THE HONG KONG INSTITUTION OF ENGINEERS
香港工程師學會
Biomedical Division
生物醫學分部

BME2020
Biomedical Engineering Conference

Biomedical Engineering Conference BME 2020

Fighting COVID-19 and Future Pandemics with Innovation & Technology

27-28 November 2020

Co-organizer

機電工程署
EMSD

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BME2020
Biomedical Engineering Conference

Co-General Chairs' Message

Ir Prof Richard SO
The Hong Kong University of Science & Technology

Ir Raymond POON
Electrical and Mechanical Services Department

Welcome to BME 2020!

In March 2020, we faced a difficult decision to either cancel or postpone the conference or press ahead in the mist of raising COVID-19 cases. At the end, we decided to press ahead and switch the conference to online mode. Although the pandemic is still with us, I am pleased to report that we have over 400 registered participants, 1 keynote presentation, 3 plenary talks, 24 regular papers and 11 posters from more than 10 different countries. The selection of submission has not been easy and we are proud to share that we have collected high quality scholarly works covering a wide range of topics from management (e.g., health system and hospital management, development of smart hospital), to passive protection (e.g., anonymous block chain contact tracking, geo-fencing, smart fever screening), to diagnosis (e.g. deep learning technology in diagnosis of 2019-nCoV), to patient care (e.g., innovations in ventilator technology and COVID-19 related medical products), and active protection (e.g., vaccine development, antimicrobial technologies).

As a discipline, biomedical engineers are proud to be able to stand on the front line with medical professionals to fight the pandemic. We are particularly pleased to share that our speakers hail from a wide range of backgrounds: Hospitals, NGOs, Governments, Industries and Academics. This unfortunate pandemic has drawn us together with one common goal to fight and triumph over the COVID-19 pandemic.

We hope you will be able to take a break from your busy schedule to learn from the leaders of the field. Last but not least, stay safe!

Ir Prof Richard SO
Co-General Chair, BME 2020
Past Chairman of HKIE Biomedical Division 2019/20

Ir Raymond POON
Co-General Chair, BME 2020
Past Chairman of HKIE Biomedical Division 2017/18

BME 2020 Committee

Conference Chairs of BME 2020

Ir Prof Richard SO, Co-General Chair
The Hong Kong University of Science & Technology

Ir Raymond POON, Co-General Chair
Electrical and Mechanical Services Department

Ir Bryan SO, Programme and Co-Area Chair
The Chinese University of Hong Kong

Ir Prof Raymond TONG, Co-Chair on Industry Area
The Chinese University of Hong Kong

Dr Kannie CHAN, Co-Chair on Clinical Engineering Area
The City University of Hong Kong

Dr Thomas LEE, Co-Chair on Research & Development Area
The Hong Kong Polytechnic University

International Technical Committee

Dr April CHOW
CUHK Medical Centre

Prof James GOH
National University of Singapore

Prof Johnson Chih-Chung HUANG
National Cheng Kung University

Prof CT LIM
National University of Singapore

Conference Organising Committee

Ir Prof Daniel CHOW, EdUHK
Ir Yorkie CHOW, DH
Ms Martha HAO, Wise Ally
Ir Dr LIN Yuan, HKU
Mr Will LEUNG, EMSD
Ir Dr CK LI, HKAAST
Ir Karon LO, Wise Ally
Ir Stanley SIU, EMSD
Ir Prof Min WANG, HKU
Prof Terence WONG, HKUST

Conference Secretariat of BME 2020
c/o Mr Will Leung
Email: bme2020hkie@gmail.com

Guests of Honour

Ir Alfred SIT Wing Hang, JP

Secretary for Innovation and Technology
The Government of the HKSAR

Mr Alfred Sit joined the Government as Assistant Electrical and Mechanical Engineer in 1984 and was promoted to Chief Electrical and Mechanical Engineer in 2001, to Government Electrical and Mechanical Engineer in 2007, to Deputy Director of Electrical and Mechanical Services in 2011. He was Director of Electrical and Mechanical Services and Electrical and Mechanical Services Trading Fund General Manager since October 2017. On 22 April 2020, Mr Sit was appointed Secretary for Innovation and Technology.

