervised learning machine learning classifier, is applied to the drowsiness data acquired from all 15 subjects who attended drowsiness experimental sessions.

### P2-128

**수면상태 감지를 위한 HMM기반 가속도계 분석 방법**

류지우, 박철수

광운대학교 컴퓨터공학과

In ubiquitous health monitoring system, sleep detection is one of the essential task, as information on sleep is one of the most important factors in patient's health. In this paper, sleep detection algorithm based on hidden Markov model (HMM) using accelerometer data is proposed. Accelerometer data was acquired from five male and female patients, and the average length of data is 60 hours. Using five-fold cross validation, state probabilities and transition matrix were estimated using training data, and the performance of the proposed method was measured using test data.

## P2-129

## A New Paradigm of Health-Care Related Market: Reverse Innovation

J. Ahn<sup>1</sup>, H. Lee<sup>2</sup>

Department of Medical Device Research and Management, SAIHST, SKKU

Reverse innovation is an innovation that a product firstly developed from emerging economies as a low-cost product then it transfers to advanced economies. Although cases of health-care related reverse innovation are yet to be researched much, interests of it have been increasing rapidly. The aim of this paper is to present cases, analyze the process and the driving factors of reverse innovation. We provide a better understanding of outsourcing strategy and internalization process under an aspect of transaction costs theory, which can identify possible driving factors; driving factors of reverse innovation are depend on a phase of the innovation and an origin of Multinational Corporation (MNC).

## P2-130

## 족저 압력 분포 추정을 위한 깔창 시스템 개발

정현우<sup>1</sup>, 최안렬<sup>1</sup>, 신기영<sup>1</sup>, 이동준<sup>1</sup>,  
채혜선<sup>2</sup>, 이경숙<sup>2</sup>, 문정환<sup>1</sup><sup>1</sup>성균관대학교 생명공학대학 바이오메카트로닉스학과<sup>2</sup>농촌진흥청 국립농업과학원 재해예방공학과

The purpose of this study was to develop the plantar pressure measurement system utilizing a small number of FSR sensors from a portable U-Health perspective. The sensors were attached to the peak pressure locations based on anatomical landmarks. The system was constructed using an ATmega 8 MCU with programmable flash

memory. Spatial interpolation method was used to estimate overall foot pressure distributions. As a result, a large plantar pressure concentration was found in the fore-foot and heel of both subjects that corresponds to a previous study. This system supports the development of a U-Health-specific plantar pressure measurement device.

## P2-131

## 선형보간에 의한 광용적맥파 극점위치복원 특성 고찰

강성탁, 노동근, 최민주, 신항식  
전남대학교 의공학과

The purpose of this research is to investigate the effect of linear interpolation to peak points of the photoplethysmogram (PPG) sampled with lower sampling rate. We generated 5,000 Hz, 1,000 Hz, 500 Hz, 250 Hz, 100 Hz, 50 Hz, 25 Hz and 10 Hz sampled PPGs from 10 kHz sampled PPG. Then, we interpolated down-sampled PPGs by linear interpolation, and investigated the time difference of peak points of PPG waveform. Result shows that time difference is dramatically decreased ( $<0.1$  ms) at 25 Hz or higher frequencies. However, 10 Hz sampled case still shows meaningful time difference.

## P2-132

## 4060세대 심질환자 관리를 위한 심전도 신호 측정 가능한 아웃도어용 스마트 의류 연구

박지애<sup>1</sup>, 한희정<sup>2</sup>, 이종하<sup>1</sup><sup>1</sup>계명대학교 의과대학 의용공학과<sup>2</sup>계명대학교 미술대학 패션디자인전공



## POSTER II

Heart disease is the serious reason to lead death in the world over the past 10 years. So, heart disease patients take warning cardiac arrest and arrhythmia in the daily life. This study is to develop a wearable smart-clothes with detects ECG signal using electrically conductive fiber. The entire sensor system has small size and low-power-consumption because it can use to the daily life. In addition, signal conditioning and processing were implemented to remove motion artifacts. Actually, the patients put on this clothes and monitor ECG signal by the smart-phone application. As a result, we have successfully demonstrated that the wearable sensing clothes could detect ECG signal 100%. So, patients who have heart disease put on clothes easily and monitor ECG signal.

