ICBHI2021

International Conference on Biomedical and Health Informatics 2021

"Digital Transformation in Healthcare"

November 10 (Wed) -12 (Fri)

Virtual

www.kosombe.or.kr
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Hosted by The Korean Society of Medical & Biological Engineering

Organized by The Korean Society of Medical & Biological Engineering, YONSEI UNIVERSITY

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Welcome Message

President of KOSOMBE

Dongwook Kim, Ph.D.

Dear IFMBE and KOSOMBE members,

Although the continuing pandemic of COVID-19 seems to dominate our thinking and behavior, your academic enthusiasm and growth must be a great driving force to get over this situation.

IFMBE and KOSOMBE will jointly hold the 2021 Autumn Conference as “Joint Conference of the International Biomedical Engineering Conference (IBEC2021) and the International Conference on Biomedical and Health Informatics (ICBHI2021)”

Yonsei University, which forms the organizing committee of this conference and prepares the event, started at "Gwanghyewon," the first modern hospital in Korea. It contributed greatly to the modernization of healthcare services and education and also biomedical engineering in Korea. I am pleased to prepare for this conference with the university that played a pivotal role in the establishment of our society, KOSOMBE.

'Digital Transformation in Healthcare' has been selected as the theme of this conference. Digital technology is leading the innovation in every healthcare technology sector, and we would like to identify what our roles are and how we can contribute to a prosperous future.

I hope that many members will participate in this conference and share our academic alliance and common interest as an academic community.

Sincerely,
Dongwook Kim, Ph.D.
President of KOSOMBE
Chair, ICBHI2021

Welcome Message

President of IFMBE

Shankar Krishnan, Ph.D.

Welcome Message from the President of IFMBE

On behalf of the International Federation for Medical and Biological Engineering (IFMBE), I am delighted to extend a warm welcome to all of you to this exciting event. This International Biomedical Engineering Conference (IBEC 2021) and the International Conference on Health and Biomedical Informatics (ICHBI 2021) is jointly organized by the Korean Society of Biomedical Engineering (KOSOMBE) and IFMBE.

IFMBE has over seventy national and transnational member societies and KOSOMBE is an esteemed member society in the Asian Pacific Region for IFMBE. We are pleased that Yonsei University is hosting the conference and the faculty of POSTECH, Yonsei University and KOSOMBE have done a commendable job in a remarkably brief time.

The unwelcome COVID- 19 has impacted the global community severely for the past twenty months triggering the need for innovative approaches in most aspects of our lives. The convergence of biomedical engineering and life sciences with digital health has created tremendous opportunities to transform patient care from diagnosis to therapy to drug development. Digital technologies involving wearables, artificial intelligence, cybersecurity, and interoperability will greatly enhance patient data analytics and improve patient outcomes. “Digital healthcare” has certainly been a key factor in the overall management and efficient and timely mitigation of the pandemic and has been selected as the main theme for this conference.

ICBHI 2021 is the fourth thematic international conference on Biomedical and Health Informatics. The conference program includes plenary lectures, invited talks by accomplished international biomedical professionals, scientific research presentations, and student paper competitions covering the broad spectrum of digital healthcare, education, and research.

Based on regulatory guidelines and in conformance with strict safety guidelines, this conference is conducted in the virtual mode. With modern communication technologies, you can network and exchange innovative ideas leading to productive partnerships. We hope that all the attendees will find this conference informative, inspiring, enjoyable, and beneficial.

Our best wishes to you to be safe and healthy as we continue our dedicated efforts in the fascinating field of biomedical engineering towards better health for all !

Shankar Krishnan, Ph.D.
President, IFMBE
Co-Chair, ICBHI 2021

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		Ki Chang Nam	Dongguk University (S. Korea)

Program at a Glance (ICBHI2021)

11 Nov. (Thursday)

Joint Session | ICBEC Program

Time	Room F	Room G	Room H
09:00~09:30	Opening Ceremony (Joint Session)		
09:30~10:00	Plenary Session 1 (Joint Session)		
10:00~10:30			
10:30~11:00	Student Paper Competition		Poster Session
11:00~11:30			
11:30~12:00			
12:00~12:30	Lunch		
12:30~13:00			
13:00~13:30			
13:30~14:00	Medical Imaging and AI : Part I	Multimodal Medical Imaging Informatics 1	
14:00~14:30			
14:30~15:00			
15:00~15:30	Break		
15:30~16:00	Digital Health Trends and Regulatory Considerations	Enabling Digial Health Transformation with Interactive Process Mining	
16:00~16:30			
16:30~17:00			
17:00~17:30	Digital Health Applications	Future Diagnositc and Therapeutic Technologies	
17:30~18:00			
18:00~18:30			

12 Nov. (Friday)

Joint Session	ICBEC Program

Time	Room F	Room H
09:00~09:30	Plenary Session 2 (Joint Session)	
09:30~10:00		
10:00~10:30	ICBHI Award	Poster Session
10:30~11:00	Multimodal Medical Imaging Informatics 2	
11:00~11:30		
11:30~12:00		
12:00~12:30	Lunch	
12:30~13:00		
13:00~13:30		
13:30~14:00	Medical Imaging and AI : Part II	
14:00~14:30		
14:30~15:00		
15:00~15:30	Closing Ceremony	

Program in Detail

11 Nov. (Thursday)

Plenary Session 1 (Joint Session) — Room A (09:30~10:30)
Session Chair: Kwang Gi Kim (Gachon University, S. Korea)

Student Paper Competition — Room F (10:30~12:00)
Session Chair: Jinah Jang (POSTECH, S. Korea)

Digital Health Applications	Room F (17:00~18:30)
	Session Chair: Ratko Magjarevic (University of Zagreb, Croatia)

Future Diagnositc and Therapeutic Technologies	Room G (17:00~18:30)
	Session Chair: Sung-Min Park (POSTECH, S. Korea), Jinah Jang (POSTECH, S. Korea)

12 Nov. (Friday)

Plenary Session 2 (Joint Session)	Room A (09:00~10:00)
	Session Chair: Sung-Min Park (Pohang University of Science and Technology, S. Korea)

Plenary Session 1 (Joint Session)

Session Chair: Kwang Gi Kim (Gachon University, S. Korea)

11 Nov. (Thursday)	Room A (09:30~10:30)

Wearable Devices for Detection of Atrial Fibrillation and Seizure Prediction in Divers

Ki Chon (University of Connecticut, USA)

Ki Chon
Krenicki endowed chair professor and chair of BME
University of Connecticut

Wearable Devices for Detection of Atrial Fibrillation and Seizure Prediction in Divers

Abstract

The efforts of my research group at University of Connecticut have been focused on wearable devices, biosignal processing, and development of novel algorithms for detection of atrial fibrillation (AF) and seizure prediction in Navy divers due to oxygen toxicity. My laboratory has been working on developing low-cost wearable devices and algorithms for continuous monitoring for the above-noted applications. To this end, we have been developing novel and low-cost approaches to intermittently and continuously monitor paroxysmal AF. For intermittent monitoring of paroxysmal AF, we will discuss using a smartphone’s video camera to detect AF. For continuous monitoring of paroxysmal AF, we will discuss the development of a low-cost, leadless and wireless wearable device including a smartwatch. My talk will also detail our recent work on using electrodermal activity (EDA) sensors for seizure prediction due to oxygen toxicity in Navy divers.

Brief Biosketch

Ki H. Chon received the B.S. degree in electrical engineering from the University of Connecticut, Storrs; the M.S. degree in biomedical engineering from the University of Iowa, Iowa City; and the M.S. degree in electrical engineering and the Ph.D. degree in biomedical engineering from the University of Southern California, Los Angeles. He spent three years as an NIH Post-Doctoral fellow at the Harvard-MIT Division of Health Science. He is currently the John and Donna Krenicki Professor and Head of Biomedical Engineering at University of Connecticut, Storrs, CT.

He has published 184 peer-reviewed journal articles, and more than 125 book chapters, conference proceedings and abstracts to date, and has 13 U.S. patents granted. He has received more than $22M in grants from the NIH, NSF, DoD and industry. His patent concerning an algorithm for real-time detection of atrial fibrillation has been licensed to a Holter company and the Holter monitor is currently on the market. He is fellow of National Academy of Inventors, International Academy of Medical and Biological Engineering American Institute of Medical and Biological Engineering, and Asia-Pacific Artificial Intelligence Association.

The Joint Conference of the IBEC2021 and the ICBHI2021

Student Paper Competition

Session Chair: Jinah Jang (POSTECH, S. Korea)

11 Nov. (Thursday)	Room F (10:30~12:00)
Pressure Ulcer Prediction with Deep Learning	Yeonhee Kim (Ewha Womans University, S. Korea)
Point-of-care (POC) Blood Coagulation Test using High-frequency Ultrasound	Jinhee Yoo (POSTECH, S. Korea)
Deep learning-based anomaly detection of bone scan images	Dongha Kim (Yonsei University, S. Korea)
Speckle Reduction via Deep Content-Aware Image Prior for Precise Breast Tumor Segmentation in an Ultrasound Image	Haeyun Lee (Daegu Gyeongbuk Institue of Science & Technology, S. Korea)
Spiking neural network with sparse lateral connection for MNIST classification	Yumin Cheong (Yonsei University, S. Korea)
AI-based fully automatic scanning-guide algorithm for diagnosis of rotator cuff tear	Kyungsu Lee (Daegu Gyeongbuk Institute of Science & Technology, S. Korea)
3D bioprinting of stem cell-derived β-cell aggregates in multi-encapsulation system	Yeonggwon Jo (POSTECH, S. Korea)
Porous Graphene-based Pulse Wave Sensor using One-Step Laser Fabrication	Jina Lee (POSTECH, S. Korea)
Complex valued convolutional neural network Multi task model	Junghwan Lee (Kwangwoon University, S. Korea)
Classification of Human Activity Data Using Sharpened Dimensionality Reduction and Clustering	Jeewon Heo (University of Groningen, Netherlands)
Preclinical and Clinical Photoacoustic Microscopy and Plus: Ultrasound Imaging, Photoplethysmography, and Thermometry	Joongho Ahn (POSTECH, S. Korea)
On-Line Interactive System for the Adherence of Physical Activity of the Elderly at Risk of Frailty	Martín Pinilla (IFMBE Professional & student working group, Colombia)
HIMO (Health Intelligent Medical Own)	Leslie Yessenia Cieza Huane (IFMBE Professional & student working group, Peru)

Pressure Ulcer Prediction with Deep Learning

Yeonhee Kim[1], Gunhui Jo[2], Ho-Youl Jung[3], and Jang-Hwan Choi[1]

[1]Mechanical and Biomedical Engineering, Graduate Program in System Health Science and Engineering, Ewha Womans University, Seoul, South Korea
[2]Computer Science, Ewha Womans University, Seoul, South Korea
[3]Electronics and Telecommunications Research Institute, Daejeon, South Korea

Abstract— **Pressure ulcers are localized tissue damage to the skin and underlying tissue, primarily caused by prolonged pressure over a bony prominence. Once pressure ulcers occur, not only is it difficult to treat this disease, but it also incurs enormous economic costs in the course of treatment. Furthermore, the importance of preventive nursing is emphasized because it causes pain in patients, increases the mortality rate, and puts a burden on the medical system. Therefore, research is being actively conducted to predict bedsores. Recently, a deep learning-based prediction algorithm has been applied to healthcare data and has proven very good performance, but an algorithm for predicting the onset of pressure sores has not been proposed yet. Here, we propose a deep learning framework that predicts the onset of pressure ulcers. We utilize a multi-input recurrent neural network model for prediction of time-to-occur pressure ulcers using sequential data of patients with pressure ulcers acquired from Dankook University hospital. Our datasets include lab test data of patients, lab codes (features), and labels with an occurrence of pressure ulcers. The input-output pair datasets needed to be adapted or refined on the proposed model. Thus, we preprocessed the datasets through cleansing, interpolating missing data fields, and making sequence inputs suitable for a multi-input recurrent neural network model. As a result, we were able to accurately predict the onset of a patient within a week with the proposed algorithm.**

Short Biography— **Y. Kim received her BS degree from Ewha Womans University. She is currently pursuing her MS degree from the same university. Her research interests include bioinformatics, disease prediction, and deep learning. G. Jo is pursuing her BS degree from Ewha Womans University. H.-Y. Jung received his PhD degree in computer science from Pusan National University, and he is currently a principal researcher at the Electronics and Telecommunications Research Institute. J.-H. Choi has obtained a Ph.D. from Stanford University. Currently, he heads Ewha Medical AI Lab, and his lab conducts research on computer vision, pattern analysis and medical informatics.**

Point-of-care (POC) Blood Coagulation Test using High-frequency Ultrasound

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Pohang 37673, Republic of Korea
[2]Department of Convergence IT Engineering, Pohang University of Science and Technology
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Abstract— **For patients taking oral anticoagulants such as Warfarin in the treatment and prophylaxis of thrombotic disorders, the International Normalized Ratio (INR) is monitored to reduce misuse of anti-coag-ulants. Point-of-care (POC) device was developed to allow patients to monitor INR, but requires disposable test strips for chemical reactions and at least 8 µL of whole blood. In this study, we present a method to predict INR without chemical reaction using high-frequency ultrasound. This method uses 4 µL of whole blood, and test results can be obtained in less than 10 minutes, making it suitable for use as a POC device. After preparing a solution in which HBSS (Hanks Balanced Salt Solution) mixed with Warfarin, whole blood was diluted at a 1:1 ratio. The control solution was also prepared without Warfarin. The INR of the dilutions with or without Warfarin was measured using a POC device (CoaguChek XS), and it was measured to be 1.2 and 1.6, respectively. In addition, 8 uL of the diluted solution was placed on the surface of the high-frequency ultrasound transducer to measure the backscattering coefficient. As a result, the difference in INR 0.4 depending on Warfarin was quantified as a backscattering coefficient and statistically significant. In conclusion, this study is the first proposed method to measure POC blood coagulation using ultrasound to predict INR.**

Short Biography— **Jinhee Yoo received a B.S. degree in electrical and computer engineering from Ajou University, Suwon, South Korea, in 2018. He is currently pursuing an integrated M.S. and Ph.D. degree with the School of Interdisciplinary Bioscience and Bioengineering, Pohang University of Science and Technology, Pohang, South Korea. His current research interests include medical imaging using high-frequency ultra-sound and biomedical application with acoustic tweezers.**

Deep learning-based anomaly detection of bone scan images

Dongha Kim[1], Chongwon Pae[2], Maeng-keun Oh[2], Seungwoo Cho[1], and Hae-Jeong Park[2,3,4]

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[2]Department of Nuclear Medicine, Yonsei University College of Medicine, Seoul, Republic of Korea,
[3]Graduate School of Medical Science, Brain Korea 21 Project, Department of Nuclear Medicine, Yonsei University College of Medicine, Seoul, Republic of Korea,
[4]Center for Systems and Translational Brain Sciences, Institute of Human Complexity and Systems Science, Yonsei University, Seoul, Republic of Korea

Abstract — Deep learning made much progress in the automated analysis of the medical image data. Despite these advances, deep learning is still highly dependent on medical experts' intervention or inputs for labeling images or parts of organs for supervised machine learning. Making the outlier detection process less dependent on physicians' data labeling calls for unsupervised or semisupervised learning. Anomaly detection, detecting outliers, is one of the methods for unsupervised training. This study aims to detect the outliers in the bone scan SPECT image, a type of nuclear imaging to diagnose various types of bone disease. We developed a deep-learning model for detecting inflammation and cancer regions as outliers compared to healthy regions in bone scan via an unsupervised deep learning process. We used 30,000 samples of bone scan images, categorized into pure normal (without any inflammation or cancer nodes), inflamed or cancerous groups. The proposed model is based on the architecture of generative adversarial network (GAN) and inception. Using the model architecture, we conducted model-training and evaluation of the model in terms of image generation and detection. As a result, the designed model showed better performance on learning features of the bone scan image than other generative network-based models. The current network model showed the high performance to distinguish normal bone scans from inflamed or cancerous people and distinguish inflamed from cancerous. We conclude that the unsupervised outlier detection method used in this study could effectively detect anomal regions in the medical images without experts' labor.

Acknowledgement:
This research was supported by Brain Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Science and ICT(NRF-2017M3C7A1049051)

Speckle Reduction via Deep Content-Aware Image Prior for Precise Breast Tumor Segmentation in an Ultrasound Image

H. Lee[1], S. Youn[1], K. Lee[1], M.H. Lee[1], H.M. Lew[1], and J.Y. Hwang[1]

[1] Department of Information & Communication Engineering, Daegu Gyeongbuk Institue of Science & Technology, Daegu, South Korea

Abstract— Owing to the advancement of deep learning techniques, the performance of computer-aided diagnostic systems based on ultrasound imaging has been enhanced. However, because of speckle noise in an ultrasound image, the systems have still shown limited performance. To remove speckle noise in an ultrasound image effectively, several methods have been proposed for decades, but their performance needs to be further improved for better computer-aided diagnosis of various diseases such as cancer. In this paper, we thus propose a deep content-aware image prior with a content-aware attention module for better despeckling of an ultrasound image without a clean image. For the image prior, we firstly develop a content-aware attention module to deal with the content information on an input image. In this attention module, superpixel pooling is used to give attention to salient regions in an ultrasound image. Note that the superpixel technique allows the grouping of pixels of an image that exhibit common characteristics. Therefore, it can provide more content information on the input image compared to other attention modules. The deep content-aware image prior consists of deep learning networks based on this attention module. The deep content-aware image prior was applied as a preprocessing to state-of-the-art deep learning models for breast tumor segmentation in ultrasound images. The performance of our method was compared to that of other methods for the evaluation. As a result, the deep content-aware image prior resulted in a performance improvement of up to 10.1% in terms of the area under the precision-recall curve for breast tumor segmentation in an ultrasound image. Thus, these results demonstrate that our method enhances the quality of an ultrasound image by effectively reducing speckle noise while preserving important information in the image, thus resulting in the state-of-the-art performance of the deep content-aware image prior to despeckling of an ultrasound image.

Short Biography— **Haeyun Lee** was born in Iksan, South Korea. He is received the B.S. degree in mathematics from Jeonbuk National University, Jeonju, South Korea in 2016 and the M.S. degree in information and communication engineering from DGIST, Daegu, South Korea in 2018. He is currently pursuing the Ph.D. degree in information and communication engineering at DGIST, Daegu, South Korea. His current research interests include the image restoration and medical image analysis with deep learning.

Spiking neural network with sparse lateral connection for MNIST classification

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[5]Center for Systems and Translational Brain Sciences, Institute of Human Complexity and Systems Science, Yonsei University, Seoul, Republic of Korea

Abstract — Spiking neural networks (SNNs) that mimic biological neural networks receive growing attention in next-generation machine learning combined with neural chips. Despite increasing accomplishments in diverse machine learning tasks, relatively few efforts have developed biologically plausible network model architecture. For example, the biological neural network has spatial constraints, which base sparse, modular, and hierarchical architecture. We introduce a biologically plausible spiking neural network architecture by imposing sparsity constraints on the network architecture and imposing a self-organization mechanism. To mimic the sparse connection topology of the biological neural network, we construct an SNN architecture by splitting the receptive field into several local modules and wiring the neurons of each module to neurons in the second layer. We then integrate distance-dependent lateral inhibition in the second layer to impose self-organization.

We trained the SNN with 60,000 MNIST digit images using spike-timing-dependent plasticity (STDP) learning scheme and compared the proposed model with several biologically inspired classification methods, including population-level confidence weighting and n-gram technique. The proposed model achieves state-of-the-art performance on the unsupervised MNIST digit classification task. Neurons representing similar shape features formed clusters. We speculate that adjacent neurons with slightly different receptive fields might contribute to precise classification. We also found that the shape of neuron clusters was analogous to orientation columns of the primary visual cortex (V1). These findings suggest that biologically inspired neural networks may be effective in machine learning and help understand the biological brain.

Acknowledgement:
This research was supported by Brain Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Science and ICT(NRF-2017M3C7A1049051)

Short Biography— Hazan H, Saunders D J, Sanghavi D T et al. (2018) Unsupervised Learning with Self-Organizing Spiking Neural Networks. International Joint Conference on Neural Networks (IJCNN), pp 1-6, DOI 10.1109/IJCNN.2018.8489673.

Saunders D J, Patel D, Hazan H et al. (2019) Locally connected spiking neural networks for unsupervised feature learning. Neural Networks, 119:332-340, DOI 10.1016/j.neunet.2019.08.016

AI-based fully automatic scanning-guide algoritrhm for the diagnosis of rotator cuff tear using ultrasound imaging

K. Lee[1], M.H. Lee[1], H. Lee[1], M.J. Kang[1], C. H. Choi[2], J.Y. Kim[2] and J.Y. Hwang[1]

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[2] Department of Orthopedic Surgery, School of Medicine, Catholic University, Daegu, South Korea

Abstract— **Ultrasound imaging has been widely utilized in the field of medical imaging. For the precise diagnosis of diseases, the acquisition of ultrasound images with high quality is required. However, due to the low resolution and structural complexity of ultrasound images, it is difficult to acquire ultrasound images with high quality. In particular, the quality of ultrasound images acquired is dependent on the experience of a sonographer. Therefore, the development of a novel technique, which allows even unskilled sonog- raphers to acquire high-quality ultrasound images steadily, is needed. In this paper, we proposed a novel AI-based fully automatic scanning-guide algorithm for ultrasound imaging. The proposed scanning-guide algorithm provides scanning directions on how to move the probe and thus allows an even unskilled sonog-rapher to find target regions properly. The deep learning-based scanning-guide network compares the sim-ilarity between central/edge regions and target regions in a current frame and provides a sonographer with directions, which have the most probability for the existence of the target regions. The developed scanning-guide algorithm was evaluated with 3D ultrasound images, which contain target regions such as particularly rotator cuff tear (RCT). From the images, the 3D volume images of RCT regions were constructed, and 2D slices with 9-axis directions are randomly extracted. The extracted frames and 3D volumes of RCT are here utilized as a dataset for the ultra-sound scanning guide. Here, the annotations were automatically generated using the surficial direction indicating the location of the RCT in 3D directions. The results from the experiment demonstrated that the developed scanning-guide algorithm allowed an unskilled sonographer to find target regions while ultrasound imaging, thus resulting in acquiring high-quality ultrasound images steadily.**

Short Biography— **Kyungsu Lee** received the B.S. degree in computer science from Handong Global University, Pohang, South Korea, in 2018. He is currently pursuing the integrated Ph.D. degree with the Department of Information and Communication Engineering, Daegu Gyeongbuk Institute of Science and Technology, Daegu, South Korea. His research interest includes deep-learning in the biomedical application.