Mr Sit is an electrical engineer by profession and has over 30 years' experience in public administration. He is a fellow member of the Hong Kong Institution of Engineers. He was the President of the Hong Kong Institution of Facility Management and Chairman of the Biomedical Division of the Hong Kong Institution of Engineers.

Mr Sit holds the Associateship in Electrical Engineering from the Hong Kong Polytechnic and a master degree in Business Administration from The Chinese University of Hong Kong. He has also attended the Harvard Business School.

Ir Prof Pak Leung YUEN

President, HKIE

Ir Prof PL YUEN is the President of HKIE Session 2020/2021. He is a professional engineer working in the public hospital engineering sector in Hong Kong with more than three decades' experience. He started working in the Hong Kong Government's departments for public hospitals construction, operation and maintenance before joining the then-newly established Hospital Authority in the 90s. Currently, as part of the management of the Hospital Authority Head Office, he oversees all public hospital engineering facilities and related processes, from design and construction through to operation and maintenance. He also leads and supervises environmental and energy sustainability initiatives for both new and existing public hospitals, including two upcoming major projects for public hospital infrastructure development. He has won the US Association of Energy Engineers' (AEE) "Regional Energy Project of the Year Award" for Asia-Pacific Rim Region for different innovative energy-saving and cost-effective projects for three consecutive years.

Conference Programme

Webinar link to be found in Conference website (https://bme2020hkie.wixsite.com/bme2020)

NOV 27 FRIDAY

09:45 AM – 10:25 AM

Opening Ceremony & Remarks

Room 1

Ir Alfred SIT, Secretary of Innovation and Technology, Government of HKSAR
Ir Prof Pak Leung YUEN, President, HKIE
Ir Prof Richard SO, Co-General Chair, BME 2020 Conference

10:25 AM – 10:55 AM

Plenary Presentation 1

Room 1

Moderator: Ir Prof Daniel CHOW

Topic: Trends in HealthTech Innovations Shaping Biomedical Engineering Education

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

10:55 AM – 11:15 AM

Break

Time	Artificial intelligence and robotics Moderator: Dr Kannie CHAN | Room 1	Disease diagnosis, prevention, monitoring, treatment and therapy Moderator: Ir Prof Raymond TONG | Room 2
11:15 AM – 11:35 AM	Concurrent Session 1.1 **Artificial Intelligence Regulatory Requirements** **Dr Seil PARK** Assistant Director, Cardiovascular and Imaging Devices Division, National Institute of Food and Drug Safety Evaluation, Ministry of Food and Drug Safety, South Korea	Concurrent Session 1.2 **The Role of Hong Kong Medical Device Industry in terms of OBM, ODM, OEM and distribution against COVID-19** **Mr Rupert MOK** Secretary General, Hong Kong Medical and Healthcare Device Industries Association
11:35 AM – 11:55 AM	Concurrent Session 2.1 **Deep Learning Artificial Intelligence Applications in MRI** **Dr. Jiadi XU** Associate Professor, Russell H. Morgan Department of Radiology and Radiological Science, FM Kirby Research Centre, Kennedy Krieger Institute, School of Medicine, Johns Hopkins University	Concurrent Session 2.2 **A vaccine targeting the RBD of the S protein of SARS-CoV-2 induces protective immunity** **Dr Johnson LAU** Adjunct Professor, Department of Applied Biology and Chemical Technology, The Hong Kong Polytechnic University
11:55 AM – 12:15 PM	Concurrent Session 3.1 **Latest Development on Endoluminal Robotic Assisted Surgery and Multi-Scale Medical Robotics Center** **Prof Philip CHIU** Associate Dean (External Affairs); Professor, Department of Surgery, Faculty of Medicine, The Chinese University of Hong Kong Director, Multi-Scale Medical Robotics Center	Concurrent Session 3.2 **Investigating the possible role of two-pore channels in SARS CoV-2 virus host cell infection using zebrafish as a model system** **Prof Andrew L MILLER** Professor, Division of Life Science and State Key Laboratory for Molecular Neuroscience, Hong Kong University of Science and Technology