### P2-133

#### 생체 인증 가능한 터치리스 바이오 신호 측정 시스템 및 알고리즘 연구

김찬일, 박희준, 구정훈, 이종하  
계명대학교 의과대학 의공학학과

Effective patient monitor should measure biometric data of patients no matter when or where (anytime, anywhere). For these situations, Medical devices are getting smaller and simpler. As a result, wearable devices and implantable devices are developed. However, these devices also have demerits. Implantable devices have possibility of infection and battery problem. And wearable devices are hard to recognize identification of users. To solve existing problem, there are many researches about camera based Photoplethysmography (PPG), which is a noninvasive optical

technique for detecting microvascular blood volume changes in tissues. In this paper, we propose a system which is able to identify target and measure bio signal of target with camera. We expect this system could solve infection problem and identification problem of existing patient monitoring system.

### P2-134

#### 표본화 주파수에 따른 심박변이율 오차율 연구

이동석<sup>1</sup>, 권성준<sup>1</sup>, 박광석<sup>2</sup>

<sup>1</sup>서울대학교 협동과정 바이오엔지니어링 전공

<sup>2</sup>서울대학교 의과대학 의공학교실

Stress is critical factor related to mental stress in today's society. When stress appears, autonomic nervous system (ANS) in human body is activated, and this can be measured by examining electrocardiogram (ECG) through heart rate variability (HRV) analysis. Recently, there are many wearable devices which can measure stress level by HRV analysis. However, the performance of this device can be affected by sampling frequency in measuring such biosignals. High sampling frequency can lead to great HRV accuracy, but the calculation cost and the battery consumption become high. In this paper, we compared the HRV error rate from the signals acquired by different sampling frequency. RMSSD in time domain and HF in frequency domain showed highest error rate.

### P2-135

#### 다채널 근전도를 이용한 지화 움직임 분석

김병목, 나영민, 주효성, 양혜진, 우지환  
울산대학교 의공학과



This study aims to develop a finger motion identification method using multi-channel forearm-electromyograms (EMGs) and acceleration. The EMGs were acquired during a specific finger-language gesture. In order to predict meaning of a finger language motion, we used the machine learning algorithm. The classification results show that the EMG can be used to interpret the finger motion so that helps in communicating with a deaf and dumb person.

#### P2-136

##### ECG와 PPG의 1차 및 2차 미분신호들을 복합적으로 고려한 개인인증 가능성 여부 확인

성동석<sup>1</sup>, 김지훈<sup>1</sup>, 고명준<sup>1</sup>, 박광석<sup>2</sup>

서울대학교 대학원 협동과정 바이오엔지니어링 전공<sup>1</sup>

서울대학교 의과대학 의학과 의공학교실<sup>2</sup>

This paper shows the feasibility of Electrocardiography (ECG) and Photoplethysmography(PPG) that can be used as a personal authentication. 1<sup>st</sup> and 2<sup>nd</sup> derivative of ECG and PPG was used to improve the accuracy of the algorithm. ECG and BCG was each filtered by 1Hz~35Hz, 0.5Hz~15Hz Butterworth filter. Filtered Data were segmented and normalized. k-Nearest Neighbor algorithm, Linear Discriminant Algorithm and linear kernel based Support Vector Machine was used for classification and linear SVM showed the best performance. The accuracy of closed eye ECG was 99.10%, open eye ECG was 99.20%, closed eye PPG was 87.06% and open eye PPG was 85.73%. Most of the studies assess the accuracy of the classification algorithm using the signal in the same measurement period. However,

this paper use two different samples collected on two different days. Therefore, this proves the feasibility of ECG and PPG as personal authentication.