3D bioprinting of stem cell-derived β-cell aggregates in multi-encapsulation system

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Abstract

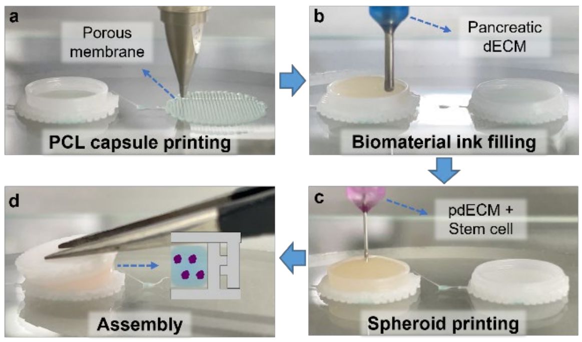
Pancreatic islet transplantation is regarded as a promising permanent treatment for type 1 diabetes. The delivery of insulin producing islets provide glycemic control without additional insulin injection. But still there are problems such as immune rejection and donor shortage that limits the clinical applications. To overcome the immune response problem, various encapsulation strategies are adopted to protect the islets. The encapsulation system has advantages on protection and the delivery of large number of islets. Furthermore, stem cell derived β-cell can be encapsulated instead of donated islets. In this study, we fabricated the stem cell derived β-cell aggregates in multi-encapsulation system in one-step process to enhance the viability and function of the engineered islets.

Background

Type 1 diabetes, which may affect quality of life and cause serious complications, is known to be an autoimmune disease that destruct the pancreatic cells. For type 1 diabetes patients to live without taking insulin injection, the only practical treatment is an islet transplantation. But just as other types of organ transplantation, islet transplantation is clinically challenging due to immune rejection and donor shortage. Moreover, as the type 1 diabetes is caused by autoimmunity, protecting islets from immune system is a key point for successful clinical outcome [1]. To provide immune-protection, encapsulation systems are highly adopted for cell delivery strategies. The semi-permeable materials used for encapsulation can provide suitable environment for cells to survive and function while protecting the cells from immune response [2]. Furthermore, engineered tissues made from the stem cell derive insulin producing cells can replace the donated organs. To promote the function of engineered tissues, intercellular interaction and tissue-specific microenvironment are essential [3].

Methods

The fabrication of the multi-encapsulation system and cell aggregates was processed using 3D bioprinting system. The printing materials were prepared and loaded in the syringe in advance of printing process. The polycaprolactone (PCL) was used for polymeric capsule and the soluble pdECM was used as a basal biomaterial ink. The pdECM biomaterial ink was obtained by decellularizing porcine pancreases and the cell-laden bioink (2.8 × 108 cells/ml) was prepared by mixing the pdECM biomaterial ink with cell suspension.



The polymeric capsule was fabricated at first with 70 μm pore size. Then, the basal pdECM biomaterial ink was filled in the container. Right after the container was filled, the cell-laden bioink was printed inside by dotting. The printed structure was incubated at 37°C for 30 min to crosslink the pdECM bioink. Lastly, the cover and container structures were assembled, and cultured in media.

The fluorescence images were obtained by using the NIS-Elements Advanced Research software on a fluorescent confocal laser scanning microscope. The samples were stained using either LIVE/DEAD Viability/Cytotoxicity Kit or antibodies by following the immunostaining protocol.

The total mRNA of each sample was isolated and reverse transcription was performed using a cDNA synthesis kit. Gene expressions were quantified with SYBR-green using Real-Time PCR system.

Results and Discussion

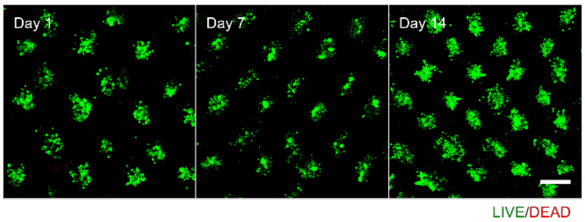


Figure 2. Viability test of encapsulated β-cell aggregates based on LIVE/DEAD assay

A qualitative evaluation of viability based on LIVE/DEAD assay showed that the β-cell aggregates in multi-encapsulation system maintained viable. The microenvironment was provided by biomaterial ink that resemble the native ECM composition.

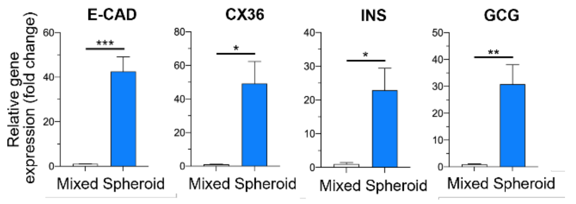
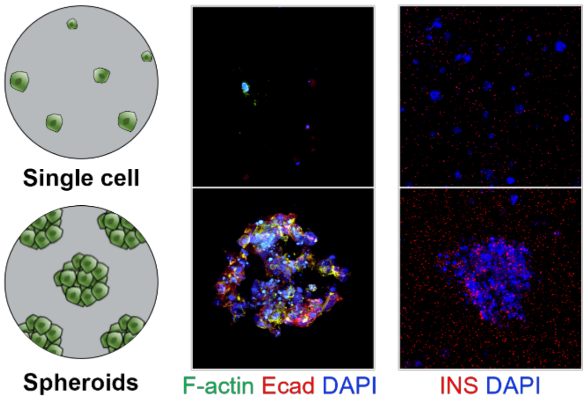


Figure 3. Gene expression analysis of encapsulated β-cell aggregates (Ecad: E-cadherin; CX36: connexin 36; GLUT1: glucose transporter-1; INS: insulin; GCG: glucagon)

The gene expression of β-cell specific transcription factors was analysed after 7 days to evaluate the effect of aggregate printing. As a result, E-cadherin (Ecad), a type of cell adhesion molecule of epithelial cells, and Connexin 36 (CX36), expressed by the insulin producing cells were upregulated when printed into aggregates. The two major endocrines secreted by pancreatic islets, the insulin (INS) and glucagon (GCG), wer also highly upregulated in aggregates.



The cell–cell junctions formed at the β cell edges were illustrated by F-actin and Ecad expression. Likewise, staining for insulin (INS) was performed to demonstrate the cell-specific functional improvement. The higher expression of INS indicates that aggregate printing promoted the functional enhancement.

The fabrication of β-cell aggregates using 3D bioprinting is verified to enhance the structural maturation and functional enhancement. Moreover, a one-step fabrication methods of multi-encapsulation system was established so that it can be produced with in simple process and controllable size.

Acknowledgements

This work funded by the National Research Foundation of South Korea (NRF) grant funded by the Ministry of Science and ICT (No. 2021R1A2C2004981).

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Porous Graphene-based Pulse Wave Sensor using One-Step Laser Fabrication

Jina Lee[1], Vega Pradana Rachim[1]*

[1] Department of Convergence IT Engineering (CITE), Pohang University of Science and Technology (POSTECH), Korea.

Abstract— With the significant advances in wearable biomedical sensors due to their potential to provide non-invasive and continuous bio-signal monitoring, the fabrication methods for the wearable sensors have attracted much interest. However, recent fabrication technologies still require high-cost facilities and a time-consuming fabrication process with a problem of scalability. From this perspective, Laser-Induced Graphene (LIG), an emerging material that can provide good electrical properties and mechanical stabilities with its chemical-free and patternable manufacturing process is employed. Herein, we propose a LIG-based flexible strain sensor for continuous monitoring of pulse wave and fabrication method that can provide a scalable fabrication process for manufacturing personalized flexible strain sensors. To fabricate a stretchable LIG sensing layer, we utilized direct lasing of commercial polyimide (PI) film using a commercial CO_2 laser cutting machine. Then, we accomplished the full transfer of LIG to elastomer using a heat-press method while controlling the thickness of the sensing layer precisely. The Optimization process to find the best laser setting for our sensor was taken and Raman spectroscopy is adopted as an analysis method to check the quality of LIG from the optimized setting. The sensor provides high sensitivity and high linearity in the low strain range (0%-2%), which is corresponding to dynamic volume changes in the radial artery owing to pulse waves. Also, the sensor provides good stability and durability of at least 1000 cycles. The feasibility of the proposed sensor in clinical assessment is also validated by a high correlation with reference PPG signal in terms of extracted Heart Rate (HR) values. Our study demonstrated that the proposed sensor can offer a promising solution to continuous and accurate measurement of multimodal bio-signal including pulse wave monitoring in a mobile healthcare environment.

Short Biography—

Jina Lee received the B.S. degree in Electronic Engineering from Pusan National University, Busan, South Korea in 2021. She is currently pursuing the M.S degree in IT Convergence engineering at Pohang University of Science and Technology (POSTECH). Her current research interests include wearable sensors, circuit design and signal processing for biomedical application.

Complex valued convolutional neural network Multi task model

Junghwan Lee[1], Cheolsoo Park[2]

[1] Kwangwoon University /Department of Computer Engineering, Kwangwoon University, Seoul, Korea
[2] Kwangwoon University/Department of Computer Engineering, Kwangwoon University, Seoul, Korea

Abstract— **Tele-medicine and monitoring have become very important. Telemedicine is thought to be actively used in cases such as infectious diseases, skin damage, or newborns. So, we tried to predict health signals PPG and respiration rate through remote facial videos. Complex valued neural network has several advantages that exist by using a complex system. This deep learning model was created using a complex valued neural network to use meaningful information on the cheeks and forehead well. While predicting PPG and Respiration rates, multi-task learning can be expected to improve performance rather than creating each one model by sharing useful expressions with each other. This Complex valued convolutional multi-task model (CVMT) was compared with the model and model performance of the Siamese network. It was seen that through multi-task learning, good expressions can be shared well and at the same time, parameters can be reduced to be meaningful for model weight reduction. In the future, it will be possible to monitor more diverse bio-signals, not the end, at ppg and repetition rates.**

Short Biography— **Junghwan Lee is in the MSc Program at the Bio Computing & Machine Learning Laboratory (BCML) in the Department of Computer Engineering at Kwangwoon University, Seoul, Republic of Korea. Junghwan Lee is currently a master student at the University of kwangwoon. His research interests include machine learning, and deep learning**

Classification of Human Activity Data Using Sharpened Dimensionality Reduction and Clustering

J. Heo[1], Y. Kim[1], J. B. T. M. Roerdink[1]

[1] Bernoulli Institute/Department of Computer Science, University of Groningen, Groningen, The Netherlands

Abstract—**Sharpened dimensionality reduction (SDR) has recently been introduced to tackle the challenges in the exploratory and visual analysis of high-dimensional data. SDR has been applied to various real-world data sets such as human activity sensory data, network signal data, and astronomical data sets. However, manually labeling the samples from the generated projection are expensive. To this extent, we propose here to use clustering algorithms such as k-means, hierarchical clustering, and Density-based spatial clustering of applications with noise (DBSCAN) to easily label the 2D projections of high-dimensional data. We test our pipeline of SDR and these clustering algorithms to a range of synthetic data sets and also real-world data sets including two different public human activity data sets extracted from smartphone accelerometer or gyroscope recordings of various movements (e.g., lying, sitting, standing, walking, running, and dancing). We choose here Landmark Multi-Dimensional Scaling (LMDS) for DR because recent research on SDR shows that sharpened LMDS (SLMDS) results in a clear separation of clusters when applied to human activity data. We test various clustering algorithms to cluster the resulting projection from SDR and assess the visual cluster separation both qualitatively and quantitatively. We conclude from these results that applying clustering algorithms to SDR assists the classification of human activity data. These findings can later be used for various semi-classification methods that harness the cluster separation power of SDR.**

Short Biography—**Jeewon Heo is currently a third-year undergraduate student in Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, University of Groningen (RUG), The Netherlands. She is enrolled in the Honours College Program at the same university to tackle challenges in identifying patterns in multidimensional projections. Her research interests include machine learning and visualization.**

Youngjoo Kim is currently a PhD student from Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence and Kapteyn Astronomical Institute of University of Groningen, The Netherlands. She is enrolled in Data Science and Systems Complexity (DSSC) and EU's Horizon 2020 program. She received her BS and MEng degree in computer engineering from KWU, Seoul, Republic of Korea, in 2015 and 2017, respectively. Her research interests include high-dimensional data analysis and visual analytics of big data in biomedicine and astronomy.

Jos B. T. M. Roerdink received a Ph.D. in theoretical physics (1983) from the University of Utrecht, the Netherlands. After a postdoctoral position (1983-1985) at the University of California, San Diego, he joined the Centre for Mathematics and Computer Science in Amsterdam, working on image processing and tomographic reconstruction. In 1992 he was appointed associate professor at the University of Groningen, where he has been full professor of Scientific Visualization and Computer Graphics since 2003. His research interests include mathematical morphology, biomedical visualization, neuroimaging and bioinformatics.

Preclinical and Clinical Photoacoustic Microscopy and Plus: Ultrasound Imaging, Photoplethysmography, and Thermometry

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Departments of Electrical Engineering, Convergence IT Engineering, Mechanical Engineering, and Medical Device Innovation Center, Pohang University of Science and Technology, 77, Cheongam-Ro, Nam-Gu, Pohang, Gyeongbuk 37673, Republic of Korea

Abstract— **Photoacoustic (PA) imaging that is hybrid imaging technology combined with optics and ultrasound (US) have been emerging with advantage of blood vessel imaging without any ionizing radiation or contrast agents. PA imaging technique can provide multi-scale imaging by adjusting the contribution ratio of optics and US, and PA microscopy (PAM) that provides high-resolution imaging is being used in both preclinical and clinial research. To obtain more reliable biomedical results of blood vessels and vascular changes, it is required to combine PA imaging with other techniques. In this study, we integrated a micro-electro-mechanical systems (MEMS)-based high-speed PAM with other imaging and sensing techniques. First, we combined PAM and US imaging using a pre-installed US transducer. This US imaging-enabled PAM can provide complementary images due to different imaging principle of PA and US. Senond, we used PAM and photopleysmography (PPG) together. The PPG can offer heartbeat information during PA imaging. Lastly, we added a temperature sensor in PAM to measure body temperature. The thermometry is able to monitor whether body temperature was maintained during PA imaging. These results suggest that PAM integrated with other imaging and sensing techniques such as US imaging, PPG, and thermometry could be potentially used as a preclinical and clinical tools for more reliable biomedical outcomes.**

Short Biography— **Joongho Ahn is a Ph.D. candidate in Department of Convergence IT Engineering at Pohang University of Science and Technology. He completed his B.S in Electronic Engineering at Kyungpook National University in 2016, and currently, his research interests include various imaging system and applications using optics, photoacoustics, ultrasonics, and magnetics.**

On-Line Interactive System for the Adherence of Physical Activity of the Elderly at Risk of Frailty

Martín S. Pinilla-Zapata; Martha L. Zequera-Díaz,
Pontificia Universidad Javeriana
Department of Electronics & Master Bioengineering Program.

This project is focused within the framework of the BASPI / FootLab research line, "Emerging technologies for the self-care of the elderly". With the development of the COVID-19 pandemic, older adults are exposed to live in preventive confinement, which increases the risk of generating conditions such as sedentary lifestyle, which added to the presence of chronic diseases directly affects their musculoskeletal functionality, and their condition, going from being completely independent individuals, to suffer from diseases such as frailty, which affects their level of autonomy.

In response to this problem, an Interactive On Line System was developed, called "Gym To Go App", which was created to assist the medical specialist in prescribing and monitoring the physical activity of older adults at risk of frailty, promoting their adherence to physical activity. Gym To Go App, allows in an interactive way the registration of general data, self-assessment, the classification of the user according to their physical condition, the prescription of their personalized exercises considering the periodicity, intensity and frequency, for their safety. It also allows the evaluation of progress by recording anthropometric variables during the exercise program for the control and follow-up by the specialist for each older adult. The above allows to evidence their adherence to the assigned physical activity program, through the periodic entry of variables that are recorded during 3, 6 or 12 weeks of the duration of their program, in order for the specialist to determine their progress or make adjustments to the program if required.

The follow-up performed by the specialist both at the beginning and during the use of the application, allows promoting the self-esteem and autonomy of the older adult in the performance of their daily exercises. Likewise, by having an Interactive On Line System, the development and evaluation of Gym To Go App can be carried out both in isolation and in other scenarios, contributing to the well-being of the older adult through the promotion of active and healthy aging, which increases the life expectancy of this population.

Key words: Older adult, frailty, Interactive System, aging, physical activity, autonomy, self-management.

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HIMO (Health Intelligent Medical Own)

Leslie Cieza[1]; Mateo Valverde[1]; Julissa Venancio[1]; Diego Bustos[1]

[1] Member of IFMBE Recent Graduates & Students Working Group (RG&S-WG)

In the world there are almost 13 million of elderly people who suffering COPD (Chronic Obstructive Pulmonary Disease), which causes 3.23 million deaths in 2019, making it the third disease with the highest mortality according to the WHO [1]. And with the appearance of COVID-19, the population of elderly people who suffering from respiratory diseases increased exponentially, but not only for the physiological part, also for the mental part.

This project establishes to cover two edges, the first is related to the photoplethysmography technology to measure saturation and heart rate parameters using a wristband containing the PPG sensor. In addition, it measures sleep quality, as COPD patients report more difficulties in initiating and maintaining sleep [2].Lack of sleep is an important factor in the psychologi-cal well-being of the elderly people. Since PPG measures have a significant correlation with PSG measures, it is an excellent method for tracking sleep in patients [3].

The second edges is about daily mental health. It is a major challenge for elderly people, especially if they suffer from COPD. In COPD patients, the presence of anxiety and depression are common and have a significant impact that has adverse effects on quality of life [4]. That's why it is an important aspect to solve in the same priority that physiological part.

In that sense, HIMO or Health Intelligent Medical Own was designed, which is a comprehensive system that captures different technologies and adapts them to the needs of patients. The different technologies implemented are: smartwatch, oxygen concentrator, and intelligent speaker. Each part of the integral system fulfills a specific function the smartwatch and the oxygen concentrator, will become two tools that collect valuable information of crucial parameters for oxygen therapy. This information will be sent by Wi-Fi towards a mobile application developed for both patient, family and doctors, in order to be able to monitor the patient all the time, and to be a help for them. Also, to the system is added a social assistant with use intelligent speakers so the patients can communicate with the system. All it is possible thanks to an artificial intelligence. The algorithm detects a greater negative sentiment throughout the day it can recommend more cheerful and positive content. The APP schedules interactions with the patient, records responses and analyzes the information for further processing and sending data to both doctors and using information to issue a pre-diagnosis through the smart speaker.

HIMO is an innovative digital project, developed by an interdisciplinary group of students from different countries: Peru, Ecuador and Argentina, in the framework of the research activities of the IFMBE Recent Graduates & Students Working Group (S&RG WG) and Latin American Summer School 2020 "Emerging Technologies in Neuroscience and Rehabilitation. Supporting and protecting elderly in post COVID-19" which was made by the Pontificia Universidad Javeriana de Colombia. HIMO was awarded the first place in the Hackathon -Summer School 2020.

Key words: Elderly people, COPD, innovation, oxygen system, mental health, integral technology system.

Acknowledgements

Prof. Shankar Krishnan, President of IFMBE; Martha Zequera, Academic Chair of the Summer School, Co-Chair of the IFMBE Recent Graduates, Students Working Group and professor at Pontificia Universidad Javeriana. Department of Electronics.

For having had the opportunity to participate in the IFMBE Lantin American Summer School at the Pontificia Universidad Javeriana and receiving the first-place award for the best project.

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The Joint Conference of the IBEC2021 and the ICBHI2021

Medical Imaging and AI: Part I

Session Chair: Ravi Managuli (University of Washington, USA)

11 Nov. (Thursday)	Room F (13:30~15:00)

Advances in Implantable Neural Prostheses for Treatment of Profound Hearing Loss
Martin Han (University of Connecticut, USA)

Study the effect of data imbalance in federated learning. Application to chest X-ray image classification
Nitin S Laxmikantha (Aster DM Healthcare Ltd., India)

The potential applications and added value of machine learning in clinical practice
Bart Bijnens (ICREA, Barcelona, Spain)

Nitin S, Laxmikantha

Study the effect of data imbalance in federated learning. Application to chest X-ray image classification

We live in times where resources are stretched thin, yet healthcare requires continued advancement by leveraging data efficiently and affordably is essential. Federated Learning (FL) enables hospitals/ medical research organizations to collaboratively learn a shared prediction model while keeping all the confidential medical data at the source. However, different distribution of training images across different sites could lead to challenges, like class imbalance, which could impact the performance of the common model. In this work, we study the effect of data imbalance for identification of Pneumonia condition from Chest X-Ray images. Further we study how data augmentation can be used to reduce this effect while keep aggregator as weighted average. Chest radiography has important clinical value in the diagnosis of pneumonia. However, AI models trained on data from on location cannot be used at another region due to variability in data across different regions. In this study we will show how pneumonia diagnosis using ChexNet Deep Learning model can be improved using Federated Learning with imbalanced datasets taken from two different sources.