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12:15 PM
12:45 PM

Plenary Presentation 2

Room 1

Moderator: Ir Bryan SO

Topic: A sharing of medical device risk management and COVID-19 impact on medical device

Ir Raymond FU
Director and Engineering Manager, Vincent Medical Manufacturing Co., Ltd.

Mr Charles CHU
Engineering Supervisor, Vincent Medical Manufacturing Co., Ltd.

12:45 PM
01:00 PM

Fast Forward Poster Section Presentation

Room 1

Moderator: Ir Prof Raymond TONG

P01: A Cloud-based Body Temperature Screening System
Kwong Chiu FUNG
The Hong Kong University of Science and Technology

P02: Rapid Histopathological Imaging by Microscopy with Ultraviolet Surface Excitation using Speckle Illumination
Ivy, Hei Man WONG
Translational and Advanced Bioimaging Laboratory,
Department of Chemical and Biological Engineering,
Hong Kong University of Science and Technology

P03: Interhemispheric Functional Reorganization and Its Structural Base after BCI-Guided Upper-Limb Training in Chronic Stroke
Kai YUAN
The Chinese University of Hong Kong

P04: Rapid temperature screening and suspect tracking in a moving crowd
Jing Wei Nick CHIN
The Hong Kong University of Science and Technology

P05: Verification of Finger Joint Stiffness Estimation Method with Soft Robotic Actuator
Xiangqian SHI
The Chinese University of Hong Kong

P06: Exoskeleton Knee Robot-assisted Gait Training for persons after stroke
Cathy CY LAU
The Chinese University of Hong Kong

P07: A Machine-Learning-Based Predictor for the Multi-Aetiological Knee Osteoarthritis with Clinical Data
Lok Chun CHAN
Department of Biomedical Engineering, The Hong Kong Polytechnic University

P08: Determination of optimal way to dendritic cells' priming with tumor antigens for enhanced cytotoxic activity of CIK cells
Assel ISSABEKOVA
National Center For Biotechnology, Nur-Sultan, Kazakhstan

01:00 PM
02:45 PM

Lunch Break

02:45 PM
03:15 PM

Keynote Presentation 1

Room 1

Topic: COVID-19 from local to global

Prof Paul KS CHAN
Clinical Professor and Chairman of the Department of Microbiology | Deputy Director of the Stanley Ho Centre for Emerging Infectious Diseases, Faculty of Medicine, The Chinese University of Hong Kong

Time	Disinfection and personal protective equipment Moderator: Ir Bryan SO | Room 1	Research, development and management of medical devices Moderator: Ir Stanley SIU | Room 2
03:15 PM 03:35 PM	Concurrent Session 4.1 **Smart antimicrobial technologies for a healthy environment** **Prof King Lun YEUNG** Professor, Department of Chemical and Biological Engineering, Division of Environment and Sustainability, The Hong Kong University of Science and Technology	Concurrent Session 4.2 **Rapid Automated Multiplex Diagnostic System for Testing Infectious Respiratory Diseases** **Prof Terence LAU** Interim Associate Vice President (Innovation and Technology Development) | Director of Innovation and Technology Development, The Hong Kong Polytechnic University
03:35 PM 03:55 PM	Concurrent Session 5.1 **Restoring Public Confidence Back to Normal** **Dr. CH WONG** Director of Science of Avalon Steritech	Concurrent Session 5.2 **Design and development of a ventilator for low resource countries** **Ir Dr Anthony CHAN** Program Head, Biomedical Engineering Technology Program, British Columbia Institute of Technology Canada
03:55 PM 04:15 PM	Concurrent Session 6.1 **Healthcare Innovations on Medical Face Masks & Respirators** **Mr Kevin ORR** Group Vice President & CIO, Winner Medical Group	Concurrent Session 6.2 **Transdermal delivery of Receptor-Binding Domain of SARS-CoV-2 Spike protein with dissolvable microneedle skin patch** **Prof Chenjie XU** Associate Professor, Department of Biomedical Engineering, City University of Hong Kong