#### P2-137

##### Hilbert Transform과 Matched Filter기반의 실시간 부정맥 파형 분류 알고리즘

장유림, 전세훈, 신수연, 송문, 신태민

연세대학교 의공학과

The most common methods of classifying arrhythmia waveform use time interval of P-QRS-Tpoint or threshold for maximum and minimum. These methods have difficulties applying to real-time system because these use complicated calculations to reduce error occurred by individual differences in ECG signal. In this study, arrhythmia waveform classification algorithm was developed to apply Real-time system. This algorithm detects R-peak using Hilbert transform and classifies arrhythmia waveform according to results of performing matched filter in ECG signal and typical QRS pattern. This algorithm was applied to the MIT-BIT arrhythmia database and performed highly with accurate arrhythmia waveform classification in 93.9%.

#### P2-138

##### 가속도계를 이용한 심폐소생술 압박 축 추정 알고리즘

남윤찬, 김현성, 전세훈, 장유림, 송문, 신태민

연세대학교 의공학과

In these days, importance of CPR(Cardiopulmonary Resuscitation) is being emphasized, however, there is

## POSTER II

no standard axis of CPR and it is being cause of CPR accuracy decrement. This paper proposes the CPR compression axis estimating algorithm by using accelerometer. By measuring an acceleration of X, Y, Z axis from accelerometer, we estimated CPR Compression Axis with 99.45% accuracy and we are expecting this algorithm can be applied to CPR quantification.

### P2-139

#### 가속도 맥파를 이용한 혈관 상태 추정 시스템

이정직, 임지현, 허정현, 김현우, 조은일, 윤영로  
연세대학교 의공학과

In this study, we aim to develop the system propose the algorithm which estimates the vascular sclerosis state by using the Photoplethysmography (PPG). Proposed system is implemented by using the analog front-end for measuring the PPG signal and the Bluetooth module for the wireless data transfer. The transmitted PPG data are displayed on the LabVIEW program, and the characteristic points of PPG are detected using Acceleration PPG (APG). Also, the algorithm for estimating vascular sclerosis state using characteristic points is implemented. It seems that user can easily measure vascular sclerosis state through the usage of proposed system.

### P2-140

#### 유전영동힘분광기를 위한 LabVIEW 기반 자동화 시스템 개발

이정직, 허정현, 김현우, 조은일, 윤영로  
연세대학교 의공학과

The purpose of this study is development

of LabVIEW based automated system for improving existing research using dielectrophoretic tweezer. this automatic system for Dielectrophoretic Force Spectroscopy(DFS), various devises are complementary to previous system. High-speed CCD camera was operated with frame grabber and arbitrary function generator was installed to PCI slots in computer. These Devices are controlled by LabVIEW Program. this program has advantage that it is easy to modify due to programming by the graphic language and three devices such as camera, function generator and oscilloscope control is possible with a single program.

### P2-141

#### 동물 모델을 이용한 단기, 장기적 스트레스에 따른 심박변이도와 혈중 코르티코스테론 분석

박다정<sup>1,2</sup>, 박성희<sup>1,3</sup>, 성준경<sup>2</sup>, 윤인찬<sup>1</sup>

<sup>1</sup>한국과학기술연구원 의공학연구소,

<sup>2</sup>고려대학교 바이오융합공학과,

<sup>3</sup>고려대학교 기계공학과

Stress is a common problem for people of today. Especially, an accumulated stress can have a fatal impact on our health both physically and emotionally. To investigate physical effects of accumulated stress, this study compared the effects of short- and long-term stress on body weight, serum corticosterone level and heart rate variability (HRV) using an animal model. As a result, both the short- and long-term stress increased the ratio between low-frequency (LF, 0.1-1.0 Hz) and high-frequency (HF, 1.0-3.5 Hz) band power reflecting an imbalance between the sympathetic and the parasympathetic nervous system. Especially, longer exposure to stress

conditions resulted in significantly higher LF/HF compared to the control group with reduced normal-to-normal interval index, reflecting suppression of the overall autonomic nervous system (ANS) activity. Therefore, our results demonstrate that exposure to the long-term stress can affect both physiological condition and the HRV, leading to abnormal activities of the ANS.