We are using ChexNet model for this analysis. 2 different datasets have been used here, both of which comprises of Chest X-Ray Images Dataset having Pneumonia condition. First dataset has total size of 6432 images, while the second has 5,863 images. Both models were run in 2 different sites and evaluated the model's performance criteria. We received better sensitivity and specificity using traditional training. Results using FL were about 2% lower than traditional training. It was observed that sensitivity was about 1% higher after using data augmentation, it shows that data imbalance could affect results even after using weighted averaging aggregator.

In conclusion, Federated Learning helps to train models to help generalize well to predict unforeseen data. However in the future, more robust AI algorithms could be included to improve performance of the FL model.

Short Biography— Nitin S. is working as a Data Analyst at Aster DM Healthcare Ltd. He has completed his Bachelor's of Technology in Information Technology from National Institute of Technology Karnataka (NITK) Surathkal, India. He has rich technical experience in data analytics across retail and healthcare sectors. He has expertise on medical data extraction and anonymization, supervised/unsupervised learning techniques, imaging analytics and natural language processing.

Bart Bijnens

Abstract

Contemporary Machine Learning (ML) algorithms have proven to be powerful for classification and data exploration tasks and have therefor been proposed for use in medical applications. While some proposed approaches have shown to be promising, there are several issues that need to be addressed when introducing them into clinical practice.

Most importantly, the proposed algorithms need to be naturally integrateable into current clinical workflows, need to either help in managing patients more efficiently or more effectively, and need to be intuitively interpretable by the clinician.

Therefore, we propose to tailor the ML approaches towards the task within the clinical workflow where it would benefit productivity or quality of care.

At the one hand there is the (clinical, imaging…) information gathering and the extraction of pertinent features from this. Here Deep Learning has shown to be beneficial, for example for the fast and reproducible segmentation of imaging data.

On the other hand, there is the information interpretation for supporting diagnosis and therapy decision and provide risk assessment. Here, 'black box' approaches, biased to training, and often inherently 'smoothing out' outliers, are much less appropriate. For these tasks, representation learning, often combining a first unsupervised stage, followed by supervised decision support, has shown recent promise.

In this talk, we will show examples of these different approach, specifically for the automated quantification of echocardiographic images as well as for the integration of imaging and clinical data for risk assessment and phenotyping of cardiac patients.

Short Biography

Bart Bijnens is an ICREA Research Professor at IDIBAPS, the research institute of Hospital Clinic in Barcelona. He is recognized as international expert in pathophysiological concepts and image-based assessment of cardiovascular diseases. He is now leading the *Translational Computing in Cardiology* research group. Recent projects include the combination of computational modelling with interpretable machine learning to use imaging and cardiac mechanics in order to implement techniques for the identification of patients at risk for adverse events, as well as to improve our understanding of disease and decision making.

The Joint Conference of the IBEC2021 and the ICBHI2021

Multimodal Medical Imaging Informatics 1

Session Chair: Chulhong Kim (POSTECH, S. Korea)

11 Nov. (Thursday)	Room G (13:30~15:00)

Multi-Contrast Photoacoustic Microscopy — Lidai Wang (City University of Hong Kong, Hong Kong)

Slit-based photoacoustic tomography with co-planar light illumination and acoustic detection for high-resolution vascular imaging in human — Jun Xia (University at Buffalo, USA)

Dermatological applications of a portable confocal Raman system — Renzhe Bi (A*Star, Singapore)

Theranostics with Radiation-induced Ultrasound Emission — Shawn Xiang (University of California, USA)

Optoacoustic and augmented intraoperative imaging - From Signals to Surgeries
Subhamoy Mandal (Maxer Endoscopy GmbH, Germany)

Multi-Contrast Photoacoustic Microscopy

Chao Liu, Jiangbo Chen, Jingyi Zhu, Yachao Zhang, and Lidai Wang

Department of Biomedical Engineering, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong SAR, China.

Abstract— **Optical-resolution photoacoustic microscopy has been developed for anatomical, functional, and molecular imaging but usually requires multiple scanning for different contrasts. Here, we present multi-wavelength optical-resolution photoacoustic microscopy for simultaneous imaging of hemoglobin concentration, oxygen saturation, blood flow speed, and molecular/nano-probes in single raster scanning. We develop a multi-wavelength pulsed laser via stimulated Raman scattering. The pulsed wavelengths are in the visible and near-infrared spectrum and temporally separated by several hundreds of nanoseconds via different optical delays in fiber. Multiple photoacoustic images at these wavelengths are simultaneously acquired in a single scanning. We can image the blood vessels and dye-labeled lymphatic vessels. The blood flow speed is also measured by a dual-pulse method. The oxygen saturation is calculated with improved accuracy. Simultaneous imaging of hemoglobin concentration, oxygen saturation, blood flow speed, and other molecules/nano-probes are demonstrated in vivo.**

Short Biography— **Lidai Wang received the B.Sc. and M.A.Sc. degrees in Precision Instruments from the Tsinghua University, Beijing, China, and the Ph.D. degree in Mechanical Engineering from the University of Toronto, Ontario, Canada. He worked as a postdoctoral research fellow at the Washington University in St. Louis. Since 2015, he has been working as an Assistant and Associate Professor in the Department of Biomedical Engineering at the City University of Hong Kong. His recent research interests include photoacoustic imaging, ultrafast photography, wavefront engineering, and computational optics. He is the co-inventor of six patents and has published more than 60 papers in peer-reviewed journals.**

Slit-based photoacoustic tomography with co-planar light illumination and acoustic detection for high-resolution vascular imaging in human

Wenhan Zheng[1], Chuqin Huang[1], and Jun Xia[1]

[1] Department of Biomedical Engineering, University at Buffalo, The State University of New York, Buffalo, NY, 14260, USA

Abstract— Previously, we introduced slit-based photoacoustic tomography with nearly isotropic spatial resolution in three-dimensional imaging. The system was based on acoustic diffraction through the slit to increase the elevation coverage of a linear array. In this study, we introduce the third-generation slit-based photoacoustic tomography system with co-planar light illumination and acoustic detection. A few innovations were implemented in this system. First, we utilized an optically transparent slit, which enables both light illumination and acoustic diffraction. Second, we used a combination of cold and hot mirrors to enabled co-planar light illumination and acoustic detection. Third, we designed a water-proof transducer array with a long acoustic focus tailored for the co-planar setup. Compared to the previous designs, which used side-illumination and metal slit, the new system provides deeper imaging depth in a more compact form. We tested the system in both phantoms and in vivo imaging. Detailed vascular structures from different regions can be clearly revealed, making the system valuable for translational imaging applications.

Short Biography — Dr. Jun Xia, Ph.D., is an Associate Professor at University at Buffalo, the State University of New York, and the director of the Optical and Ultrasonic Imaging Laboratory in the Department of Biomedical Engineering. He received his doctorate in Mechanical Engineering from the University of Toronto, where he studied applied optics. After graduation, he has worked as a post-doctoral fellow at Washington University in St. Louis, where he worked on photoacoustic imaging. Dr. Xia is the principal investigator or co-investigator on multiple grants from NIH, NSF, private foundations, and industrial partners. He is a recipient of the 2017 Komen Career Catalyst Award and the 2020 Qualcomm Faculty Award. Dr. Xia's research focused on biosensing and bioimaging using the combination of light and sound. He has published three book chapters and more than eighty papers in peer-reviewed journals on related topics.

Dermatological applications of a portable confocal Raman system

Renzhe Bi[1], Ruochong Zhang[1], Dinish U.S. [1], Malini Olivo[1]

[1] Institution of Bioengineering and Bioimaging, A*STAR, Singapore

Abstract— **Instruction for preparing an abstract for IFMBE Conferences is presented. Provide an abstract of your paper no longer than 300 words.**

Atopic dermatitis (AD) is a common chronic inflammatory dermatological disease that makes the skin red and ithy. It affects around 10 million children and 16.5 million adults in the United States. 20% of the children in Singapore suffer from AD. The skin barrier function will be comprimized significantly if the patient develops AD. Raman spectroscopy is a highly sensitive and noninvasive optical technology that provides biochemical information. Most of the common molecules in skin, including ceremide, urecanic acid and water, have unique Raman spectrums. Through spectrum unmixing algorithm, the concentration of those chemical components can be quantified. We developed a portable dual-wavelength confocal Raman spectroscopy system with a flexible handheld measurement probe. By using a fast switching fiber multiplexer, quasi-simultaneous measurements of the fingerprint region and high-wavenumber region was achieved. A clinical study for differeciation of AD patients was conducted and the result suggested promising medical applications of this system.

Short Biography— **Please include the short biography of a presenting author.**

Dr Renzhe Bi obtained his PhD degree in 2015 from Nanyang Technological University (NTU) under the supervision of Prof Kijoon Lee (currently at DGIST). His research interest covers Raman spectroscopy, Photoacoustic imaging, diffuse optics, laser speckle analysis and R&D in medical devices.

Theranostics with Radiation-induced Ultrasound Emission (TRUE)

Liangzhong (Shawn) Xiang [1,2,3]

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[2]*Department of Biomedical Engineering, University of California, Irvine, Irvine, CA 92617, USA*
[3] *Beckman Laser Institute & Medical Clinic, University of California, Irvine, Irvine, CA 92612, USA*
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Abstract— **We explore new ways to generate ultrasound for theragnostics. Specifically, we use varies radiations (X-ray, laser, and electrical field) to treat diseases, simultaneously it will produce ultrasound waves for image-guided interventions. This talk will cover three primary research areas: 1) X-ray-induced acoustic computed tomography (XACT) for precision radiotherapy; 2) Proton-induced acoustic imaging for proton therapy guidance, and 3) electroacoustic tomography (EAT) for irreversible electroporation (IRE) monitoring. Prospects and challenges for the clinical implementation of these techniques will be discussed. The successful development of these technologies will expand the current clinical paradigm towards precision medicine.**

Short Biography— **Liangzhong (Shawn) Xiang is a tenured associate professor with joint appointments in the Departments of Biomedical Engineering and Radiology, and Faculty Innovation Fellow at University of California, Irvine (UCI). He is also a core faculty member in Beckman Laser Institute and Medical Clinic, and Chao Family Comprehensive Cancer Center at UCI. Dr. Xiang's lab focuses on biomedical imaging and image-guided treatment. Before joining UCI, he was awarded the Lloyd G. and Joyce Austin Presidential Professorship at The University of Oklahoma (OU). Prior to OU, he completed his postdoctoral fellowship training in medical physics at Stanford Medical School where he was awarded the DoD Prostate Cancer Postdoctoral Fellowship.**

Dr. Xiang is the recipient of the NIH MERIT Award (R37), and Research Scholar from the American Cancer Society. Dr. Xiang has served as conference chairs for the 2021 IEEE IUS, 2019 AAPM annual meeting and 2018 CIOP. He served as an SPIE Student Chapter advisor, editorial board members of numerous international journals, and grant reviewer for the NIH, Department of Energy (DOE), Russian Science Foundation (RSF), Helmholtz Association of German Research Centre, and ETH Zurich

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Optoacoustic and augmented intraoperative imaging - From Signals to Surgeries

Subhamoy Mandal[1,2]

[1] Maxer Endoscopy GmbH, Tuttlingen, Germany
[2]Manipal Academy of Higher Education, Manipal, India

***Abstract*—** In the last two decades, biomedical optoacoustic (also photoacoustic) imaging has emerged as one the fastest growing biomedical imaging modalities Optoacoustics (OA) has enabled researchers to probe optical contrast along a broad penetration scale while maintaining excellent Spatio-temporal resolution. In the meantime, fluorescence assisted surgeries (FAS) has become part of the standard interventional procedure. Tracing back the path of FAS, we predict the ever-increasing applicability of OA in surgeries. This talk aims to demonstrate the clinical translation roadmap of fluorescence and optoacoustic assisted surgeries and the benefits of added functional information in enhancing patient outcomes. Further, the talk will highlight the use of signal and image processing methods which has improved the image quality of the associated optical imaging modalities making it useful in augmented intraoperative imaging.

***Short Biography*—** Dr. Subhamoy Mandal is currently a Clinical Applications Engineer and Research Lead with Maxer Endoscopy GmbH (part of Erbe Elektomedizin Group), and an Affiliated Researcher with the Technical University of Munich. Previously, he was a Research Scientist in Molecular Imaging at the Division of Medical Physics in Radiology, German Cancer Research Center (DKFZ), Heidelberg. Previously, he was a DAAD PhD scholar at the Chair of Biological Imaging at TU München, and the Institute of Biological and Medical Imaging at Helmholtz Zentrum München. He received his MS (by research) from the Indian Institute of Technology Kharagpur, and B.E. in Biomedical Engineering from Manipal University, Karnataka, India. He is a recipient of the prestigious DAAD PhD Scholarships and the UK Commonwealth Scholarship. His areas of interest are Medical Signal & Image Processing, Medical Imaging and point-of-care affordable healthcare technologies.

The Joint Conference of the IBEC2021 and the ICBHI2021

Digital Health Trends and Regulatory Considerations

Session Chair: Ichiro Sakuma (The University of Tokyo, Japan)

11 Nov. (Thursday) Room F (15:30~17:00)

Interpreting Magnetic Resonance Images by means of Fuzzy Membership Functions
Virginia Laura Ballarin (Universidad Nacional de Mar del Plata, Argentina)

Digital Health Trends in Singapore
James Goh (National University of Singapore, Singapore)

Regulatory Scientific Consideration on Home Medical/Healthcare Devices
Ichiro Sakuma (University of Tokyo, Japan)

Wearable LTBP Detected During Sleep
Kang-Ping Lin (Chung-Yuan Christian University, Taiwan)

Interpreting magnetic resonance images by means of fuzzy memberships functions

D.S. Comas[1,2], G.J. Meschino, and V.L. Ballarin[2]

[1]Consejo Nacional de Investigaciones Científicas y Técnicas, CONICET, Mar del Plata, Argentina
[2]Image Processing Lab, Instituto de Investigaciones Científicas y Tecnológicas en Electrónica (ICyTE), Universidad Nacional de Mar del Plata-CONICET, Mar del Plata, Argentina
[3]Bioengineering Lab, Instituto de Investigaciones Científicas y Tecnológicas en Electrónica (ICyTE), Universidad Nacional de Mar del Plata-CONICET, Mar del Plata, Argentina

Abstract—**Medical imaging is currently one of the central resources for the evaluation and diagnosis of pathologies. Technological advance continuously generates new types of medical images, substantially increasing the available medical information and defining new requirements for its analysis. Considering digital image processing applied to medical images, a segmentation or a classification technique that allows discovering interpretable knowledge becomes extremely important as it can provide new knowledge regarding the type of images or the problem, which can lead to significant contributions for studying and solving medical problems. In previous works, we proposed a fuzzy-predicate-based classification method which was applied to the estimation of the volume of tissues in brain Magnetic Resonance Images (MRI) considering T1-sequences. Besides performing image segmentation, that method automatically generates membership functions from prototypes extracted from labelled examples (Gold-Standard) enabling knowledge discovery. In the present work, we propose a methodology for segmenting and interpreting brain MRI from automatically discovered fuzzy membership functions. The study is focused on both simulated and real MRI (with their corresponding Gold-Standard) in sequences PD, T1, and T2. The segmentation results indicate estimated accuracies, by 10-fold cross-validation, of 0.988±0.016 and 0.848±0.018 respectively for simulated and real images, overcoming test methods. The methodology proposed for interpretation of the resulting membership functions and predicates allows: a) to define attributes on the features and to associate them to each tissue, b) to describe relationships between attributes and tissues providing linguistic descriptions, c) to identify vagueness associated with the attributes. The results of this methodology indicate it is a sound approach for knowledge discovering: considering the previous knowledge about brain MRI, including medical experts' opinions, membership functions, predicates, and attributes are consistent. The methodology can be extended to other medical imaging domains, making it a general approach for interpreting medical images.**

Short Biography— Virginia Laura Ballarin is Electronic Engineer and PhD in Bioengineering. She is Full Professor in Signal Processing area at the Electronics Engineering Department of the Universidad Nacional de Mar del Plata (UNMDP), Argentina and Director of the Image Processing Research Group at Research Institute of Science and Technology in Electronics (ICYTE). She has directed more than 20 PhD thesis and 25 undergraduate thesis, all in biomedical image processing area. She is author of more than 75 papers in refereed journals and more than 130 conference presentations. She is creator and Director of the Postgraduate Programme in Bioengineering at the UNMDP, and from 2015, Editor of the Argentinian Journal of Bioengineering. She was President of the Argentinean Bioengineering Society from 2013 to 2015 and President of the Argentinian Chapter of EMBS – IEEE form 2016 to 2018. She was Secretary of the Argentinean IEEE WIE Affinity Group from 2013 to 2016. She is currently Chair of the Committee of Women in MBE of the IFMBE and R9 EMBS WIE representative.She is Secretary General of the Latin American Council of Biomedical Engineering (CORAL) from 2020.

Digital Health Trends in Singapore

James Goh, PhD
President, International Union of Physical and Engineering Sciences in Medicine (IUPESM)
Past- President, International Federation on Medical and Biological Engineering (IFMBE)
Department of Biomedical Engineering, Faculty of Engineering, National University of Singapore
Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine, National University of Singapore

Abstract

In recent years, healthcare has seen remarkable progress in the use advanced technology. The use of robots to patrol hospital wards, teleconsultation through video conferencing, and delivery of medicine to doorsteps using autonomous-guided vehicle are becoming a reality. A major driving force behind Singapore's push for technological and digital transform in healthcare is the rapidly ageing population due to declining birth rates and increasing life expectancy. However, majority of elderly are not comfortable with the transformation. For instance, a study by the Singapore Eye Research Institute found low acceptance of digital health services among the elderly when it comes to the use of AI to interpret their medical results and providing automatic advice. A dedicated team is necessary to assist the largely tech-averse population to get on board with digital health services, and crucial to keep the process and instructions simple. Therefore, wide-spread public education on digital health is useful for public health promotion. For example, mobile communication technology, wearable devices and the internet play the crucial role in empowering individuals with health literacy in Singapore's war on diabetes. The monitoring and motivation of daily physical activities and healthy food consummation. Diabetes Prevention Program study has shown that 30 minutes a day of moderate physical activity along with a 5 to 10% weight loss can produced a 58% reduction in diabetes. Development and use of technology in early screening, detection and diabetes management can certainly prevent onset of complications such as cardiovascular diseases, blindness, and limb amputation.

Biographical Sketch

Prof James GOH obtained his BSc (1st Class Honors) in Mechanical Engineering (1978) as well as PhD in Bioengineering (1982) from the University of Strathclyde, Glasgow, UK. He is currently Professor and Head, Department of Biomedical Engineering, Faculty of Engineering, National University of Singapore (NUS) and holds a joint appointment as Research Professor in the Department of Orthopaedic Surgery, Yong Loo Lin School of Medicine, NUS. Prof Goh is on several national as well as international committees. He is the President of the International Union of Physical and Engineering Sciences in Medicine (IUPESM) as well as the Past-President of the International Federation of Medical and Biological Engineering (IFMBE) and the President of the Biomedical Engineering Society (Singapore). He is Fellow of the Institute of Engineers, Singapore (IES) and chairs IES' Technical Committee on Biomedical Engineering. He is also a Fellow of the American Institute of Medical and Biological Engineering (AIMBE) as well as Fellow of the ASEAN Academy of Engineering and Technology (AAET) and the International Academy of Medical and Biological Engineering (IAMBE). He is a member of the Biomedical and Health Standards Committee (BHSC) and chairs its Technical Committee on Medical Devices. Prof Goh has been actively involved in organizing international conferences and had served on numerous International Advisory Boards and Scientific Committees. He chaired the World Congress of Biomechanics (2010), TERMIS-AP (2011) and ICBME (2015). He is the Advisor to the IUPESM World Congress 2022 to be held in Singapore. Prof Goh has a strong research interest in musculoskeletal research and actively promotes the field of biomedical engineering. He has given numerous invited talks at international and regional conferences. He has published well over 150 international peer review journal papers, more than 500 conference papers and 12 book chapters.

Regulatory Scientific Consideration on Home Medical/Healthcare Devices

Ichiro Sakuma[1]

[1] School of Engineering, The University of Tokyo, Bunkyo-ku, Tokyo, Japan

Abstract— **Japan is facing a super-aging society with a declining birthrate. This situation will be also a challenges for many developed and emerging countries in the future. In areas where the population is declining, the medical environment is expected to change since the labor force decline will be significant even for medical workers. In response to such changes in society, the developments of community medical / telemedicine and community-based comprehensive care systems are required augmenting present medical/health care systems. For that purpose, development of safe, effective highly reliable, and easy to operate medical devices must be developed. These devices must show performance at home equivalent to those used in hospital environment.**

Particular considerations required in risk assessment and design of these devices include:

1) Differences of environments for intended use of the devices

Environments includes housing, long-term care facilities, office environments, schools, outdoor environments, vehicles and so on. Difference in infrastructures should be considered.