#### P2-142

##### 양궁슈팅 조준-홀딩 구간에서의 가속도 데이터에 대한 주파수 분석

홍상표<sup>1</sup>, 조우형<sup>1</sup>, 권성호<sup>1</sup>, 심현민<sup>2</sup>, 이상민<sup>1</sup>

<sup>1</sup>인하대학교 전자공학과

<sup>2</sup>동서울대학교 디지털전자과

The purpose of this paper is to analyze archery shooting movement by using accelerometer. In FFT(fast fourier transform) analysis, The experimental results show that the peak frequency of accelerometer of X, Y and Z axis is gathered at 12~14Hz. This result is useful for finding the correlation between the score and archery shooting.

#### P2-143

##### 사용자의 체온을 조절할 수 있는 무선충전 가능한 웨어러블 스마트 체온 유도 센서 개발

김재경, 이종하

계명대학교 의과대학 의용공학과

Keeping temperature is the important factor for homeostasis of body. Especially, keeping standard body temperature is main cause of prevention and therapy on the cholinergic urticarial, hypothermia and cardiovascular disease etc. This study demonstrated that

artificial control of body heat can change entire temperature of body from established studies. Therefore temperature of body is changed by controlling the temperature of the wrist in this study. For artificial body-heat control, we use the thermoelement which have principle of thermocouple. Also, this experiment is recorded by thermos-graphic camera. When the standard temperature rises or descends by external environment, we increase voltage on the element. As a result, whole body temperature descends or rises about 0.5~0.6°C under the change of wrist temperature. This study demonstrated that whole body temperature is changed by artificial control of small areas.

#### P2-144

##### 탄소 나노튜브 와 폴리디메틸실록세인 혼합물을 이용한 신축성 있는 회로 제작 기술

황하련, 이상훈

KU-KIST 융합대학원 NBIT

U-health care device consist of many different part such as electrode, display window, circuit for signal processing and other parts. To sense during everyday life without any discomfort, U-health care device should be stretchable and flexible. This paper describe method for fabricating flexible circuit based on CNT (carbon nanotube)/PDMS (Polydimethylsiloxane). And feasibility test was conducted by construction of 4-bit full adder base on fabricated flexible circuit. Result shows that flexible circuit for U-health care device is possible if performance of circuit is improved.

## POSTER II

P2-145

### 스마트 생체신호 측정 휠체어를 위한 심탄도 노이즈 검출 알고리즘 개발

허정<sup>1</sup>, 심수영<sup>1</sup>, 홍승혁<sup>1</sup>, 최상호<sup>1</sup>,  
김윤재<sup>1</sup>, 김성완<sup>2</sup>, 박광석<sup>2</sup>

<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링 전공

<sup>2</sup>서울대학교 의과대학 의공학교실

Ballistocardiogram(BCG) is one of the physiological signal which is measured non-intrusively. Because BCG is based on small momentum of the heart, it can be contaminated easily by motions and movements. In this study, we developed contaminated BCG segment detection algorithm. Feature are extracted from time domain (max and min amplitude), frequency domain (power of dominant frequency) and output of peak detection algorithm (the number of peaks and peak interval's coefficient of variation). Classification is based on thresholding method.

P2-146

### 개인 인증을 위한 관성센서 기반 3-D 서명 인식 방법

강신일, 이승재, 주성수, 이종실, 김인영  
한양대학교 의공학교실

In this paper, an inertial sensor-based user authentication method to measure and analyze 3-D signature is presented implementing H-IMU (Hanyang Inertial Measurement Unit) we developed using a combination of gyroscope, accelerometer and magnetometer sensors. We have built a calibration jig with 9 degree of freedom(9-DOF) to minimize offset and gain error of inertial sensors. For measuring accurate 3-D signature, we used mahony algorithm to

remove gravity error and used trapezoidal method to minimize integration error. To evaluate the performance of the proposed method, we analyzed streams of signals returned by accelerometer when the user uses H-IMU to draw alphabet in A4 paper(210x297mm).