2) Differences of knowledge/skill levels of users

The users include the patient himself / herself, the general public who are non-medical workers. Thus excellent usability is essential required similar to consumer products. medical professionals (medical doctors, nurses, emergency rescuers, and long-term care givers who do not have sufficient knowledge about the medical devices, assuming the shortage of medical staffs.

Risk management must be performed by clearly defining how home medical devices are used in overall medical care. For this purpose, it is necessary to make full use of various IoT related technologies, robot technologies, virtual reality technologies, artificial intelligence etc. to develop medical devices that show the high quality performance currently required in hospitals without risk of misuse. In this presentation various factors to be considered and required design changes will be discussed.

Short Biography— **Ichiro Sakuma, PhD is currently Professor, Medical Device Development and Regulation Research Center, Department of Bioengineering, and Department of Precision Engineering, School of Engineering, The University of Tokyo. He is also serve as the director, Research Institute for Biomedical Science and Engineering, The University of Tokyo. His research interests include computer aided surgery, interventional devices, cardiac electrophysiology and related medical devices, bioinstrumentation, and regulatory science for medical devices. He served as the president of Japanese Society for Medical and Biological Engineering from 2014-2016. He is currently regional representative from Asia Pacific region to Administrative Council of IFMBE,**

The Joint Conference of the IBEC2021 and the ICBHI2021

Enabling Digial Health Transformation with Interactive Process Mining

Session Chair: Carlos Fernandez-Llatas (Institute at Universitat Politècnica de València, Spain)
Paulo de Carvalho (University of Coimbra, Portugal))

11 Nov. (Thursday)	Room G (15:30~17:00)
Interactive Process mining in Healthcare	Carlos Fernandez-Llatas (Universidad Politecnica de Valencia, Spain)
VALUE in the Emergency department	Gema Ibanez (Universidad Politecnica de Valencia, Spain)
VALUE supporting STEMI center allocation in central Portugal	João Rosa (Centro Hospitalar e Universitário de Coimbra, Portugal)
Cardiological one-stop clinics analysis through process mining	Juan Lull (Universidad Politecnica de Valencia, Spain)
Data privacy and Security with Process mining	María Dolón (Universidad Politecnica de Madrid, Spain)
A Value Based Health Care Evaluation framework for the assessment of an innovation technology solution	Maria Sanchis (AQUAS, Spain)

Interactive Process Mining In Healthcare

Carlos Fernandez Llatas

Universitat Politecnica de Valencia/ Karolinska Institutet

E-mail: cfllatas@itaca.upv.es

Short Bio: Dr. Carlos Fernández-Llatas is Deputy Director at SABIEN Group at ITACA institute at Universitat Politècnica de València (Spain), Afiliated Researcher at Karolinska Institutet (Sweden). He received the PhD degree in Computer Science in the Pattern Recognition and Artificial Intelligence Program of that university. He is member of the IEEE CIS Task Force on Process Mining. He participated in more than 30 projects through IV, V VI and VII European Framework program, H2020 program and Spanish Government funded projects. He has published more than 100 scientific papers. He has been member of the Organizing Committee in more that 10 international conferences and member of the Scientific Committee in more than 30. He is reviewer in several Indexed journals in Bioengineering and Medical Informatics. His research is mainly focused in the use and promotion of Process Mining technologies as wellas Process Management, representation and execution techniques for their application in health and human behaviour modelling.

Short Abstract: Interactive Process Mining in a new paradigm that aims to support health experts in the understanding of the processes in which there are involved. This is madefollowing a Data Driven methodology but, integrating health experts in the process of automatic learning. This paradigm combines the application of process mining technologies in healthcare using interactive machine learning paradigm for supporting health professionals in inferring new knowledge from past actions and providing accurate and personalized knowledge for future decisions and improve patients’ treatments and quality of life.

VALUE in the Emergency Department

Gema Ibañez

Universitat Politècnica de València - Instituto Universitario de Tecnologías de la Información y Comunicaciones (UPV-ITACA)

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Short Bio: Degree in Computer Science Engineering (2004) at the UPV. Until now she has more than fifteen years of experience in European projects within the VI, VII Framework Programme, H2020 and EIT HEALTH, and Spanish funded projects dealing most of them with health care and social services making use of Information Communication Technologies. She has participated as product manager in universAAL project and pilot's coordinator of ReAAL project, as well as MyCyFAPP and INTER-IoT projects of H2020 to bring innovative service for wellbeing from children to elderly. She is the product owner of the solution developed at VALUE project where is developing her phD, which is focused on the impact assessment of new technologies and services applied to health and wellbeing fields by means of Process Mining, fostering digital health transformation in health organizations.

Short Abstract: The Emergency Department is a 24-hours service constantly under pressure, being the most critical service in a hospital. The quality of care provided may be affected due to different factors such as more affluence of patients, less experienced personnel, weather conditions among others, but understanding what the real causes are is far away from the current situation.

Nowadays, there are software programs that provide since traditional indicators to advanced analysis to guide health professionals in their daily practice. Even though, in most of the cases, these solutions may not provide all the clues to understand the root causes because, for example, do not take into account the variability and complexity of the patients or are not completely adapted to the real case.

VALUE solution breaks with these issues and provides to the health expert the understanding and granularity needed to deep into real problems, being able to analyse from general to individual

VALUE: process mining tools supporting the allocation of a new P-PCI centre in central Portugal

João Borges-Rosa

Centro Hospitalar e Universitário de Coimbra, Praceta Prof. Mota Pinto, 3000-075,Coimbra

E-mail: joaopedroborgesrosa@gmail.com

Short Bio: Cardiology resident in Centro Hospitalar e Universitário de Coimbra (since 2019). First year of Clinical Residency, Hospital do Divino Espírito Santo, Ponta Delgada, Portgual (2018). Integrated Master's Degree in Medicine, Faculdade de Medicina da Universidade de Coimbra, Portugal (2011-2017). Master's thesis: "Is early repolarization pattern associated with sudden cardiac death?". Erasmus exchange program in Third Faculty of Medicine, Charles University, Prague, Czechia (2017). Several publications in indexed journals as full-text or abstract. Multiple oral presentations in national and international congresses. Sub-investigador in the clinical trials ROPPET-NAF (NCT03233243), SELECT (NCT03689244), and AEGIS-II (NCT03473223). Trainer at Ekos - Formar para a Especialidade, a preparation course for the residency admission national exam.

Short Abstract: For patients with acute myocardial infarction with ST segment elevation (STEMI), time to reperfusion is key. The prognosis is linearly related to treatment delay, which is best performed by means of mechanical reperfusion (percutaneous coronary intervention – PCI). The central region of Portugal has significant heterogeneities in PCI availability, due to variable distance to primary PCI centres. We hypothesize that the location of STEMI diagnosis influences treatment performance, with superior performance in regions closer to PCI centres (higher PCI rate, lower no reperfusion and fibrinolysis rate, reduced time delay, and reduced mortality). Using process mining (PM) methods to assess our current performance in central Portugal, we hypothesize that the global picture of STEMI care network will be depicted in a clear fashion, incorporating performance features and prognosis. Therefore, we aim to demonstrate the potential of a new primary PCI centre, in a specific location, which improves outcomes at a lower expense.

Cardiological one-stop clinics analysis through process mining

Juan Lull

Instituto Universitario de Tecnologías de la Información y de las Comunicaciones(ITACA),

Universitat Politècnica de València, Camino de Vera S/N,Valencia, Spain

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Short Bio: Juan J. Lull is a Senior Researcher at the ITACA-SABIEN research group, at Universitat Politècnica de València. He is deeply involved in the Process Mining for Health Lab, with experience in different applications of Interactive Process Mining. He has a wide background ranging from the Medical Imaging research to the management of software teams, startups creation and IoT integration for VEs

Short Abstract: Many patients arrive to cardiology departments, referred from primary care services. This creates a high number of outpatient visits with a great diversity in their cardiological health status. One-stop clinics aim to distinguish, at the entry point of the patient, the possible symptomatology and the need for extra tests and consultations, or the discharge.

Different Key Indicators exist that let doctors measure the efficiency in the clinics. In this work, Interactive Process Mining was applied in different iterations with interactions between medical doctors, process mining experts and in-site data experts. Interactive Process Indicatorswere generated and validated with the doctors and the data experts. Though the Interactive Process Mining application to this case has yet to evolve, it shows promising results and thereis a new tool that doctors can use to get a deeper knowledge about the behaviour of the cardiology department.

The results include the possibility of differentiating the outpatient path between the pre- COVID-19 and during COVID-19 phases. Efficiency can also be easily measured by the doctorsat any point in time.

Data privacy and security with process miningMaría

Dolón

Universidad Politécnica de Madrid

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Short Bio: María Dolón works as a researcher in the InnoTep group of the Polytechnic University of Madrid (Spain). He studied the degree in Telematics Engineering and specialized with a Master in Cybersecurity. Currently, he is doing his PhD where his research activity focuses on cybersecurity, more specifically on data protection and the creation of systems aligned with the GDPR. At the same time, he is participating in the VALUE research project in the study and deployment of security in safe spaces, in the application of process mining techniques for the discovery of patterns, identities and behavior modeling. She previously participated in the "8th Conference on information and Communication Technologies of Ecuador" in 2020 organized by the Universidad Salesiana of Ecuador in the session of Biomedical Sensors and Wearebles Systems. And in 2021 she participated in the "IEEE-EMBS International Conference on Biomedical and Health Informatics (BHI'21)".

Short Abstract: During the processes that take place in the field of health and research, large amounts of sensitive data are collected. These data are processed by various teams of experts in the domain and by tools from different organizations to carry out the appropriate analyses and studies. To guarantee the protection of the data and to obtain evidence of the treatment that is being carried out, it is necessary that this treatment has appropriate security mechanisms. Process Mining is a tool that allows you to discover the processes and events thattake place during processing. Therefore, with this tool, we will be able to detect the path that the data have followed in their treatment and the people who have intervened. However, in addition, it is possible to identify patients if the data collection has been excessive and the principle of minimization has not been followed. In short, more data has been collected and processed than is needed to obtain the purpose of the processing. To avoid this, Process Mining can be a quite useful tool.

A Value Based Health Care Evaluation framework for the assessment of an innovation technology solution

Abstract

Numerous frameworks have been developed over the past 20 years with the aim of facilitating a better understanding of health systems and enabling health systemperformance assessments (Papanicolas, 2013; Fekri, Macarayan & Klazinga, 2018[1])

A particularly influential framework is the WHO[2] "building blocks" framework for health systems strengthening. Additionally, the European commission through a document release in 2019[3] by EXPH proposes to define "value-based healthcare (VBHC)" as a comprehensive concept built on four value-pillars: personal, technical, allocative and societal value.

The methodological framework created for the VALUE project is based In the Theory of Change framework and a combination of the WHO and VBHC frameworks.

The Value Based Health Care Evaluation framework for the assessment of an innovation technology solution is based on a human-centre approach. This approach give VALUE an overall perspective of different actors/stakeholders involved in healthcare delivery service.and impact will be measured in six different groups (patients, healthcare professionals, healthcare providers, health systems, innovation and technology providers and socio-economic determinants) according to the different stakeholders involved in the project. Each of these groups are defined by different determinants[3] that would be assess using the proper indicators adapted for each of the use cases.

Finally, the dimensions of the evaluation assessment will be done in 4 blocks or axis of growth: Quality and evidence evaluation, Implementation in the clinical workflow, Technology adoption evaluation, Scalability and replicability

Maria Sanchis-Amat, PhD, PMPEmail:

maria.sanchis@gencat.cat

Catalan Agency for Health Quality and Evaluation (AQuAS), Government ofCatalonia.

Bio:

[1] https://www.sciencedirect.com/science/article/pii/S0168851013002078?via%3Dihub

[2] https://www.ncbi.nlm.nih.gov/books/NBK549277/

[3] https://www.hbs.edu/faculty/Publication%20Files/10-099_0b80d379-8e88-4992-9e8f-4b79596b1ff9.pdf

Maria Sanchis is a Senior Health Innovation Project Management, specialized in the Innovation Public Procurement and Pre-commercial Procurement of Innovation in the Value-based Healthcare program of the Health Departament, Government of Catalonia (AQuAS). PhD in Organic and Medicinal Chemistry from Loughborough University (UK) and a PMP certificate (Project Manager Professional) from the PMI (Project Manager Institute, USA) is currently working in the evaluation and impact analysis of innovation solutions of different nature. OncNGS -PCP, pre-commercial procurement of innovation solution for the future of Next Generation Sequencing in Liquid Biopsy at European Level, VALUE, enabling digital transformation with Interactive Process Mining, ASB-PCP, pre-commercial procurement of innovation solution for antimicrobial resistant infections' detection in hospital settings.

Dr.Sanchis-Amat is also reviewer for the EC in the Eureka program (Eurostars and Innowide) to assess technology development, implementation and readiness.

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Digital Health Applications

Session Chair: Ratko Magjarevic (University of Zagreb, Croatia)

11 Nov. (Thursday)	Room F (17:00~18:30)

Artificial Intelligence in Medicine and Health Care: Opportunity and/or Threat?
Lenka Lhotska (Czech Technical University in Prague, Czech Republic)

Biomedical and Clinical Engineering sustained by Open Source ICT
Marc Nyssen (Vrije Universiteit Brussel, Belgium)

The Ecosystem of Digitally Enabled Diabetes Care During the COVID-19 Pandemic
Piotr Ladyzynski (Polish Academy of Sciences, Poland)

Health monitoring of elderly through wireless wearable sensors
Ratko Magjarevic (University of Zagreb, Croatia)

Artificial Intelligence in Medicine and Health Care: Opportunity and/or Threat?

Lenka Lhotska

Czech Technical University in Prague

Abstract

The aim of the talk is to present the development of artificial intelligence (AI) methods and their applications in medicine and health care. Current technological development contributes to generation of large volumes of data that cannot be evaluated only manually. We describe the process of patient care and its individual parts that can be supported by technology and data analysis methods. There are many successful applications that help in the decision support process, in particular in processing complex multidimensional heterogeneous and/or long-term data. On the other side, failures appear in AI methods applications. In recent years, deep learning became very popular and to a certain extend it delivered promising results. However, it has certain flaws that might lead to misclassification. The correct methodological steps in design and implementation of selected methods to data processing are briefly presented.

Bio

Lenka Lhotská, PhD, CEng, MIET, MIEEE, graduated as Master of Science in Electrical Engineering at the Czech Technical University in Prague (CVUT), Czech Republic. In 1989 she got her PhD degree in Cybernetics from CVUT. Currently she is head of the COGSYS Department (Cognitive Systems and Neurosciences) at the Czech Institute of Informatics, Robotics and Cybernetics and deputy head of Department of Natural Sciences of the Faculty of Biomedical Engineering, CVUT.

Her research focuses on following areas: Knowledge-based systems, data and knowledge representation, application of artificial intelligence methods to medicine, digital signal processing, machine learning, feature extraction and feature selection, semantic interoperability, mobile technologies in healthcare, electronic health record. She is chair of the Working Group Personal Portable Devices of European Federation for Medical Informatics (EFMI) and member of the EFMI Council, Member of the Council of the Czech Society for Biomedical Engineering and Medical Informatics, National representative in International Society for Telemedicine and eHealth (IsfTeH), National representative in International Federation for Medical and Biological Engineering (IFMBE), member of Council of Societies of IFMBE, co-chair of the WiMBE WG of IFMBE, chair of the Women in Medical Physics and Biomedical Engineering Task Group of IUPESM, and Member of the Engineering Academy of the Czech Republic.

The Ecosystem of Digitally Enabled Diabetes Care During the COVID-19 Pandemic

Piotr Ladyzynski

Nalecz Institute of Biocybernetics and Biomedical Engineering, Polish Academy of Sciences
Warsaw, Poland, e-mail: pladyzynski@ibib.waw.pl

Diabetes is one of the most prevalent noncommunicable chronic diseases. It affects 463 million adults worldwide. According to the International Diabetes Federation this number will increase to 700 million till the year 2045. People with diabetes developing COVID-19 are at increased risk for severe symptoms, complications and mortality. The goal of the diabetes treatment is to keep the course of glycemia as close as possible to that of a healthy person. It was not easy to reach this goal even before the COVID-19 pandemic. Lockdowns and restricted contacts between people with diabetes and their caregivers made it even more difficult.

In all people with type 1 diabetes, and many with other types of diabetes, achieving the treatment goal requires regular, preferably continuous, blood glucose monitoring, and adjusting insulin dosage according to meals, exercise and glucose levels. Some of the basic components of the digital ecosystem facilitating diabetes treatment have been already available in pre-COVID-19 times. However, almost all these components need improvements and integration to create fully connected, digitally enabled, ubiquitous ecosystem for diabetes treatment.

There are glucometers for intermittent blood glucose concentration testing as well as the flash and continuous monitoring (CGM) systems with transcutaneous or subcutaneous sensors. However, these devices use plethora of different communication protocols which makes their interoperability difficult. Moreover, noninvasive glucose monitoring systems are not available. Automatic bolus calculators can be used to monitor food intake, but these require the person with diabetes to self-estimate the carbohydrate content of the meal. Automatic meal composition recognition based on image processing techniques, verbal description of the meal and speech-to-text conversion, as well as the monitoring such activities as chewing and swallowing are not fully developed. Physical activity monitoring with sensors such as accelerometers, GPS receivers, step counters, etc., which are integrated in smartwatches, smartphones, armbands or smart shoes has limited accuracy compared to the state of the art techniques. There are some educational materials for people with diabetes available on line and a few health-focused games have been developed. However, the access to properly focused education and dietitian services for people with diabetes is limited. There are effective devices for insulin delivery such as pen-injectors and insulin pumps, both – traditional with tubing and patch pumps. Some of the pumps can communicate with CGM systems and suspend insulin delivery in response to the actual or predicted low glucose level. However, insulin delivery devices are invasive and there is not implantable insulin pump under production.

Finally, telehomecare and mobile telecare systems for people with diabetes have been developed and clinically tested for the last three decades. The crisis caused by COVID-19 pandemic has been a driving force of accelerated implementation of telemedicine services in diabetes treatment. This will most likely shift paradigms in the way diabetes care is delivered in the future. Yet, integration of the data provided by various devices into electronic health records is still very clunky. Sophisticated algorithms using artificial intelligence techniques to analyze the patient collected data, identify important trends and reduce the burden upon physicians are still to be developed. Only then will telemedicine services in combination with the aforementioned technical components create a digitally enabled, easily accessible, clinically effective, personalized and economically sound diabetes care ecosystem.

Piotr Ladyzynski, Ph.D., D.Sc., Professor at IBBE PAS (Warsaw, Poland)

Piotr Ladyzynski received his Ph.D. (with distinctions) and D.Sc. (habilitation) in biocybernetics and biomedical engineering in 1997 and 2009, respectively. Since 2009, he has been a professor and a member of Scientific Council at the Nalecz Institute of Biocybernetics and Biomedical Engineering of the Polish Academy of Sciences (IBBE PAS). Since 2014 he has been the director of the International Centre of Biocybernetics PAS. In 2000, Dr. Ladyzynski received a fellowship from the Japan Society for the Promotion of Science and spent 12 months at the Nara Institute of Science and Technology. His scientific interests include technical support for diabetes treatment, artificial organs, including artificial pancreas, telemedicine and the use of ICT in medicine. He is an author of 200 peer-reviewed publications including monographs, book chapters, journal articles, patents and conference papers. He served as a governor of the European Society for Artificial Organs (ESAO) from 2007 to 2012, and was the President of ESAO from 2019 to 2021. He is the Chairman of the Industry Working Group of the International Federation for Medical and Biological Engineering (IFMBE) since 2016. He is the Editor-in-Chief of *Biocybernetics and Biomedical Engineering* since 2017.

Health monitoring of elderly through wireless wearable sensors

Goran Seketa, Dominik Dzaja, Sara Zulj, Ratko Magjarevic
University of Zagreb, Faculty of Electrical Engineering and Computing
Zagreb, Croatia
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The population of elderly is expected to significantly increase in near future, and according to the prediction of the authorities of the EU, those aged over 65 years will account for over 30% of EU's population. With aging, damage to various tissues in the body occurs and increases risk for chronic diseases and other impairments to bodily functions. Medical technology has contributed to the increase of life expectancy, and many diseases previously considered to be fatal, due to early diagnostic, efficient health interventions and improved treatment, are at present categorized as chronic diseases. However, healthcare costs attributed to increasing ageing are considerably growing and healthcare authorities worldwide are trying to find a way to decelerate the aging process and prolong the ability of independent living for the elderly.

The quality of life of elderly comprises of physical, emotional and psychic health and well-being and it is not only dependent on the chronological age but also by presence of chronic disease(s), genetics, lifestyle, nutrition and other conditions. Several studies show that the perceived life expectancy is higher (compared to a person of the same age) if an individual is physically active and/or regularly exercises, keeps healthy weight and bodily shape and participates in enjoyable activities. Technologies that are currently being developed will substantially alter health care and social environment only if all stakeholders, from individuals (patients), health professionals and institutions, payers and medical equipment manufacturers change their attitude to preventive actions and management of chronic diseases in direction of enabling independent and quality life of elderly and those who will inevitably one day become older, i.e. a member of the elderly group in population. Prevention may be achieved by knowing the statistical group characteristics of particular groups in the population: these are measures based on procedures and recommendations within public health. From the perspective of an individual, personalized health risk assessment is preferable and may be modeled on trustful information gathered primarily from sensors for continuous monitoring of different physiological, mechanical and behavioral information, without any intervention from medical staff. There is an obstacle to that since many of wearable sensors do not have proven utility, feasibility of integration into the information system of the health care nor eligible costs and they often disrupt the users. In this paper, we will show the results of our research which is focused towards minimizing those obstacles by optimizing characteristics of wearable wireless sensors, sensor networks for remote patient monitoring and information transfer within the network. The wearable intelligent wireless sensor integrates measurements from accelerometers, gyroscopes and magnetometers, measurement of heart rate and/or ECG in order to differentiate activities of daily life, recognizes and evaluates movements during physical exercising and it is used as a high reliability fall detector. For individuals with diabtes Type 1, who are using CGM sensors, data from insulin pump is added for short term insulin trend prediction.