P2-147

### 만성질환관리 모바일 어플리케이션 및 프로토콜 개발

허정현, 김현우, 이정직, 이재훈, 윤영로  
연세대학교 의공학과

In recent days, as chronic diseases increased, the importance of the precautionary health care system increased. To prevent the chronic diseases, the continuous management is required. The user can check their health information quickly and easily anywhere, anytime by expanding the web-based healthcare monitoring services to mobile. In this study, we designed user interface, considering the accessibility and ease of use. We also designed Protocol that users can easily view the health information dependent on the mobile environment. Finally we implemented the mobile-based diabetes and hypertension management service application.

P2-148

### 모바일 기반 심폐소생술 교육 어플리케이션 개발

임현미<sup>1</sup>, 임승의<sup>1</sup>, 현수진<sup>2</sup>, 전상은<sup>2</sup>, 구정훈<sup>1</sup>  
계명대학교 의과대학 의용공학과<sup>1</sup>  
계명대학교 간호대학 간호학과<sup>2</sup>

Objective: We aimed to develop and

suggest mobile based cardiopulmonary resuscitation (CPR) education application. Method: The application was designed to increase a self-efficacy and accuracy of CPR performance. It has 3 steps (education, test, and feedback). The artificial respiration module was developed for detect expiration performance accurately. Preliminary Experiment: The preliminary experiment was conducted for the clinical evaluation of the effectiveness of the developed program with two students who has the knowledge of CPR and not. Discussion: The results showed that this program helps to understand the knowledge of CPR and to increase self-efficacy and accuracy of CPR performance. This system would be helpful to encourage performing CPR.

#### P2-149

##### 스트레인 게이지를 이용한 실시간 척추 측만 관리 시스템에 관한 연구

허정현, 이정직, 김현우, 윤영로  
연세대학교 의공학과

Traditional orthosis for scoliosis has several disadvantage. User should put on orthosis over than 23 hours a day and it gives uncomfortableness. So it results in psychological burden for user. In this study, we developed scoliosis treatment system based on variation of strain gauge attached on back. It can give us spontaneous treatment and is less restrictive. An application was also developed for user's convenience so real-time scoliosis treatment would be possible.

#### P2-150

##### 근육진동신호(MMG)를 이용한 엄지손가락 움직임 분류

한지호, 이재훈, 임지현, 윤영로  
연세대학교 의공학과

The studies on the finger movement recognition have been conducted for many years. Especially, the studies of interface with human's muscles have been done with Mechanomyography (MMG). MMG is a vibration signal which is generated by muscular contractions on the surface of the skin. The earlier studies have a limit point that is hard to be processed in real time because the earlier studies use more than 2 channels to acquire the vibration signals of muscular contraction and more than 40 characteristic points for pattern recognition. Accordingly, this study proposes the method to classify thumb's Flexion and Extension motions from the acquired MMG signal using only 1 channel. Consequentially, it seems to be able to develop the wearable device being used in real life using proposed method.

#### P2-151

##### 생체신호 기반 개인인증을 위한 데이터베이스 구축에 관한 선행 연구

김지훈<sup>1</sup>, 고명준<sup>1</sup>, 성동석<sup>1</sup>, 박광석<sup>2</sup>  
<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링  
<sup>2</sup>서울대학교 의과대학 의공학교실

In this study, we studied the standardized database methodology for new biometric authentication system. We examined the capability of brain signal and heart signal as personal identification. 50 healthy volunteers were recruited for this database and EEG, ECG, BCG, PPG, fingerprints of each subjects were measured.



## POSTER II

Physiological signals were digitized and coded into standardized-data format. We analyzed database using k-nearest neighbor algorithm and leave-one-out cross validation for feature classification. The best total correction rate for personal identification is 99.51% of ECG and worst case is 73.55% of BCG. In Authentication mode, ECG has 18.32% of equal error rate for imposter-mode test.