The Joint Conference of the IBEC2021 and the ICBHI2021

Future Diagnositc and Therapeutic Technologies

Session Chair: Sung-Min Park (POSTECH, S. Korea)
Jinah Jang (POSTECH, S. Korea)

11 Nov. (Thursday)	Room G (17:00~18:30)

Cuffless Blood Pressure Monitoring Towards Precision Management of Cardiovascular Risks
Yali Zheng (Shenzen Institue of Advance Technology, China)

AI and disruptive innovation in healthomics
Caroline Li (University of Kent, UK)

Coaxial Bioprinting of Blood Vessel Grafts and Vascular Disease Models
Ge Gao (Beijing Institute of Technology, China)

Expanding Extrusion-based 3D Bioprinting Windows and Capabilities
Liliang Ouyang (Tsinghua University, China)

Cuffless Blood Pressure Monitoring Towards Precision Management of Cardiovascular Risks

Yali Zheng[1]

[1] College of Health Science and Environmental Engineering/Biomedical Engineering, Shenzhen Technology University, Shenzhen, China

Abstract— **High Blood Pressure (BP) is the primary modifiable risk factor for cardiovascular diseases (CVDs). Although the current clinical practice mainly adopts the noninvasive and cuff-based BP monitors for the diagnosis and treatment decisions of CVDs, it is still unsatisfactory as they only provide snapshot measurements, which is insufficient to capture the intrinsic dynamicity of BP and thus failed to establish good correlations with the expected clinical outcomes. And the newly discovered independent risk predictors including the nighttime ambulatory BP, systolic BP time in target range and etc, suggest that a more holistic view of individual BP profiles in daily settings is highly desirable. Therefore, the cuffless BP monitoring has raised great attention in the past years. This abstract will discuss the recent progress on the modeling methods for the wearable and cuffless BP estimation based on pulse transit time, including biophysical models and data-driven models. The modeling and validation in two different scenarios will be presented, including: the ambulatory BP monitoring in daily life settings, and the continuous monitoring in dynamic conditions. The challenges and future work in cuffless BP monitoring will also be briefly discussed. In conclusion, although the accuracy of existing cuffless BP monitoring methods are not fully validated for clinical use, and the way of integrating the cuffless BP in the standard of care is also unclear yet, the realization of the cuffless BP monitoring technique still holds the promise due to the clinical need for more comprehensive BP measurement and the impact of patient self-management of BP in daily life settings for the precision management of cardiovascular risks.**

Short Biography— **Dr. Yali Zheng is currently an assistant professor in the Department of Biomedical Engineering, Shenzhen Technology University, Shenzhen, China. She received her PhD degree from the Dept. of Electronic Engineering, the Chinese University of Hong Kong in 2014. From 2014-2018, she was a postdoctoral fellow with Department of Surgery, Faculty of Medicine, The Chinese University of Hong Kong. Her research interests include smart wearable medical devices and intelligent analysis of biomedical sensing data for the prevention of chronic diseases and active health monitoring.**

Dr. Zheng published more than 30 scientific papers in the area of biomedical engineering. The Google citations of her work are more than 1600 times and her recent H-index is 14. She is the affiliated member of IEEE-EMBS Wearable Biomedical Sensors and Systems Technical Committee, and the Executive Committee Member of IEEE EMB Hong Kong-Macau Joint Chapter. She also served as a member of the Organizing Committee for BSN'19 and BSN'21. She serves as a reviewer for several peer-reviewed journals.

AI and disruptive innovation in healthomics

Abstract—

The five most cited disruptive innovations in healthcare are 'omics' technologies, mobile health applications, telemedicine, health informatics and retail clinics. It is well known that all sorts of wearable sensors and clinical monitoring devices are used more and more widely nowadays. With the advancement of technological development, informed decision making and real-time monitoring are made possible for healthcare. In this talk, a number of application in the healthcare domain will be elaborated as the innovations as illustration of the innovation in healthomics. Data analytics models and how to evaluate the model will be discussed, including model reliability, and uncertainty-aware architectures.

Short Biography—

Dr Li is the Deputy Director of the Institute for Creative and Cultural Industries at the University of Kent, and the Director of Internationalisation and the Founder of the Brain|Cognition|Computing Lab at the School of Computing responsible for coordinating multidisciplinary research between Computing and other disciplines. She has been leading the research through building the multidisciplinary BC^2 Lab focusing on understanding human health and wellbeing, developing advanced data analytics methods for domain-specific applications such as physical and cognitive states identification and tracking, AI for clinical applications, novel wearable technologies in health-related areas. For example, EEG-based biomarker for brain diseases, brain-controlled robotics, EMG-controlled robotics, ECG pattern extraction, and human motion and human behaviour analysis.

She has been active in the international research community. She worked under large scale project including the £6 million EPSRC project "ESPRIT with Pervasive Sensing". She also works closely with industry and organisations to deliver research impact, including winning of Samsung GRO Award, the DASA funding awards, EIRA funding supported by Research England, Charity funded project (i.e. the £1.3 million project funded by the LifeArc), over £5m Research Council funding in Symbiotic Creativitiy. She is actively developing cutting-edge technologies in how human interact with the culture and creative domain. She won the British Council "Showcase Your Innovation" bid with the project of the brain composed modern art. And several awards in this domain, including Best Paper Award at the Flagship conference ICED (International Conference on Engineering Design).

Coaxial Bioprinting of Blood Vessel Grafts and Vascular Disease Models

Ge Gao[1] and Dong-Woo Cho[2]

[1] Institute of Engineering Medicine, Beijing Insititute of Technology, Beijing, China
[2]Department of echanicineering, POSTECH, Pohang, Korea
Prof. Ge Gao: gaoge@bit.edu.cn
Prof. Dong-Woo Cho: dwcho@postech.ac.kr

Abstract— **Cardiovascular disease (CVD) is the leading cause of global death, which demands millions of bypass procedures every year to rescue the patients. As the main precursor of CVD, atherosclerosis is a complex inflammatory disorder that still lacks clear pathological mechanisms and effective regenerative therapies. Hence, advanced tissue-engineering techniques are urgently needed to develop vascular bypass graft and disease models for clinical applications and physiopathology research. Coaxial bioprinting has emerged as a novel biofabrication strategy for the rapid tissue-engineering of cell-laden tubular, fibrous, and core-shell spheroid constructs. Due to its unique advantage, this technique showed unparalleled potential for building living vasculatures. Combining with a vascular tissue-specific material formulated from decellularized extracellular matrix bioink, the coaxial bioprinting technique has been utilized to successfully fabricate (1) cell/drug-laden bio-blood-vessels for the recovery of ischemic disease, (2) perfusable and functional vascular in vitro models that can recapitulate the physiopathology of endothelial tissue, (3) geometry-tunable artery equivalents to emulate the early-stage atherosclerotic events, and (4) endothelium/smooth muscle dual-layered blood vessels as small-diameter vascular grafts. These achievements suggest that the coaxial bioprinting is a promising biofabrication strategy that can leverage the strength of 3D bioprinting to build a variety of novel vascular constructs for matching the laboratory and clinical demands.**

Short Biography— **Please include the short biography of a presenting author.**

Prof. Ge Gao received his PhD at the Department of Mechiancal Engineering at POSTECH in 2019, and worked as a postdoctoral fellow until 2020 in Prof. Dong-Woo Cho's lab. He joined Beijing Institute of Technology in the end of 2020 as an assistant professor in the Institute of Engineering Medicine. His research focuses on novel 3D bioprinting strategies, formulation of tissue-specific bioinks, as well as the building of 3D tissue/organ mimicking constructs for tissue regeneration and in vitro analytics and diagnostics. In particular, his successfully developed in vitro vascular models and blood vessel grafts. These achievementsmay lead to clinical applications for providing advanced therapeutic methods, understanding disease mechanisms, and engineering regenerative tissue equivalents.

Expanding Extrusion-based 3D Bioprinting Windows and Capabilities

Liliang Ouyang[1,2,3]

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3D Bioprinting has opened a new avenue for tissue engineering and regenerative medicine [1]. Despite the considerable progress in the last decade, there remains a significant demand for feasible bioinks. Taking extrusion- based bioprinting as an example, one of the primary challenges for developing a new bioink is printability achievement. A conventional way to enhance structural integrity is to increase the bioink viscosity by using higher biopolymer concentration or introducing additional components, which would usually add to the matrix density in the printed constructs. However, too high matrix density would likely hinder cell migration and proliferation in 3D cell culture. Alternatively, novel chemistry has been introduced to hydrogels to modify the rheology in favor of bioprinting process.

Here, we explore facile strategies to achieve structural printability for less-printable materials, such as low-concentration hydrogels. We previously introduced a generalizable in-situ crosslinking strategy to print non-viscous photo-crosslinkable hydrogels (viscosity < 15 m Pa) [2]. In this approach, the printer nozzle was modified with a light-permeable needle, to which light would be introduced to shape the bioinks into filament building blocks. Recently, we've investigated alternative approaches that can be readily transferred to commercial printer systems. For example, we have introduced a void-free bioprinting strategy, where multiple bioinks (e.g., one with removable gelatin and one with photo-crosslinkable hydrogel) are deposited next to each other without designed voids [3]. Compared to the typically void-containing bioprinting process, this approach has the deposition of each layer on a relatively flat surface and thus could minimize the gel filaments collapse, especially when the bioinks are less viscous. We have shown that standard lattice constructs are fabricated with excellent cross-sectional features - uniform tubular porosity has been achieved. We further demonstrate the successful printing of 5% gelatin methacryloyl (GelMA), which is normally regarded as non-printable formulation. Another benefit from the void-free bioprinting process is that in-situ endothelialization could happen by pre-loading cells in the templating phase. Without the need for post cell seeding, uniform and tubular endothelium could be generated in the one-step process. In another example, we explore the use of the gelatin-doping approach [4] to develop a library of photo-crosslinkable bioinks. We demonstrate a universal printability for nearly twenty bioink formulations, including those with extremely low concentrations (e.g., 2.5% GelMA, 0.5% methacrylated hyaluronic acid) [5]. We further demonstrated that such a soft matrix was necessary for the 3D culture of cells from tissues of soft origin, such as the brain. Our work of printing low-concentration hydrogels would expand the current Biofabrication window and provide more opportunities for the engineering of soft tissue.

References

[1] L Ouyang. Springer. 2019 ISBN 978-981-13-9455-3.

[2] L Ouyang et al. Advanced Materials. 2017;29(8):1604983.

[3] L Ouyang et al. Advanced Functional Materials. 2020: 1908349.

[4] L Ouyang et al. Biofabrication. 2016. 8 (3): 035020.

[5] L Ouyang et al. Science Advances. 2020, 6, eabc5529.

Plenary Session 2 (Joint Session)

Session Chair: Sung-Min Park (POSTECH, S. Korea)

12 Nov. (Friday)	Room A (09:00~10:00)

Models to Incorporate Digital Health in Biomedical Engineering Education

Shankar Krishnan (IFMBE President, USA)

Models to Incorporate Digital Health in Biomedical Engineering Education

Shankar Krishnan

Educational program models in Biomedical Engineering (BME) especially in the undergraduate and master's levels go through continual refinement in their curricula. The major reasons at the undergraduate level are requirements from the accreditation agencies as well as the need to keep the educational program comprehensive, competitive, attractive to top quality students and faculty, financially sustainable, and successful. Technologies are advancing at rapid rates in all engineering fields and being an interdisciplinary field, BME must embrace and adopt the technologies for appropriate applications in the healthcare field. Covid-19 pandemic has triggered an array of disruptive phenomena in all our professional lives across the globe. In particular. the importance of digitalization spread across the healthcare domain has been highlighted. Based on a glimpse of the current BME programs, it is evident that inclusion of digital health is essential after careful reviews of the contents of existing curricula and necessary modifications. The key objectives of this plenary lecture are to provide a background of the overall curriculum structure in undergraduate and graduate BME programs, propose new models to incorporate digital health at various configurations, and address consequent rewards and challenges.

While many established programs with BME as a major discipline exist, some universities offer BME as a concentration or a minor field of study. There are also limitations in terms of the number of credit hours and the total duration of the program both at the baccalaureate and master's levels. The salient parameters in curriculum design include the foundational courses, the core courses and the elective courses, the number of credit hours for the lecture, lab, and capstone project components, the program educational objectives and the student learning outcomes, and additional courses in humanities and social sciences. Vital factors such as the estimated student size, available manpower and facility resources, and job and advanced studies opportunities for graduates must be prudently considered. The pervasive spread of digitalization especially in the MedTech industries and the health care delivery domain has led to the need for incorporation of digital health in the BME academic programs.

Different educational models are proposed to formulate BME curricula with varying degrees of inclusion of courses. The models could have an undergraduate minor or a concentration or a concentration in Digital Health. The number of courses would vary with the model type. All models at the undergraduate level would also require project work or independent study in conjunction with experiential learning or internship modules. At the master's level, a sizable percentage would be in digital health related courses and the project or thesis work must be on solving current and emerging problems in digital health associated areas. It is realized that any addition of digital health components in the tightly packed curricula and over-stretched resources would have to meet the standard metrics for the success of modified or innovative programs. result in meaningful return on investment. In the current environment, it is proposed to add courses such as Health Informatics, Artificial Intelligence, Machine Learning, Interoperability, Privacy, Cybersecurity, Big Data and Predictive Analytics, Regulatory Affairs, and Data Science applied to BME and health care.

Educational models tend to have regional and national specificity and their successful outcomes will depend heavily on the commitment by the faculty, resource allocation by the Board of Trustees of public or private academic organization, and the interactions with industries, the advisory councils as well as support by the governmental agencies.

In conclusion, different models of adding digital health components in BME programs will encounter numerous challenges but will yield beneficial rewards. Purposeful intra and inter university and industry collaborations at national and international levels as well as careful planning and execution of digital health incorporation in the BME programs would pave the way to better preparation of industry-ready graduates and greater contributions by all of us to the health care field to achieve better health for all.

The Joint Conference of the IBEC2021 and the ICBHI2021

Rising Women Engineers in BME (Joint Session)

Session Chair: Jennifer Hyunjong Shin (Korea Advanced Institute of Science and Technology, S. Korea)

12 Nov. (Friday)	Room C (10:30~12:00)

Recent Progress of Optical Imaging Techniques for Diagnosis and Treatment Assessment of Breast, Ovarian and Colorectal Cancer
Quing Zhu (Washington University in St Louis, USA)

Quantitative histopathology using Normalized Raman Imaging (NoRI)
Seungeun Oh (Harvard Medical School, USA)

Real-time Extended Field-of-view Ultrasound Imaging with Multi-GPU Reconstruction
Eun-Yeong Park (Stanford University, USA)

Microphysiological Human Intestine Models to Decipher Host-microbiome Crosstalk
Woojung Shin (Harvard University, USA)

Quing Zhu
Professor
Washington University in St Louis

Recent Progress of Optical Imaging Techniques for Diagnosis and Treatment Assessment of Breast, Ovarian and Colorectal Cancer

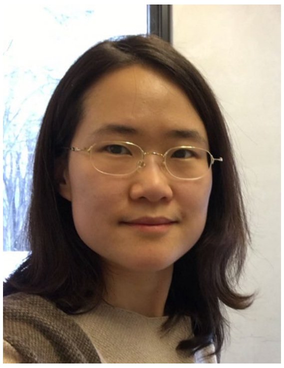
Abstract

This talk will focus on our recent progress utilizing Optical Imaging Techniques to advance diagnosis and treatment assessment of breast, ovarian and colorectal Cancer. Ultrasound imaging has co-registered with the optical imaging techniques to provide lesion morphology while optical imaging maps out lesion functional activity. The co-registered optical and ultrasound imaging techniques have implemented on hand-held probes suitable for imaging breast, ovary and rectum. This talk will also discuss roles of deep-learning in cancer diagnosis and treatment prediction as well as challenges with deep-learning in new optical imaging modalities.

Brief Biosketch

Professor Quing Zhu joined Washington University in St. Louis as a professor of the Department of Biomedical Engineering in July 2016. She also has a joint appointment in Electrical and System Engineering, and Radiology at Washington University School of Medicine in St Lois.

Professor Quing Zhu has been named a Fellow of Optical Society of American (OSA), a Fellow of SPIE- International Society for Optics and Photonics. Her research interests are focused on imaging techniques of photoacoustic, diffused light, ultrasound, optical coherence tomography for cancer detection, diagnosis and treatment assessment and prediction.



Seungeun Oh
Instructor
Harvard Medical School

Quantitative histopathology using Normalized Raman Imaging

Abstract

Stimulated Raman Scattering (SRS) microscopy visualizes the chemical composition of biological samples without any use of staining and has opened exciting opportunities in basic research as well as clinical histopathology. We created Normalized Raman Imaging (NoRI), a computational enhancement that can transform SRS images to calibrated chemical analysis. NoRI reports the chemical component at each pixel in a physical unit (mg/ml) by removing the effect of light scattering originating from samples. We demonstrated NoRI measurement of the absolute concentration of protein and lipids mass in tissues with high 3-dimensional spatial resolution. Since NoRI images show all protein and lipids, tissue microarchitecture is visualized in a similar manner as the Hematoxylin & Eosin (H&E) stained histological slides. As such, information equivalent to conventional H&E staining can be extracted from NoRI images by simply applying pink and purple pseudo-color to protein and lipids, while being free of the thin-sectioning artifacts and staining intensity variability of the conventional H&E histology. The novel and potentially critical quality of NoRI data lies in the physiological meaning of protein and lipid concentrations that are intrinsic properties specific to cell types, reflecting the health and disease states of the tissue. NoRI imaging of cells and tissues revealed quantitative biomarkers including condensation/dilution of the cytoplasm in various circumstances including mitosis entry and enrichment of lipids in the brains of Alzheimer's disease mice. Specifically, the lipid measurement is likely rich in novel information as lipid is extracted in typical paraffin-embedded histology samples. Owing to these characteristics, NoRI histology enables novel approaches in computational histology image analysis including machine learning-assisted analysis.

Brief Biosketch

Seungeun Oh, Ph.D. is an instructor at the department of Systems Biology at Harvard Medical School where she studies growth and homeostasis of cells and tissues using quantitative biophysical approaches. She utilizes label-free optical methods including quantitative phase microscopy and stimulated Raman scattering microscopy to measure protein and lipid biomass in developing or diseased tissues.

Eun-Yeong Park
Postdoctoral Scholar
Department Radiology, School of Medicine, Stanford University

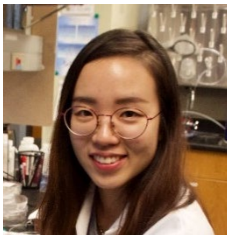
Real-time extended field-of-view ultrasound imaging with multi-GPU reconstruction

Abstract

Ultrasound (US) imaging has been routinely used for medical diagnosis and image-guided therapy thanks to the excellent safety, real-time imaging capability, and portability. New 1024 (or larger) channel imaging systems provide unprecedented opportunities to acquire data from 1D and 2D arrays with extended field-of-view (FOV) imaging. However, it is challenging to capture tissue motion or therapeutic procedures in real-time due to the enormous datasets. Here, we present a partial beamforming (BF) process with 1024-channel and multi-GPU cards for video-rate volumetric US imaging.

Brief Biosketch

Eun-Yeong Park received her B.S. and Ph.D. degrees in Electronic and Electrical Engineering from Pohang University of Science and Technology, Republic of Korea, in 2013 and 2020, respectively. Her Ph.D. work focused on the development of non-ionizing and non-invasive biomedical imaging techniques including photoacoustic/ultrasound imaging and their clinical applications. She joined the Ferrara lab at Stanford University in 2020 where she has been working on developing an ultrasound/photoacoustic dual-modal computed tomography system.



Woojung Shin, PhD
Postdoctoral Fellow
Wyss Institute for Biologically Inspired Engineering at
Harvard University

Microphysiological human intestine models to decipher host-microbiome crosstalk

Abstract

Human microbiome and its crosstalk with the host play a key role in regulating human health and disease. However, it is still largely unknown how the microbiome affects the development, progression, and therapeutics of human diseases, mainly because of a lack of reliable experimental platforms. The human gut-on-a-chip is a microphysiological intestine model that closely recapitulates the intestinal microenvironment, including the three-dimensional epithelial structure, biomechanics, and physiological functions. Importantly, this innovative *in vitro* platform supports a stable and robust co-culture of the living microbiome, enabling the investigation of host-microbiome crosstalk in various gastrointestinal disease milieu. Here, we provide examples of the development and utilization of the gut-on-a-chip technology, including the mechanistic investigation of epithelial morphogenesis, the establishment of a novel platform to co-culture anaerobic bacteria, the identification of a trigger of intestinal inflammation, and the development of patient-specific intestinal disease models by integrating patient's samples. We envision that our technological innovation and findings will disseminate translational impacts in biomedical, clinical, and pharmaceutical science.

Brief Biosketch

Woojung is currently a postdoctoral researcher and an NIH/NCI F99/K00 fellow, working with Dr. Jim Collins and Dr. Don Ingber at the Wyss Institute at Harvard University. She got her expertise in human organ-on-a-chip during her PhD research at the University of Texas at Austin, working with Dr. Hyun Jung Kim. Now, she is trying to integrate synthetic biology approaches into the human organ-on-a-chip.