P2-152

### 깊은 인공신경망 분류기를 이용한 서파수면 검출

주광민  
서울대학교 협동과정 바이오엔지니어링

Slow wave sleep is a part of sleep stages included in NREM (Non rapid eye movement) Sleep. Many research find that slow wave sleep is related with physiological function like recovery of tired brain, memory consolidation. We detect slow wave sleep using HRV (Heart Rate Variability). For classification, we train the deep neural network to classify deep sleep on 13 normal subjects. The deep neural network has the various parameters, such as number of layers, units, learning rate. In various conditions, the trained neural network model that show the best performance is consist of two layers of ten units.

P2-153

### 무구속적 대퇴부 광역적맥파(PPG)의 움직임 구간 분석

홍승혁<sup>1</sup>, 허정<sup>1</sup>, 최상호<sup>1</sup>, 김윤재<sup>1</sup>, 박광석<sup>2</sup>  
<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링 전공  
<sup>2</sup>서울대학교 의과대학 의공학교실

The heart rate is the essential information to observe the cardiac status. And one of the approved methods to detect the heart rate is the photoplethysmography. In this study, we measured the unconstrained photoplethysmogram of the femoral artery from 5 males during 4 kinds of motions. The morphologies of photoplethysmogram for deriving the heart rate were dependent on the acceleration of motions. We made an algorithm to decide the unreliable periods of the signals considering the motion artifacts.

P2-154

### 액티브 러닝 기법을 이용한 파킨슨 환자의 보행 동결 탐지 알고리즘 개발

김한별, 이홍지, 이웅우, 전범석, 박광석  
서울대학교 공과대학 바이오엔지니어링

Freezing of gait (FOG) is one of the most frequent symptoms experienced by about 50% of Parkinson's disease patients. With increasing use of wearable sensors and smartphones, it is promising to detect FOG using these devices. Conventional machine learning algorithms were generally used to discriminate normal gait and FOG by training motion patterns, but it required doctor's truth annotation of considerable length of sensor data. Active learning technique achieves similar or better performance by querying small, but most informative unlabeled samples. In this paper, we explored the feasibility of active learning technique to train FOG classifier by comparing performances of both learning strategies.



P2-155

## 미세전극칩시스템과 신경세포 패터닝 기술

김현석<sup>1</sup>, 박광석<sup>2</sup>

<sup>1</sup>서울대학교 공과대학 협동과정 바이오엔지니어링

<sup>2</sup>서울대학교 의과대학 의공학교실

Neuronal-on-a-Chip technology is based on advanced neuronal culture technique, surface micropatterning, microelectrode array technology, and multi-dimensional data analysis techniques. The combination of these techniques allows us to design and analyze live biological neural networks in vitro using real neurons. In this review article, underlying technologies are reviewed: Microelectrode array technology and Neuronal patterning technology. There are new opportunities in the fusion of these technologies to apply them in neurobiology, neuroscience, neural prostheses, and cell-based biosensor area.

# 실험동물자원은행 거점기관



## 실험동물자원은행이란?

실험동물은 신약개발 및 의약품 안전성·유효성 평가 등 광범위한 분야에 사용되고 있지만, 실험동물의 타겟장기 활용 후, 기타 자원은 연구종료와 동시에 버려지고 있는 실정입니다.

그러나 오랜 기간 약물 등을 처치한 실험동물의 생체시료는 귀중한 연구자원으로 활용이 가능합니다. 이러한 실험동물 생체자원을 다시 활용하기 위해 국가 차원에서 수집, 관리하여 연구자들에게 분양하여 국내 신약개발 연구 및 생명연구를 활성화하고자 식약처에서 설치·운영하는 생체은행입니다.