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Multimodal Medical Imaging Informatics 2

Session Chair: Wonseok Choi (POSTECH, S. Korea)

12 Nov. (Friday)	Room F (10:30~12:00)

Changes in Healthcare delivery to patients: lessons learnt from Covid19
Devyani Chowdhury (University of Pennsylvania School of Medicine, USA)

Ultra-fast Super-Wide-field Photoacoustic Microscopy of Functional Brain Activities
Junjie Yao (Duke University, USA)

Deep learning assisted compact desktop photoacoustic tomography
Manojit Pramanik (Nayang Technological University, Singapore)

Shining new lights into deep biological tissue via wavefront shaping: a brief review of recent development and perspectives
Puxiang Lai (The Hong Kong Polytechnic University, Hong Kong)

High Speed Photoacoustic Imaging
Chengbo Liu (Shenzhen Institute of Advanced Technology, China)

Devyani Chowdhury MD

Changes in Healthcare delivery to patients: lessons learnt from Covid19

Covid 19 has changed the world forever.
There are many lessons learnt from the pandemic which will continue to influence our current practice. Remote monitoring and Telemediicne have advanced to meet the need of the hour. Disparities in care delivery took on a new challenge. The health care system went through adaptive changes to deal with the pandemic. Many of these changes are here to stay and be a part of our current system.

Devyani Chowdhury MD, MHA is a Pediatric and Adult Congenital Cardiologist in Lancaster PA. She completed her Medical School in India and her training at North Shore University Hospital , Cornell University program in NY. She also completed a Masters in Health Care Administration from George Washington University in 2019. She is board certified in both Pediatric Cardiology and Adult Congenital Heart Disease. She is currently the Director of Cardiology Care for Children in Lancaster,PA where she also delivers care to the Plain (Amish and the Mennoniet) community. She is also the Medical Director of Adult Congenital Heart Disease at Nemours Cardiac Center in Wilmington, DE. Dr. Chowdhury is a Clinical Professor at Sidney Kimmel Medical Center at Thomas Jefferson University.

Ultra-fast Super-Wide-field Photoacoustic Microscopy of Functional Brain Activities

Junjie Yao[1]

[1] Duke University, Department of Biomedical Engineering, Durham, NC, USA

Abstract— **Acoustically detecting the optical absorption contrast, photoacoustic microscopy (PAM) has become an enabling tool in small-animal brain studies, with its unique capability of single-cell spatial resolution, intrinsic sensitivity to functional information, and relatively deep penetration in tissues. However, previous PAM techniques cannot achieve simultaneously a high imaging speed, a high spatial resolution, and/or a large field of view, impeding the study of highly dynamic physiologic and pathophysiologic brain processes over a large region of interest. Here we have developed a high-speed PAM system with an ultra-wide field of view, enabled by an innovative water-immersible polygon-mirror scanner and a high-speed two-color Raman laser source. The new PAM has achieved a cross-sectional frame rate of as high as 5 kHz over a 10-mm scanning range, which is more than 5000 times faster than previous motor-scanner-based PAM system. Such a high scanning speed and scanning range are highly desired for imaging a large field of view of the mouse brain. Using this high-based PAM system, we have imaged, for the first time, epinephrine-induced vasoconstriction in the whole mouse brain, vascular reperfusion after ischemic stroke and cardiac arrest, and functional brain response in response to electrical stimulations, with a spatial resolution of 10 μm and a volumetric imaging speed of 3 Hz. We have systematically studied the brain's functional responses to cardiac arrest and the potential adverse impact of epinephrine to the brain microvessels during this process. We expect that the high-speed PAM system will become a powerful tool for small animal brain imaging where the hemodynamic responses over a large field of view are of particular interest.**

Short Biography— **Dr. Junjie Yao is currently Assistant Professor at the Department of Biomedical Engineering at Duke University, and a faculty member of Duke Center for *In Vivo* Microscopy, Duke Cancer Institute, Duke Institute of Brain Sciences, and Fitzpatrick Institute for Photonics. Dr. Yao received his B.S. (2006) and M.S. (2008) degrees in Biomedical Engineering from Tsinghua University (Beijing, China), and his Ph.D. degree in Biomedical Engineering at Washington University in St. Louis in 2013. Dr. Yao is the receipt of the 2019 IEEE Photonic Society Young Investigator Award, and 2021 National Jewish Fund Faculty Fellowship. He serves on the editorial board in Scientific Reports, Quantitative Imaging in Medicine and Surgery, Journal of Photoacoustics and Near-infrared and Laser Engineering. Dr. Yao has published more than 100 articles in peer-reviewed journals such as Nature Biotechnology, Nature Methods, Nature Medicine, and Nature Biomedical Engineering,. Dr. Yao's research interest is in photoacoustic tomography (PAT) technologies in life sciences, especially in high-speed functional brain imaging and early-stage cancer detection. Dr. Yao has received research funds from various agencies including NIH, AHA, and CZI. More information about Dr. Yao's research at http://photoacoustics.pratt.duke.edu/**

Deep learning assisted compact desktop photoacoustic tomography

M. Pramanik[1]

[1] School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore

Abstract—**Photoacoustic imaging is a novel hybrid imaging technique combining both optical and ultrasound imaging. We developed a low-cost, portable, desktop photoacoustic tomography (PAT) system using pulsed laser diodes. With multiple transducers we achieved an imaging speed of 2 frames/second. This type of circular scan PAT system suffers from poor tangential resolution. Although several techniques have been proposed to improve the tangential resolution, they have inherent limitations such as high cost and the need for customized detectors. Herein, we proposed a novel deep learning architecture to counter the spatially variant tangential resolution in circular scanning PAT imaging systems. We used a fully dense U-Net based convolution neural network architecture along with 9 residual blocks to improve the tangential resolution of the PAT images. The network was trained on the simulated datasets and its performance was verified by experimental in vivo imaging. Results show that the proposed deep learning network improves the tangential resolution by eight folds, without compromising the structural similarity and quality of image. Although, the use of multiple transducer improves the imaging speed, but such system requires calibration process to find the exact radius of each transducer for accurate image reconstruction. Here, we developed a novel deep learning approach to alleviate the need for radius calibration. We used a convolutional neural network (fully dense U-Net) aided with a convolutional long short-term memory (LSTM) block to reconstruct the PAT images. Our analysis on the test set demonstrate that the proposed network eliminates the need for radius calibration and improves the peak signal-to-noise-ratio by ~73% without compromising the image quality. In vivo imaging was used to verify the performance of the network.**

Short Biography— **Associate Professor Manojit Pramanik received his Ph.D. degree (2010) in Biomedical Engineering from Washington University in St. Louis, Missouri, USA. He joined the School of Chemical and Biomedical Engineering (SCBE) at Nanyang Technological University (NTU), Singapore in January 2014. He obtained his masters (MTech) from Department of Instrumentation at Indian Institute of Science (IISc), Bangalore, India in 2004 and his undergraduate (BTech) from the Department of Electrical Engineering at Indian Institute of Technology (IIT), Kharagpur, India in 2002. His industry experiences include two years at General Electric Global Research (GRC), Bangalore, India and one year at Philips Medical System, Bangalore, India. His research interest is in Medical Imaging Systems, Photoacoustic and Thermoacoustic Imaging, Image Reconstruction, Machine Learning, Medical Image Processing, Contrast Agents, Molecular Imaging, Monte-Carlo Simulation for light-tissue interaction, Biomedical Optics, Biomedical Device Design, Healthcare Innovation, Clinical Application areas such as Breast Cancer Imaging, Brain Imaging, Pancreatic Cancer, Diabetes, Treatment Monitoring etc. He serves as the Editorial Board Member of the Journal of Biomedical Optics, Photoacoustics. He is a Senior Member of SPIE. Professor Pramanik is also the inaugural "Biodesign Faculty Fellow" offered by the Singapore Biodesign Programme (in collaboration with Stanford Biodesign Fellowship).**

Shining new lights into deep biological tissue via wavefront shaping: a brief review of recent development and perspectives

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Abstract

The usage of light has considerably reshaped the landscape of biomedicine in the past decades from imaging, sensing, treatment, stimulation, to control. The applications, however, are limited to superficial layers beneath sample surface or compromised resolution at depths due to the inherent nature of strong optical scattering in tissue. Many approaches have been processed to tackle this challenge, such as switching to longer wavelengths to have lower tissue scattering coeffieincts, converting light into not-so-scattering acoustic waves at the signal detection side, *etc.* In this talk, we will focus on wavefront shaping, a strategy of suppressing scattering by precompensating for the scattering-induced phase distortions. Due to the time limit of presentation, we will briefly present our recent endeavors in this direction to overcome scattering of light and aim for robust and optimum optical focusing and stimulation at depths in biological tissue. Future roadmap is also discussed.

Short Biography

Dr. Puxiang Lai received his PhD from Boston University in 2011 and currently serve as an Associate Professor of Biomedical Engineering at the Hong Kong Polytechnic University. Dr. Lai's research focuses on the synergy of light and sound as well as its applications in biomedicine, such as wavefront shaping, photoacoustic imaging, acousto-optic imaging, and computational optical imaging. His research has fueled more than 50 top journal publications, such as Nature Photonics, Nature Communications, and Advanced Sciences. He has been invited to give more than 70 seminars or invited talks worldwide.

High Speed Photoacoustic Imaging

Chengbo Liu[1]

[1] Shenzhen Institute of Advanced Technology,Chinese Academy of Sciences, Shenzhen 518055, P.R.China

Abstract—**Photoacoustic imaging possesses the merits of both high optical contrast and large acoustic penetration. It is expected to play a more and more important role in both fundamental research and clinical applications, and has the potential to revolutionize the playground of tumor and cardiovascular disease management and treatment. In this talk, I will focus on how we improve the speed of photoacoustic imaging. I will start with conventional photoacoustic microscopy using point-by-point mechanical scanning. Then I will move on to fast optical scanning based on MEMS and polygon mirror devices. After that, I will introduce single pixel imaging method without the need of scanning. Combined with sparse sampling, the imaging speed can be improved by 20 times. Besides photoacoustic microscopy, we also built photoacoustic computed tomography system which uses an array of ultrasound transducers to sense the signals. Due to simultaneous acquisition of photoacousic signals, PACT can acquire 100 frames of two dimensional images in one second. We applied our technology and instrumentations to study tumor microenvironment and evolution of tumor, as well as to investigate the mechanism of neurovascular coupling in the brain. We also intraoperatively guided a biopsy needle with photoacoustic imaging to extract tissue samples from sentinel lymph node to monitor tumor metastasis status. Our technology has also been successfully translated to human imaging to diagnose vascular plaques and image periphery blood vessels, aiming at better management of diseases such as diabetic foot or varicosity.**

Short Biography—**Chengbo Liu is a Professor at SIAT, CAS. He received both his Ph.D and Bachelor degree from Xi'an Jiaotong University, each in 2012 in Biophysics and 2007 in Biomedical Engineering. During his Ph.D. training, he spent two years doing tissue spectroscopy research at Duke University as a visiting scholar. Now he is a Professor at SIAT, working on multi-scale photoacoustic imaging and its translational research.**

The Joint Conference of the IBEC2021 and the ICBHI2021

Medical Imaging and AI: Part II

Session Chair: Ravi Managuli (University of Washington, USA)

12 Nov. (Friday)	Room F (13:30~15:00)

Small Aperture Transducers for Intravenous Sonothrombolysis

Xiaoning Jiang (North Carolina State University, USA)

Brdiging the gap in healthcare delivery in LMIC through AI and technology

Babar Hasan (Associate Professor Agha Khan University, Pakistan)

Enhancing optoacoustic imaging performance via model-based inversion

Xose Luis Dean Ben (ETH, Switzerland)

Reducing storage costs for large-scale medical imaging data

Santosh Bharani (Intelpixel, USA)

Small Aperture Transducers for Intravenous Sonothrombolysis

Xiaoning Jiang, Bohua Zhang and Huaiyu Wu

North Carolina State University, Raleigh, NC, USA

Abstract— Venous thromboembolism (VTE), including deep venous thrombosis (DVT) and pulmonary embolism (PE), causes considerable morbidity and health care costs for hospitals and survivors. Ultrasound-enhanced thrombolysis (sonothrombolysis) has been studied as an alternative therapy promoting efficient thrombus dissolution without increasing the risk of complications associated with existing thrombolysis methods. Transcutaneous sonothrombolysis with and without microbubble mediation has shown promising lysis efficacy in clinical trials. Intravenous sonothrombolysis with side-looking transducers has been applied together with thrombolytic agents for DVT and PE treatments, which still takes a relatively long time (e.g., 10s of hours). Moreover, the existing sonothrombolysis techniques have limited efficacy in treating chronic thrombosis (or retracted clots). In this paper, small aperture forward-looking transducers with frequency < 1 MHz were designed, fabricated, and characterized for intravenous sonothrombolysis. Sonothrombolysis is known to enhance the permeation of thrombolytics and to disrupt a clot through acoustic radiation force and acoustic cavitation, respectively. In order to achieve reasonably high acoustic output with the relatively small transducer aperture (< 2 mm), a multilayer stacking design was adopted, and the electrical impedance of the designed transducer can be reasonably close to 50 Ohm. Transducers with 6 to 20 layers of piezoelectric plates and frequencies ranging from ~ 200 kHz to ~ 800 kHz were prototyped, followed by electrical impedance and acoustic characterizations. The measured peak negative pressures of the prototyped transducers are about 0.5 MPa-> 4MPa, which can cause significant cavitation that is needed for effective sonothrombolysis. *In-vitro* intravenous sonothrombolysis tests were conducted by using the prototyped small aperture transducers, microbubbles/nanodroplets, bovine blood clots, and a flow model. The results show that an unprecedented sonothrombolysis rate can be achieved, *in-vitro*, for both unretracted and retracted clots using the low frequency (< 1 MHz) forward-looking transducers, which is promising to advance DVT and PE treatments.

Short Biography— Dr. Xiaoning Jiang is a Dean F. Duncan Distinguished Professor of Mechanical and Aerospace Engineering and a University Faculty Scholar at North Carolina State University. He is also an Adjunct Professor of Biomedical Engineering at North Carolina State University and the University of North Carolina, Chapel Hill, and an Adjunct Professor of Neurology at Duke University. Dr. Jiang received his BS, MS and Ph.D. degrees from Shanghai Jiaotong University (1990), Tianjin University (1992) and Tsinghua University (1997), respectively. He received his Postdoctoral training from the Nanyang Technological University (1996-1997) and the Pennsylvania State University (1997-2001). He was the Chief Scientist and Vice President at TRS Technologies, Inc. prior to joining NC State in 2009. Dr. Jiang is the author and co-author of two books, 6 book chapters, 14 issued/published US Patents, 140 peer reviewed journal papers and over 120 conference papers on piezoelectric ultrasound transducers, ultrasound for medical imaging and therapy, drug delivery, nano-acoustics, ultrasound NDT/NDE, smart materials and structures, and M/NEMS. Dr. Jiang is a member of the technical program committee for a few international conferences including IEEE Ultrasonics Symposium (TPC-5), SPIE Smart Structures and NDE, ASME IMECE, IEEE NANO and IEEE NMDC. He is NTC Vice President for Technical Activities in 2022-2023, the NanoAcoustics Technical Committee Chair for IEEE NTC (2016-), IEEE NTC Distinguished Lec-turer (2018 and 2019), an editorial board member for the journal Sensors, a senior associate editor for the ASME Journal of Engineering and Science in Medical Diagnostics and Therapy, and Co-Editor-in-Chief of IEEE Nano- technology Magazine (2020 and 2021). Dr. Jiang is a Fellow of ASME and SPIE.

Dr Babar Hasan MD

Disparity in health care seen in low to middle income countries (LMICs), though multi-factorial, is mainly due to an imbalance in disease burden and health care resources equation. A dearth of skilled workforce in complex care delivery leads to poor quality of care and outcomes. Task sharing where the skills of the frontline force can be augmented using digital solutions (IoT, AI, wearables etc) and through the support of the limited high skilled provider, can help in early detection of disease, proper triage, timely referral and management. Such solutions may be an efficient way of using the existing resources and workforce. We present some examples of such work being done in a peri-urban setting with high burden of disease and significant lack of resources.

Dr Babar Hasan MD
Associate Professor
Consultant Pediatric Cardiologist
Department of Pediatric and Child Health.

After graduating from the Aga Khan University in 1999, Dr Hasan proceeded to do his residency in general pediatrics from Riley Hospital, IUPUI followed by fellowship in general pediatric cardiology and advanced fellowship in imaging and interventional cardiology from Boston Children, Harvard Medical School. He then returned to Pakistan in 2011 and held several important positions at AKU namely section head pediatric cardiology and chief of children hospital service line. Dr Hasan has nearly 80 papers in indexed journal and several National and international grants. His research focus is around quality improvement in complex disease using a 4 prong approach of creating QI collaborative, transforming systems, predictive analytics and quality over the life cycle of health. In line with these interests he serves on steering committee of several congenital heart disease outcome collaboratives.

Enhancing optoacoustic imaging performance via model-based inversion

X. Luis Dean-Ben and D. Razansky

Abstract

Optoacoustic (OA, photoacoustic) imaging capitalizes on the low scattering of ultrasound in biological tissues to provide optical contrast with high resolution at depths not reachable with optical microscopy. OA image formation for this depth range is based on acoustic inversion methods. The OA forward problem for short-pulsed excitation can be mathematically derived, which has facilitated the development of model-based algorithms outperforming standard back-projection methods. Model-based reconstruction can additionally be used to enhance the optoacoustic imaging performance. In this regard, it was possible to achieve super-resolution imaging beyond the acoustic diffraction barrier, image reconstruction with a single time-resolved signal and high-resolution imaging through the human skull. Herein, we provide an overview of this recent work and an overall perspective on model-based optoacoustic reconstruction.

Satosh Bharani

Reducing storage costs for large-scale medical imaging data

Healthcare organizations need access to real-time, accurate, and reliable data to care for patients and manage populations. However, the ongoing digitization of medicine is generating vast amounts of patient data making it challenging and expensive for healthcare organizations to manage this data effectively. Medical imaging is one of the top contributors to this problem with 3D imaging such as CT and MRI and gigapixel microscopy generating data in the order of gigabytes per exam. To address this problem, we've developed a system to compress and index medical imaging data. Our system converts images from DICOM, a commonly used medical imaging format, to a compressed representation testing different JPEG compression methods to save on storage costs. We also developed a indexing system based on Elasticsearch that combines image-level metadata from DICOM headers with patient information found in HL7 messages. The resulting system reduces overall storage costs and makes DICOM data more searchable and actionable. We evaluate the compression ratios, imaging artifacts, and overall cost and ease of use of our system as compared to storing raw medical imaging data for a large healthcare organization.

Bio:
Santosh Bhavani is a Sr. Technical Product Manager with Amazon AI Platforms team. Previously, he held various roles across research, product and sales in Healthcare AI startups, most recently as Sr. Director at JLK Group, an AI-based medical and security solutions company. Santosh's background is in Computer Science and Statistics at Carnegie Mellon where he worked on computer vision algorithms for high content screening of drugs. In his spare time, he enjoys traveling, playing tennis, and drinking lots of Pu’er tea.

The Joint Conference of the
IBEC2021 and the ICBHI2021

Poster Session

Multi-transducer photoacoustic tomography without radius calibration using Deep learning.

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Abstract— **Pulsed laser diodes (PLD) are widely employed in photoacoustic tomography (PAT) as excitation sources due to its compact size, low cost, and high repetition rate. When PLD's are used with multiple SUT's it can significantly reduce the imaging speed. However, placing the SUT's at same distance from the scanning center is not feasible. Thus, the PA data acquired can be reconstructed without degradation only if the radii of each SUT's are known. Moreover, the radii of each SUT's vary with different experimental scenarios and its estimation is a time-consuming, cumbersome process. Herein, we propose a deep leaning approach to alleviate the need of radius calibration by reconstructing the uncalibrated radius PAT images. We used a fully dense U-Net based convolutional neural network with a recurrent neural network based convolutional long short-term memory (LSTM) block to reconstruct the uncalibrated radius PAT images. The network was trained on a mixture of simulation as well as experimental datasets and its performance was evaluated by experimental in vivo imaging. Results indicate that the proposed deep learning network plays a very good role in transcending the uncalibrated radius PAT images to calibrated radius PAT images, without compromising the quality of the image.**

Short Biography—**Praveenbalaji Rajendran is a PhD student at School of Chemical and Biomedical Engineering, Nanyang Technological University (NTU). He received his masters degree from Department of Biomedical Engineering, Indian Institute of Technology Hyderabad in 2017. His research work focuses on the on the development of novel deep-learning architectures for photoacoustic image reconstruction and enhancement. His research interest includes development of photoacoustic imaging systems, computer vision, machine learning for medical imaging etc.**

Dedicated Photoacoustic Imaging Instrument for Human Periphery Blood Vessels: A New Paradigm for Understanding the Vascular Health

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Abstract— **Peripheral Vascular Disease (PVD) refers to a variety of pathophysiological syndromes that affects the arteries, veins, and lymphatic circulation. Peripheral vascular imaging has important clinical value and significance for the prevention, diagnosis and treatment of PVD. Photoacoustic imaging technology, which combines the advantages of high contrast optical imaging and ultrasound imaging of deep penetration performance, is a new type of noninvasive biomedical imaging method that can compensate for the shortcomings of existing peripheral vascular imaging methods and has the potential to revolutionize the playground of PVD diagnosis and treatment. In this work, a novel photoacoustic imaging system based on a semi-ring transducer array is proposed to image peripheral blood vessels. The system's penetration depth is deep (~15 mm) with high spatial (~200 μm) and temporal resolution. In a pre-clinical study, volumetric photoacoustic data of limbs were obtained for about 30 s with the volunteers in the standing and sitting posture. Compared to the previous studies, our system has many advantages, including (1) Larger field of view; (2) Finer elevational and in-plane resolutions; (3) Enhanced 3D visualization of peripheral vascular networks; (4) Compact size and better portability. The 3D visualization and cross-sectional images of five healthy volunteers clearly show the vascular network and the system's ability to image submillimeter blood vessels. This high-resolution PA system has great potential for imaging human periphery vasculatures noninvasively in clinical research.**

Short Biography— **Dr. Tao Chen is an assistant research fellow at SIAT, CAS. He received his B.S. degree in Physics from Nanjing University in 2014, and his Ph.D. degree in Condensed Matter Physics from Institute of High Energy Physics, Chinese academy of Sciences in 2019. Chen joined SIAT as a postdoc fellow in 2019. Now, His research interests focus on the development and application of photoacoustic computed tomography technology.**

Chengbo Liu is a Professor at SIAT, CAS. He received both his Ph.D and Bachelor degree from Xi'an Jiaotong University, each in 2012 in Biophysics and 2007 in Biomedical Engineering. During his Ph.D. training, he spent two years doing tissue spectroscopy research at Duke University as a visiting scholar. Now he is a Professor at SIAT, working on multi-scale photoacoustic imaging and its translational research.

Visualizing Tumor Angiogenesis and Boundary with Polygon-Scanning Multiscale Photoacoustic Microscopy

Zhiqiang Xu[1], Chengbo Liu[1*]

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Abstract—**Recently, we developed an integrated optical-resolution (OR) and acoustic-resolution (AR) PAM, which has multiscale imaging capability using different resolutions. However, limited by the scanning method, a tradeoff exists between the imaging speed and field of view, which impedes its wider applications. Here, we present an improved multiscale PAM which achieves high-speed wide-field imaging based on a homemade polygon scanner. Encoder trigger mode was proposed to avoid jittering of the polygon scanner during imaging. Distortions caused by polygon scanning were analyzed theoretically and compared with traditional types of distortions in optical-scanning PAM. Then a depth correction method was proposed and verified to compensate for the distortions. System characterization of OR-PAM and AR-PAM was performed prior to in vivo imaging. Blood reperfusion of an in vivo mouse ear was imaged continuously to demonstrate the feasibility of the multiscale PAM for high-speed imaging. Results showed that the maximum B-scan rate could be 14.65 Hz in a fixed range of 10 mm. Compared with our previous multiscale system, the imaging speed of the improved system was increased by a factor of 12.35. In vivo imaging of a subcutaneously inoculated B-16 melanoma of a mouse was performed. Results showed that the blood vasculature around the melanoma could be resolved and the melanoma could be visualized at a depth up to 1.6 mm using the multiscale PAM.**

Short Biography—**Zhiqiang Xu is a Postdoctoral Research Fellow at SIAT, CAS. He received both his Ph.D. and Bachelor degree from Wuhan University of Technology, each in 2020 in Information and Communication Engineering and in 2012 in Electronic Information Engineering. His research focuses on photoacoustic microscopy and its applications.**

Chengbo Liu is a Professor at SIAT, CAS. He received both his Ph.D and Bachelor degree from Xi'an Jiaotong University, each in 2012 in Biophysics and 2007 in Biomedical Engineering. During his Ph.D. training, he spent two years doing tissue spectroscopy research at Duke University as a visiting scholar. Now he is a Professor at SIAT, working on multi-scale photoacoustic imaging and its translational research.

A Big Data Platform based on Lifelog Data for Digital Health Service

E. Urtnasan[1,2], J. H. Lee[2], Y. Kim[2], K. H. Lee[1,2], S. Hwang[1,2], H. Hong[1,2], H. Y. Lee[2,3], H. Youk[2,3], and S. B. Koh[2,4]

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Abstract— **In this study, we developed and implemented a big data platform based on lifelog big data for digital health services. The developed big data platform and center are described in terms of organizational, functional, and technical aspects of this manuscript. At first, a big data platform is consists of two sides that include the big data center and the platform. Currently, we have thirteen big data centers are responsible for collecting, cleansing, and uploading the lifelog or clinical big data, and the platform is responsible for the quality control, integration, analysis, visualization, and distribution of the up-loaded big data. Among other things, four university hospitals in charge of the big data centers as produce and provide clinical big data, and nine corporate built up the big data centers to provide life-log data. We performed general functions of the big data platforms it can be classified into 'data collection, data purification, data quality, data analysis, data visualization, data distribution, and system operation'. To implement these functions, we used advanced data processing technologies like edge computing and IoT are applied for data collection, and a database is built and managed in a cloud environment for data purification and quality diagnosis, then various machine learning, artificial intelligence models, and methods were used for data analysis or visualization. At this time, a big data platform discloses about 200 types of data products on the distribution portal and provides diverse services as customized data, AI data, and various lifelog big data. In particular, we developed an innovative service model based on the accumulation of big data in health care and are currently providing it as a service to the public. In conclusion, we have built a big data platform based on lifelog data, and provide one-stop data service for collecting and distributing lifelog data.**

Acknowledgement— This research was supported by National Information Society Agency (NIA) funded by the Ministry of Science, ICT through the Big Data Platform and Center Construction Project (No. 2020-Data-W123)

Short Biography— **ERDENEBAYAR URTNASAN** (M'85) received the B. S. degree in computer science from Huree University of ICT, Ulaanbaatar, Mongolia, in 2007 and the M. S. degree in electronic engineering from Inha University, Incheon, Korea, in 2010 and the Ph.D. degree in biomedical engineering from Yonsei University, Seoul, Korea, in 2018. Since 2010, he has been a professor with the Medical Engineering Department, Huree ICT University, Mongolia. From 2018 to 2020, he was a Post-doc with the Biomedical Engineering Department, Yonsei University. Since 2020, he is served as a research professor with Artificial Intelligence Bigdata Medical Center, Wonju College of Medicine, Yonsei University. His research interests include medical AI, medical data analysis, machine learning, deep learning, biomedical signal processing, sleep signal analysis, and data science.

Identifying a Depressive State Using Gait Accelerometry and a Long Short-Term Memory Network

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Abstract— **With the elderly suffering from depression increasing today, new techniques to tackle undiagnosed and untreated geriatric depression are in need. Hence this study aimed to propose an approach of identifying a depressive state of the elderly using gait accelerometry and a long short-term memory network. A total of 101 community-dwelling elderly individuals participated in this study. The participants were categorized into non-depression and depression groups based on their scores on the Short-form Geriatric Depression Scale: 51 participants in the non-depression group and 50 participants in the depression group. The participants completed a 7-meter walking twice at their preferred speeds with an accelerometer on their lower back. The measured trunk anterior-posterior acceleration signals were segmented into acceleration falling and rising phases. Then eight descriptive statistical and six morphological parameters were extracted from each phase. The extracted parameters were ordered chronologically to be used as gait sequence features for training the bidirectional long short-term memory network-based classifiers. The five-fold cross-validation of the classifiers that used the gait sequence feature for the acceleration falling time and slope and the variabilities in the rising acceleration as input resulted in an average accuracy of 0.958 in classifying the non-depression and depression groups. The proposed approach could pave the way for unobtrusive monitoring of geriatric depression in non-clinical settings without professional help, which can open the door for earlier diagnosis of geriatric depression and more timely intervention.**

Short Biography— **Dawoon Jung, the first author of the study, is a researcher at Korea Institute of Science and Technology. She obtained her Ph.D. in Biomedical Engineering at Seoul National University. Her areas of interests include data-driven healthcare technologies using artificial intelligence.**

Development and Validation of Hand-holding Cuff-less Blood Pressure Monitor

Jinhyeok Baek[1] and Vega Pradana Rachim[2]

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Abstract— **Blood pressure (BP) is a significant parameter for cardiovascular diagnosis in clinical medicine. However, conventional cuff-based BP measurement is inconvenient for ambulatory BP measurement which is essential to diagnose hypertension. In this study, we developed the handholding cuff-less blood pressure monitor communicate wirelessly with the mobile phone to validate arterial pulse arrival time (PAT) based cuff-less BP estimation algorithm. The study data comprised an ECG waveform, a finger PPG waveform obtained from the hand-holding device and oscillometric BP measurement from 5 subjects. The data recording occurred before and after the leg-raise holding for 8 hour at one-hour Interval. According to the Bland-Altman analysis, the results of the experiment showed root-mean-squared-error(RMSE) = -0.323±9.67 for SBP, and RMSE = -0.388±7.301 mmHg for DBP respectively.**

Short Biography— **JIN-HYEOK BAEK was born in Busan, South Korea, in April 1991. He received the B.S. degree from the Department of Electronic Engineering, Soongsil University, Seoul, South Korea, in 2015, and the M.S. degree in electrical engineering from the Pohang University of Science and Technology (POSTECH), Pohang, South Korea, in 2017, where he is currently pursuing the Ph.D. degree with the School of Interdisciplinary Bioscience and Bioengineering. His current research interest includes medical device applications.**

Machine learning models as alternative diagnostic tools for cognitive impairment

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Abstract— The potential benefits of early access to treatment and support are maximized when cognitive impairment is diagnosed in its early stages. However, many elderly people delay receiving a formal diagnosis due to fear or lack of information. Therefore, development of alternative, more accessible methods of detecting cognitive impairment could increase the number of elderly people receiving early diagnosis. In the recent years motor and sensory functions have been examined as potential markers for cognitive decline due to their respective functional areas of the central nervous system being affected by neurodegenerative diseases. The current study examined the gait, auditory and balance functions of elderly Korean men. The participants were divided into three groups, cognitively healthy group, group with mild cognitive impairment, and group with severe cognitive impairment, based on their Montreal cognitive assessment score. The motor and sensory function parameters were utilized to predict the participants' cognitive assessment scores and which group they belong to. This was accomplished through machine learning algorithms and the best classification model from the given dataset was obtained. The results of multiple linear regression concluded that a model combining years of education, gait cadence, number of mistakes on the sentence recognition test, and postural stability index provided the best prediction for the given dataset. Implementation of such models as diagnostic tools could allow more accessibility in terms of primary diagnosis, which could lead more elderly people to seek medical treatment earlier in the cognitive deterioration process.

Short Biography— Emilija Kostic received her B.S. degree from the University of Belgrade, Serbia in 2018, and her M.S. degree at Jeonbuk National University, the Republic of Korea in 2021. She is currently in the process of obtaining her Doctoral degree at Jeonbuk National University. Her major research interests are machine learning utilization in healthcare, sensory processing, rehabilitation engineering, and elderly cognition.

Parameters for identifying the elderly with diminished cognitive function with a possibility of progression to cognitive impairment

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Abstract— Although various approaches to cure severe cognitive impairment have been investigated and attempted in numerous studies, there are no completely cured cases. Hence, it is important to detect the stage in cognitive decline that can develop into cognitive impairment as early as possible. Considering the association between cognitive function and gait performance, investigating the aspects of motor control of gait in the elderly experiencing cognitive decline may contribute to finding early markers for identifying older adults who have a higher risk of developing severe cognitive impairment. Thus, the aim of the present study was to examine the gait of the elderly with and without cognitive decline and to investigate parameters and mechanisms of motor control that differed significantly. Community-dwelling older adults over the age of 65 participated in this study. Cognitive function status of each participants was assessed using the Korean version of Montreal cognitive assessment, and they were divided into the normal cognitive function group (NCF) and the declined cognitive function group (DCF). The gait of all participants was captured using three-dimensional motion analysis system and analyzed using inverse dynamics approach. There were no differences in gait velocity, whereas significant differences in motor control patterns appeared mainly at the hip joint. Up until the terminal stance phase, extension range of the hip joint for the DCF was less than that of the NCF. In addition, the maximal hip extensor moment and power were less for the DCF. During the swing phase, the peak hip flexor power was also less for the DCF. These results mean that the elderly with declined cognitive function adapt their motor control patterns, and suggest that walking speed as an early marker for identifying possibility of developing cognitive impairment may be insufficient, and other gait parameters should be considered.

Short Biography— Kiyoung Kwak. He received the Ph.D. degree from Jeonbuk National University, in 2018. He is currently a postdoctoral researcher at the Division of Biomedical Engineering, Jeonbuk National University. His main areas of research interests are human biomechanics, sensory-motor integration, and cognitive function in the elderly.

Multi-modal Bio-signal Sensor System (MBSS): Simultaneous Monitoring of Electrocardiogram, Respiratory Waveform, and Electrogastrogram

Namho Kim[1], Wonju Seo[1], Sujeong Im[1], and Vega Pradana Rachim[1]

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Abstract— **We developed abdominal-attachable wearable multi-modal bio-signal sensor system (MBSS) for simultaneous monitoring of three different bio-signals: electrocardiogram (ECG), respiratory waveform (RESP), and electrogastrogram (EGG). MBSS mainly comprises two bio-potential measurement ICs, which are for measuring ECG and EGG respectively, and one 3-aixs accelerometer, which is for capturing abdominal movement for RESP derivation. To verify the practical reliability of MBSS, we collected the three bio-signals from seven subjects with using both MBSS and commercial bio-signal amplifiers, then compared the signals of two instruments through feature analysis. For all of the three bio-signals, we found that the coefficients of determination were moderate or high enough in the feature analysis (r^2_{meanH}= 1.000 for ECG; r^2_{meanBR} = 1.000 for RESP; r^2 = 0.426 for EGG). We expect that MBSS can be utilized in multiple bio- signal studies, especially for the purpose of clinical application.**

Short Biography— **Kim received the B.S. degree in Creative IT Engineering from Pohang University of Science and Technology (POSTECH), Pohang, South Korea, in 2018. He is currently working as a graduate student toward the Ph.D. degree (M.S.–Ph.D. joint program) in Convergence IT Engineering at POSTECH. His main research topics are physiological signal processing and healthcare system integration.**

Towards Interpretation for Blood Glucose Level Prediction Models

Wonju Seo[1], Namho Kim[1], Sujeong Im[1], and Sung-Min Park[1,2]

[1]Department of Convergence IT Engineering, POSTECH, Republic of Korea
[2]Department of Electrical Engineering, POSTECH, Republic of Korea

Abstract— **Patients with diabetes need to manage their blood glucose (BG) level to prevent diabetic complications such as retinopathy and cardiovascular diseases. We developed tree-based machine learning (ML) and deep learning (DL) models with continuous glucose monitoring (CGM) data points to improve the BG management. We extracted 20 CGM time series from 20 virtual patients with type 1 diabetes generated by UVA/Padova Type 1 Diabetes Metabolic Simulator, set 12 CGM data points as input, and the CGM data point after 30-min prediction horizon as output. The long short-term memory showed the lowest average root mean squared error (17.37 mg/dL) and mean absolute percentage error (8.33 %). In the clinical analysis,the deep neural network showed the highest percentage in region A (92.53 %) of Clarke error grid analysis (CEGA) and all models had the high percentage in region A and B (> 99 %) of CEGA. Then, we analyzed each model's feature importance and found that the models exhibited different feature importance. We believe that the presented method will help to manage BG levels of patients with diabetes and to interpret the BG level predictive models.**

Short Biography— **Wonju Seo received his B.S degree from the School of Electrical and Electronics Engineering at Chung-Ang University, South Korea, in 2017. He is currently a M.S./Ph.D. student of the department of Convergence IT Engineering at Pohang University of Science and Technology (POSTECH, Pohang, South Korea). His main research interest is developing deep neural networks to analyze physiological signals.**

Enhancing the Elevation Resolution in Photoacoustic Tomography Using Deep Learning

Huijuan Zhang[1], Wei Bo[2], Depeng Wang[1,3], Anthony DiSpirito III[3], Chuqing Huang[1], Nikhila Nyayapathi[1], Emily Zheng[1], Tri Vu[3], Yiyang Gong[3], Junjie Yao[3], Wenyao Xu[2], Jun Xia[1,*]

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Abstract— **Linear-array-based photoacoustic tomography has shown broad applications in biomedical research and preclinical imaging. However, the elevational resolution of a linear array is fundamentally limited due to the weak cylindrical focus of the transducer element. While several methods have been proposed to address this issue, they all handled the problem in a less time-efficient way. In this work, we propose to improve the elevational resolution of a linear array through Deep-E, a fully dense neural network. Deep-E exhibits high computational efficiency by converting the three-dimensional problem into two-dimension: it focused on the training along the elevational direction by using the 2D data in the axial and elevational plane and thereby reducing the computation burden in simulation and training. We demonstrated the efficacy of Deep-E through various datasets, including simulation, phantom, and human subject results. We found that Deep-E could improve elevational resolution by at least four times and recover the true size of the object. We envision that Deep-E will have a significant impact in linear-array-based photoacoustic imaging studies by providing high-speed and high-resolution image enhancement.**

Short Biography— **Huijuan Zhang is a third-year Ph.D. student. She comes from Wuhan in China. She received her bachelor's degree in biotechnology from Wuhan University of Technology. She is currently working toward the Ph.D. Degree in Biomedical Engineering at University at Buffalo in New York State. Her research is related to photoacoustic tomography in medical imaging. Her current research interests include developing photoacoustic breast cancer imaging system, aiming at improving the early cancer diagnosis, and investigating deep learning to enhance image quality in medical imaging.**

Second-generation Dual Scan Mammoscope with Photoacoustic, Ultrasound, and Elastographic imaging capabilities

Emily Zheng,[1] Huijuan Zhang,[1] Goswami Soumya,[2] Kabir Enan,[2] Marvin M. Doyley,[2] AND Jun Xia[1,*]

[1] Department of Biomedical Engineering, University at Buffalo, The State University of New York, Buffalo, NY 14260, USA

[2] Department of Electrical & Computer Engineering, Rochester Center for Biomedical Ultrasound, University of Rochester, Rochester, NY 14627, USA

Abstract:

We recently developed the photoacoustic dual scan mammoscope (DSM), a system that images the patient in standing pose analog to X-ray mammography. The system simultaneously acquires three-dimensional photoacoustic and ultrasound (US) images of the mildly compressed breast. Here, we describe a second-generation DSM (DSM-2) system that offers a larger field of view, better system stability, higher ultrasound imaging quality, and the ability to quantify tissue mechanical properties. In the new system, we doubled the field of view through laterally shifted round-trip scanning. This new design allows coverage of the entire breast tissue. We also adapted precisely machined holders for the transducer-fiber bundle sets. The new holder increased the mechanical stability and facilitated image registration from the top and bottom scanners. The quality of the US image is improved by increasing the firing voltage and the number of firing angles. Finally, we incorporated quasi-static ultrasound elastography to allow comprehensive characterization of breast tissue. The performance of the new system was demonstrated through in vivo human imaging experiments. The experimental results confirmed the capability of the DSM-2 system as a powerful tool for breast imaging.

Biography:

Emily Zheng graduated with B.S. from the department of Biomedical Engineering at UB in 2020. She joined Dr.Xia's lab in Summer 2019 as a research assistant and was admitted to the PhD program in Fall 2020. Emily is a 2020 Schomburg fellow and currently works on breast cancer imaging.

Deep image prior for undersampling high-speed photoacoustic microscopy

Tri Vu[1], Anthony DiSpirito III[1], Daiwei Li[1], Zixuan Wang[3], Xiaoyi Zhu[1], Maomao Chen[1], Laiming Jiang[4], Dong Zhang[2], Jianwen Luo[2], Yu Shrike Zhang[3], Qifa Zhou[4], Roarke Horstmeyer[5], and Junjie Yao[1*]

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[2] Department of Biomedical Engineering, Tsinghua University, Beijing, China, 100084
[3] Division of Engineering in Medicine, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Cambridge, MA 02139 USA
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[5] Computational Optics Lab, Duke University, Durham, NC 27708 USA

Abstract— **Photoacoustic microscopy (PAM) is an emerging imaging method combining light and sound. However, limited by the laser's repetition rate, state-of-the-art high-speed PAM technology often sacrifices spatial sampling density (*i.e.*, undersampling) for increased imaging speed over a large field-of-view. Deep learning (DL) methods have recently been used to improve sparsely sampled PAM images; however, these methods often require time-consuming pre-training and large training dataset with ground truth. Here, we propose the use of deep image prior (DIP) to improve the image quality of undersampled PAM images. Unlike other DL approaches, DIP requires neither pre-training nor fully-sampled ground truth, enabling its flexible and fast implementation on various imaging targets. The DIP network acts as a parametrization, which iteratively seeks an optimized, fully sampled image that approximates the undersampled image, given a known downsampling mask. The DIP model learns features of the distorted images from the applied convolutional filters, and then imposes these implicit traits (*i.e.*, prior) on the restored output. Our results have demonstrated substantial improvement in PAM images with as few as 1.4 % of the fully sampled pixels on high-speed PAM. Our approach outperforms interpolation methods, and is competitive with pre-trained supervised DL methods. The reconstructed vascular images by DIP maintain a high level of connectivity and edge smoothness – key physiological features of blood vessels. Our DIP method provides a practical solution for high-speed PAM applications with severe undersampling and is readily translatable to other high-speed imaging modalities.**

Short Biography— **Tri Vu received his bachelor's degree in Biomedical Engineering from State University of New York at Buffalo. He is currently a PhD candidate at Department of Biomedical Engineering in Duke University. His research interests are high-speed small-animal photoacoustic imaging systems and photoacoustic image enhancement using deep learning.**

What communication challenges has COVID-19 brought into our lives?