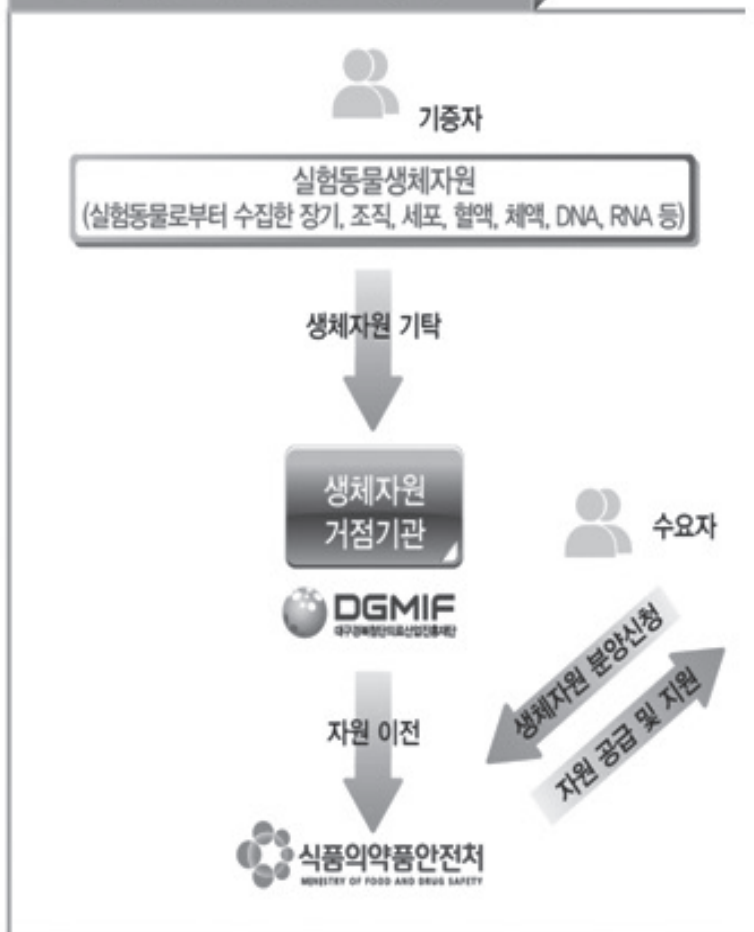
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실험동물자원은행을 통해 연구자들이 활용 가능한 다양한 생체자원을 산·학·연 협력기관 및 연구자로부터 확보하는 중심기관입니다. 2015년 현재, 대구경북첨단의료산업진흥재단 실험동물센터가 거점기관으로 지정되었습니다.

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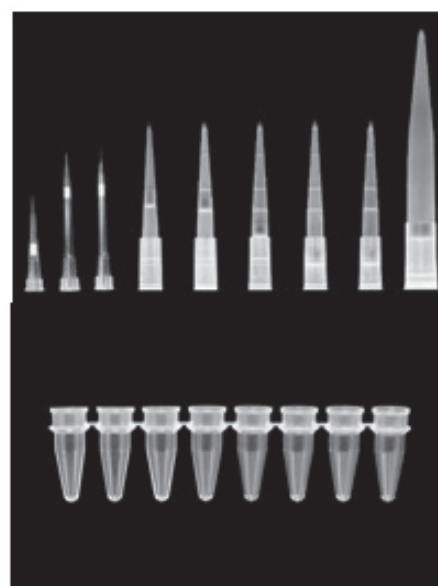
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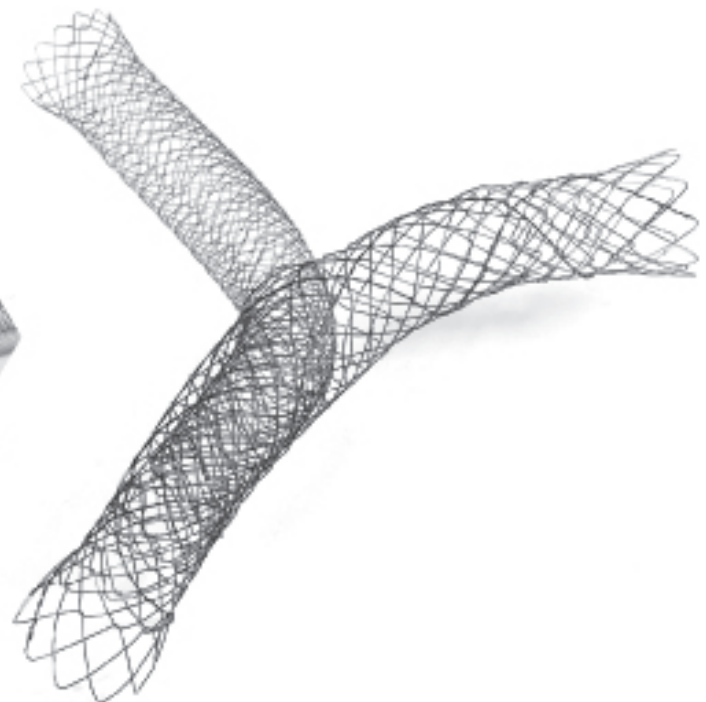
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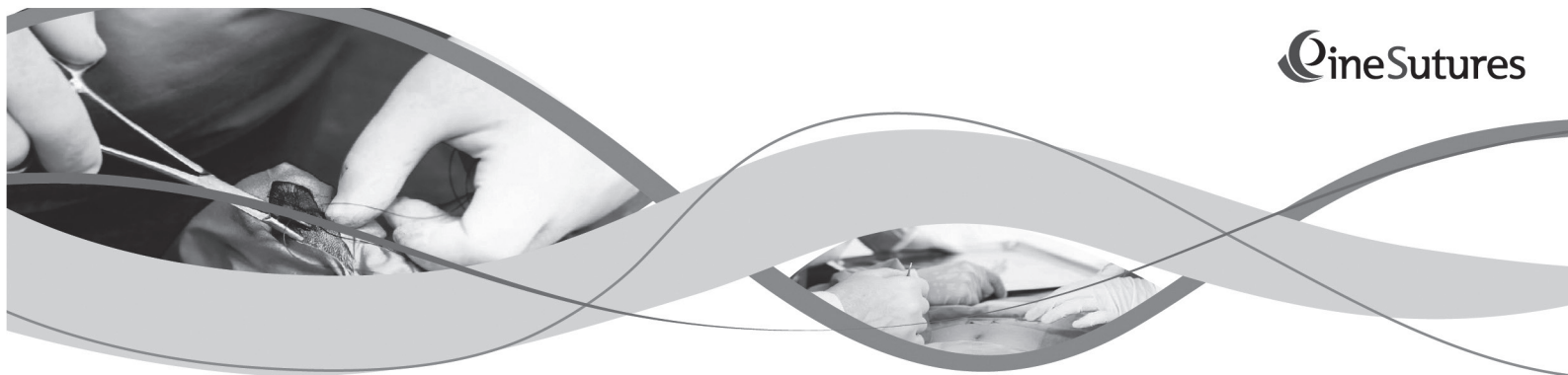


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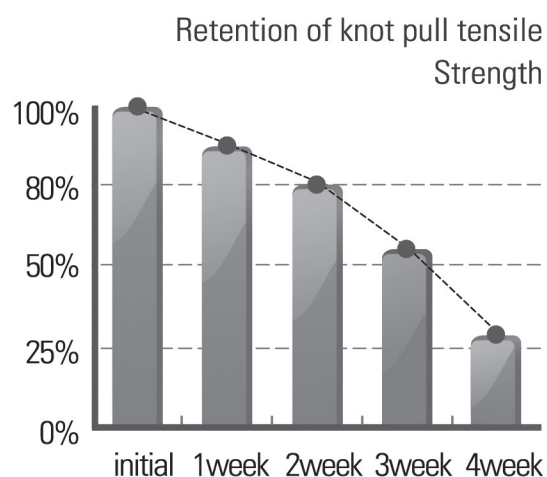


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