Hye Yoon Seol AuD[1,2], Soojin Kang PhD[3], Ga-Young Kim PhD[2], Mini Jo BS[2], Sung Hwa Hong MD PhD[2,4], and Il Joon Moon MD PhD[2,5]

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[3]Korea School of humanities and social sciences, Korea Advanced Institute of Science and Technology, Daejeon, Korea
[4]Department of Otolaryngology-Head & Neck Surgery, Samsung Changwon Hospital, Changwon, Korea
[5]Department of Otolaryngology-Head & Neck Surgery, Samsung Medical Center, Seoul, Korea

Abstract— **The COVID-19 pandemic has led to unprecedented challenges in life. As social distancing and face mask became mandatory to prevent the spread of the virus, individuals, especially those with hearing loss (HL), faced the following challenges: (1) reduced sound energy and (2) loss of visual cues. Fabrics, common materials for face masks, absorb sound energy, so sounds become muffled. Visual cues, such as facial expression and gesture, are lost due to the face mask. In this study, the impact of a face mask on speech recognition in noise is explored. Seven individuals with normal hearing (NH) and 10 with HL completed puretone audiometry and speech-in-noise (SIN) testing. The SIN testing was performed in a semi-anechoic chamber using a video of a female and a male speaker saying the Korean Standard Sentences Lists for Adults (KSSL-A) with (mask condition) and without (no mask condition) a face mask. Participants were instructed to listen to the KSSL-A sentences in noise and repeated them back to the tester. The presentation level of the target speech and noise was 50 dBA (0 dB signal-to-noise ratio). For the NH group, the Wilcoxon signed-rank test revealed no significant difference between no visual cues and visual cues conditions for the no mask and mask conditions. However, statistical difference between no visual cues and visual cues conditions for the no mask and mask conditions was obtained for the HL group ($P < 0.05$). Findings of the study showed that when it comes to speech recognition in noise, seeing the conversational speaker (visual cues) was beneficial for people with HL even if the speaker was wearing a face mask. These results are consistent with previous literature that visual cues positively affect speech understanding. Healthcare professionals should continue utilizing communication strategies when interacting with those with HL.**

Short Biography— **Hye Yoon Seol is a postdoctoral researcher at Samsung Medical Center and Medical Research Institute of Sungkyunkwan University School of Medicine. She received BS in Speech and Hearing Sciences at University of Washington and AuD (Doctor of Audiology) at University of Wisconsin-Madison. Her research focuses on hearing technology, virtual reality, and tinnitus.**

Innovative heuristic algorithm in wavefront shaping – parameter-free algorithm

Qi Zhao[1], Chi Man Woo[1], Huanhao Li[1], Tianting Zhong[1], Zhipeng Yu[1], and Puxiang Lai[1*]

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Abstract

Light plays an important role in modern biomedicine. Optical focusing and imaging is an essential part of biomedical imaging. However, since biological tissue is highly scattering, we have to properly shape the wavefront so that light can be focused inside/through biological tissues. Over the past decade, iterative wavefront shaping has been widely adopted by researchers due to its simple experimental setup and ease of integration with other systems, and successful optical focusing through scattering media and various related applications have been demonstrated. However, for different heuristic algorithms, including genetic algorithm (GA), particle swarm optimization (PSO), bat algorithm (BA), etc., the final performance (e.g., peak-to-background ratio (PBR)) strongly depends on the choice of parameters. Researchers need to spend quite some time tuning the parameters to suit different scattering media or experimental conditions, including different noise levels. In addition, the users' experience and luck can also affect the final optimization results. In this work, we introduce a parameter-free algorithm (PFA) for iterative wavefront shaping that can automatically adjust the parameters and achieve high PBR after focusing inside/through scattering media. PFA is a hybrid algorithm that adopts the general framework of GA, the optimal solution finding scheme of BA, and the mutation rate tuning process of dynamic mutation algorithm (DMA). The simulation and experiment results show that without a parameter-tunning process, PFA can outperform BA and GA. Therefore, it can save researchers a lot of time and effort in achieving optimal optical focusing performance inside/through scattering media.

Short Biography

Qi Zhao is currently a Ph.D. student at The Hong Kong Polytechnic University, Department of Biomedical Engineering. He obtained the Master's Degree from Tsinghua University (China) in 2020 and the Bachelor's Degree from Northwestern Polytechnical University (China) in 2017. His research interests focus on optical wavefront shaping, heuristic algorithms, and deep learning.

High-resolution photoacoustic microscopy with deep penetration through learning

Shengfu Cheng[1,2], Yingying Zhou[1,2], and Puxiang Lai[1,2]

[1] Department of Biomedical Engineering, The Hong Kong Polytechnic University, Hong Kong SAR
[2] The Hong Kong Polytechnic University Shenzhen Research Institute, Shenzhen, China

Abstract— **Instruction for preparing an abstract for IFMBE Conferences is presented. Provide an abstract of your paper no longer than 300 words.**

Optical-resolution photoacoustic microscopy (OR-PAM) enjoys superior spatial resolution and has received intense attention in recent years. The application, however, has been limited to shallow depths because of strong scattering of light in biological tissues. In this work, we propose to achieve deep-penetrating OR-PAM performance by using deep learning enabled image transformation on blurry living mouse ear images that were acquired with an acoustic-resolution photoacoustic microscopy (AR-PAM) setup. A generative adversarial network (GAN) was trained in this study and improved the imaging lateral resolution of AR-PAM from 54.0 µm to 5.1 µm, comparable to that of a typical OR-PAM (4.7 □ m). The feasibility of the network was evaluated with living mouse ear data, producing superior microvasculature images that outperforms blind deconvolution. The generalization of the network was validated with in vivo mouse brain data. Moreover, it was shown experimentally that the deep-learning method can retain the high resolution at depths beyond one optical transport mean free path. Whilst it can be further improved, the proposed method provides new horizons to expand the scope of OR-PAM towards deep-tissue imaging and wide applications in biomedicine.

Short Biography— **Please include the short biography of a presenting author.**

Shengfu Cheng is a PhD student at the Department of Biomedical Engineering in the Hong Kong Polytechnic University. He received his Bachelor degree from Sichuan University. His research interests include deep learning application for photoacoustic imaging and multimode fiber based endoscopy.

식품의약품안전처

혁신의료기기 지정제도

혁신의료기기란?

"혁신의료기기"란 「의료기기법」 제2조제1항에 따른 의료기기 중 정보통신기술, 생명공학기술, 로봇기술 등 기술집약도가 높고 혁신 속도가 빠른 분야의 첨단 기술의 적용이나 사용방법의 개선 등을 통하여 **기존의 의료기기나 치료법에 비하여 안전성·유효성을 현저히 개선하였거나 개선할 것으로 예상되는 의료기기로서 「의료기기 산업 육성 및 혁신의료기기 지원법」** 제21조에 따라 식품의약품안전처장으로부터 지정을 받은 의료기기를 말합니다.

사용적합성이란?

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03	국내외 제품 인허가를 받으시는 경우
04	검증된 공인시험기관에서 제품을 개선하고자 하는 경우
05	연구과제의 성과를 성취하고자 하는 경우

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장점

국내 최고의 의료 인프라

연구자 우선 지원

최상의 시설

국제공인 시험성적서

장소

서울대학교병원 융합의학기술원 9층 사용적합성평가실

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* A multicentre validation study of the deep learning-based early warning score for predicting in-hospital cardiac arrest in patients admitted to general wards. Resuscitation. 2021 Apr 22;163:.78-85

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오송첨단 의료복합단지

| 세계 최고 수준의 바이오클러스터 |

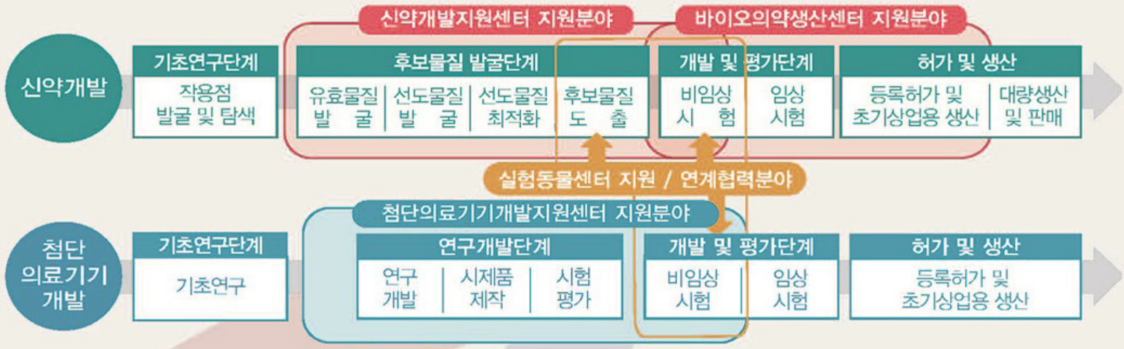
- 의료산업을 국가발전의 신성장동력으로 키워 나가기 위해 첨단의료로 특화된 연구개발단지
- 글로벌 신약과 첨단의료기기에 필요한 인적, 물적 인프라가 집적된 세계 최고수준의 의료연구개발 산업단지

편의시설 · 연구지원 CORE 인프라 · 바이오 메디컬시설 · 연구기관 · 보건의료 행정타운

오송첨단 의료산업 진흥재단

| 핵심 4개 센터 지원분야 |

- 바이오의약품 / 첨단의료기기의 연구 개발부터 인허가, 상용화까지 오송첨단의료산업진흥재단은 글로벌 수준의 우수 인력과 첨단 장비, 보건의료산업 사업화 지원 시스템을 통해 **'Death Valley' 를 극복하기 위한 지원 서비스를 제공합니다.**



첨단의료기기 개발지원센터

| 비전 | 첨단의료기기 개발을 위한 글로벌 수준의 One-stop 서비스 지원

대·내외 협력 네트워크 구축

- 국내외 의료기기 관련 기관과 협력 체계 구축
- 심포지엄 및 학회 개최
- 첨단의료기기 개발을 위한 전문 인력 양성

인프라를 활용한 제품화 기술 지원

- 제품화를 위한 시제품제작
- 장비 및 시설을 활용한 기술 지원
- 시제품의 안전성, 성능, 생체적합성, 전자파 시험검사

BT기반 의료기기 공동연구개발 지원

- 인체삽입형 3,4등급 의료기기 집중 지원
- 수요자 맞춤형 공동연구개발
- 기반기술구축 공동연구개발

산업체수요조사

- 의료기기 시장 및 기술 동향
- 의료기기 IP 현황
- 의료기기 클러스터 정책 동향

| 주요업무 |

기초연구	연구개발	시제품제작	시험평가	임상 및 상용화
산·학·연 기초연구 시장분석	〈기술지원〉 미래선도형 핵심기술 수요자맞춤 공동기술 인프라를 활용한 공동연구수행	시설장비 활용 시제품 제작 지원 · 설계 해석 · 3D 조형제작 · 초정밀가공 및 측정 · 핵심부품 정밀가공	· 의료기기 인·허가 시험지원 · 의료기기 비임상시험(GLP)지원 · 국제공인시험(KOLAS) 지원	임상시험 품목허가 생산판매

| 지원방향 및 역할 |

국내 의료기기 기업의 시장 진입을 위한 인프라 지원, 애로기술 해결, 성능/신뢰성 강화 등 제품화 중심의 One-stop Total Solution 지원

[공동연구개발] 기초 R&D 기술검증 및 제품화 애로기술 해결 지원

[설계·시제품 제작] 의료기기 설계 및 해석을 통한 시작품 및 시제품 제작, 초정밀 가공을 통한 광학계 제작 지원

[시험검사 및 평가] 품목허가를 위한 시험검사, 성능·신뢰성평가 및 전임상시험 지원

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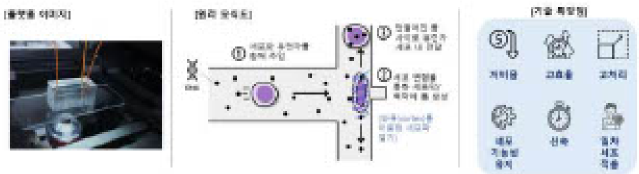
MxT Biotech은 고려대학교 바이오의공학부 정아람 교수 연구실 창업 기업으로, 미세유체 기반 세포 내 물질 전달 원천기술인 "유체천공기"(Hydroporator™)를 이용하여 암 면역치료에 새로운 방향을 제시하고자 합니다.

Hydroporator™ (유체천공기)

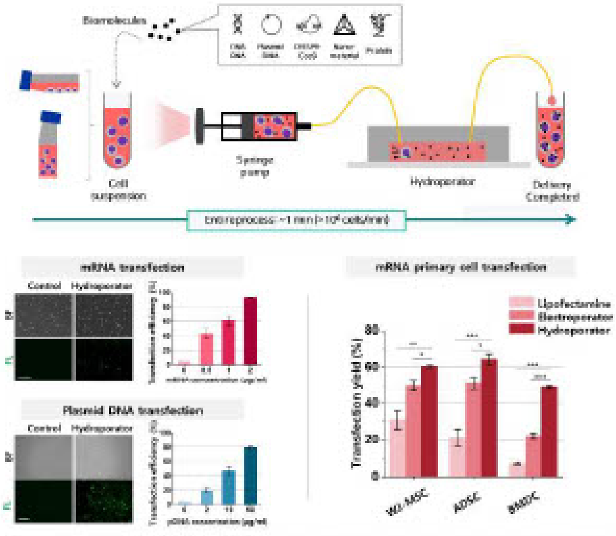
유체천공기는 미세유체관(microfluidic channel) 내에서 일어나는 특이적 유동을 이용하여 세포막과 핵막을 열어 그 속으로 외부 유전자를 전달하는 기기입니다. 본사는 유체천공기를 활용하여 유전자 편집을 통한 고효능 암 면역 세포 치료제 및 치료제 생산플랫폼을 개발하여 현재 바이러스 기반의 세포치료제 시장의 패러다임을 바꾸고자 합니다.



Simple, Rapid & High Performance

유체천공기는 사용자 위주의 간편한 시스템 구성 및 프로세스를 특징으로 일반인도 손쉽게 이용 가능합니다. 그리고, 분당 10^6-10^7개 이상의 세포를 연속적으로 신속하게 처리할 수 있는 고처리 플랫폼입니다.

최근 보고한 연구 논문(ACS Nano, 2020)에서는 유체천공기를 사용하여 mRNA와 plasmid DNA의 고효율 전달 및 형질변환(transfection)이 가능함을 입증하였으며, 경쟁 기술인 지질입자(Lipofection) 및 전기천공(Electroporation) 기법들과 비교함에 있어 전달/형질변환 효율의 비교우위를 확인하였습니다. 또한, 일차 줄기 및 면역세포(primary stem and immune cell)에도 적용 가능함을 확인하여 높은 활용성을 입증하였습니다.



- Hur, J., Park, I., Lim, K.M., Doh, J., Cho, S.-G., Chung, A.J., ACS Nano(2020)

Primary T cell transfection and biostability

인간의 혈액으로부터 채취한 T 세포를 이용하여 mRNA의 전달 및 형질변환에 대한 최적화 실험을 현재 진행중에 있으며, 다양한 유전체 분석을 통하여 프로세스의 안정성에 대하여 검증을 진행하여 세포 치료제 생산 플랫폼으로서의 가능성을 입증하고 있습니다.

Contact

본사는 유전자 전달 이외에 단백질, 나노입자, 유전자 가위 물질 등의 세포 내 물질 전달에 대한 우수한 연구결과를 확보하였으며, 이를 활용하는 다양한 공동연구와 함께 나아갈 파트너 또한 찾고 있습니다. 앞으로 많은 성원과 관심 부탁드립니다.

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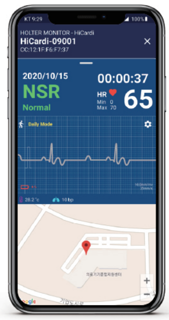
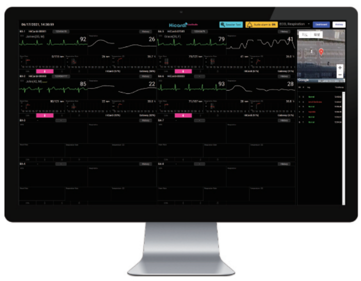


SmartView



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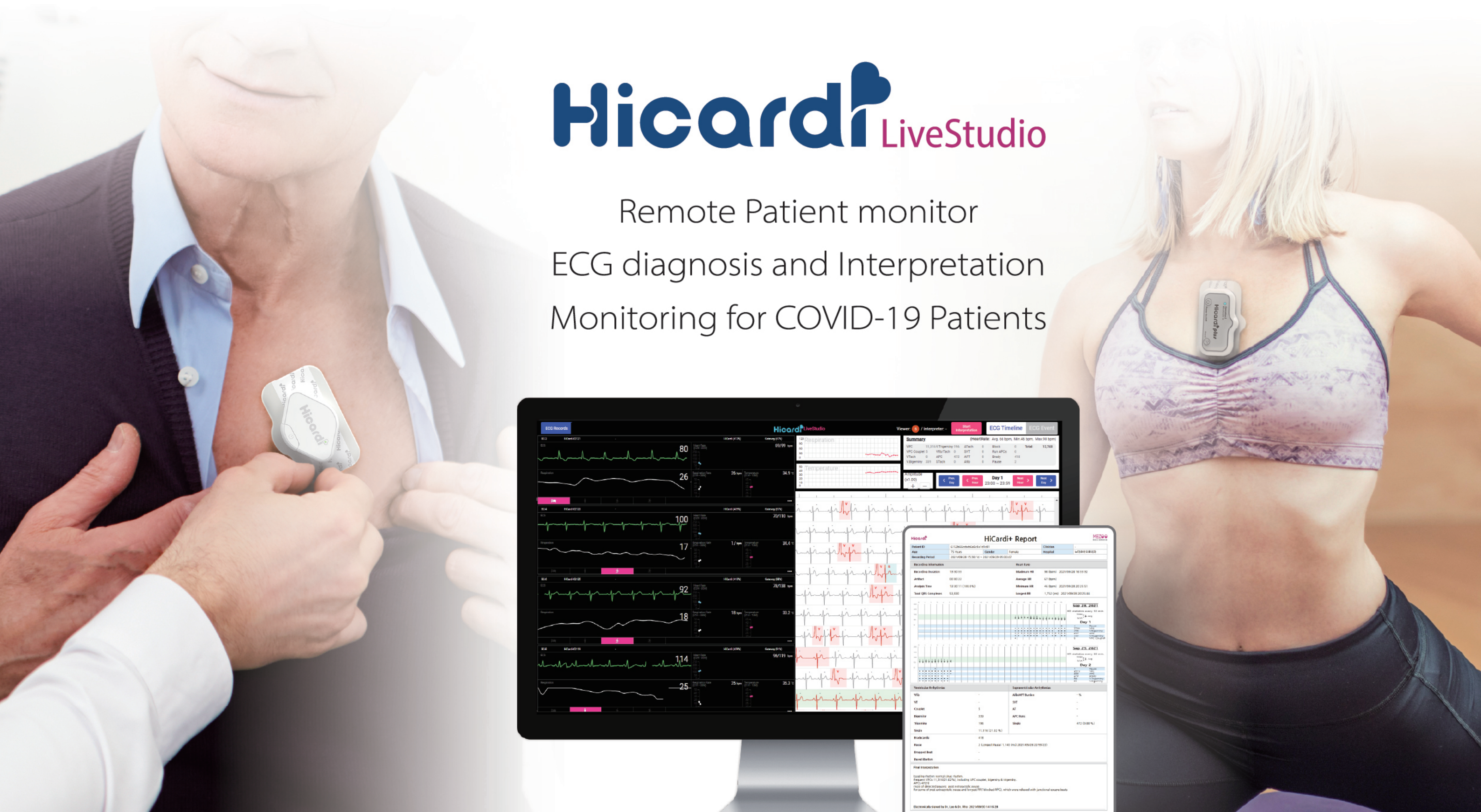

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제조사 : ㈜비스토스
경기도 성남시 갈마치로 302
우림라이온스밸리 5차 7층

Tel : 031-750-0340
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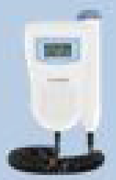
Website : www.bistos.co.kr
E-mail : domestic@bistos.co.kr

Fetal Monitor & Doppler


BT-350L


BT-380


BT-250

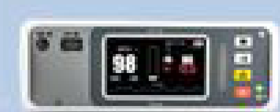

BT-200L


BT-220C


BT-200V(Vascular)

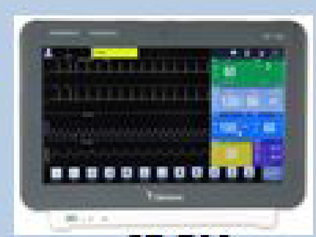
Patient Monitor


BT-710
(Puls Oximeter)

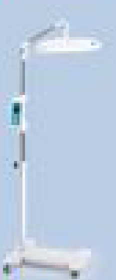

BT-720
(Vital Sign)


BT-740
(8.4")


BT-770
(12.1")

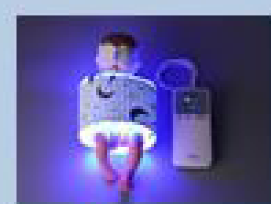

BT-780
(15.6" Patient Monitor)

Neonatal Care


BT400
(Photottherapy)


BT-500
(Infant Incubator)


BT-550
(Infant Warmer)


BT-450
(Bilibl anket)

ETC



Medical Head Lamp



Breast Pump