04:15 PM
04:30 PM

Break

04:30 PM
05:00 PM

Plenary Presentation 3 — Room 1

Moderator: Ir Karon LO

Topic: Healthcare Infrastructure Resilience in time of Pandemics

Mr Chee Keong LIM

Healthcare Solution Architect - East Asia & Japan Zone
Schneider Electric

05:00 PM
05:15 PM

Closing Remark — Room 1

Ir Raymond POON, Co-General Chair, BME 2020 Conference

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NOV 28 SATURDAY

	Healthcare system and infrastructure Moderator: Prof Terence WONG | Room 1	Healthcare data management Moderator: Dr Thomas LEE | Room 2
09:30 AM 09:50 AM	Concurrent Session 7.1 **Development of Singapore's National Centre for Infectious Diseases (NCID)** Mr Stephen LOH Chief Development Officer, Tan Tock Seng Hospital, Singapore	Concurrent Session 7.2 **Innovation, the Smart Hospital and COVID 19** Mr Kevin CAI Chief Information Officer, Hospital Authority
09:50 AM 10:10 AM	Concurrent Session 8.1 **Evidence-Based Maintenance of Medical Equipment** Dr Binseng WANG Vice President, Program Management, Sodexo Health Technology Management	Concurrent Session 8.2 **Post-pandemic Travel with a Blockchain Immunity Passport** Mr Eric CHAN Chief Architect of Open Platform, WeBank
10:10 AM 10:30 AM	Concurrent Session 9.1 **Management of Medical Devices in Clinical Setting in Combatting Infectious Diseases** Mr Eric WOO Regional Director, Asia Pacific, ECRI	Concurrent Session 9.2 **IoT Geofencing and Contact Tracing to Fight Against Covid-19** Prof Gary CHAN Professor, Department of Computer Science and Engineering, The Hong Kong University of Science and Technology
10:30 AM 10:45 AM	Break	

	In-vitro diagnostics and rapid screening Moderator: Prof Terence WONG | Room 1	Precision healthcare Moderator: Ir Dr Yuan LIN | Room 2
10:45 AM 11:05 AM	Concurrent Session 10.1 **Guiding COVID-19 vaccine design using genetic data analysis** Prof Matthew MCKAY Professor, Department of Electronic & Computer Engineering | Department of Chemical & Biological Engineering, The Hong Kong University of Science and Technology	Concurrent Session 10.2 **Phylogeny and Transmission tracing of SARS-CoV-2 in Hong Kong** Dr Gilman SIU Associate Professor Department of Health Technology and Informatics, The Hong Kong Polytechnic University
11:05 AM 11:25 AM	Concurrent Session 11.1 **AI Diagnostic System for COVID-19 Pneumonia** Prof Kang ZHANG Faculty of Medicine, Macau University of Science and Technology	Concurrent Session 11.2 **Wearable device supporting smart social distancing in hostel** Mr Yiu Chau TAM Master of Philosophy Student, Department of Biomedical Engineering, The Hong Kong Polytechnic University
11:25 AM 11:45 AM	Concurrent Session 12.1 **Closed-loop inertial microfluidics for deformability-based sorting under continuous flow** Ms Junchen LIAO Ph.D. candidate, Department of biomedical engineering, City University of Hong Kong	Concurrent Session 12.2 **Automated analysis of COVID-19 from CT images via Semi-supervised Deep Learning** Dr Huang-Jing LIN Director of Research & Development, Imsight Medical Technology Co. Ltd
11:45 AM 11:50 AM	Closing Remark Ir Prof Raymond TONG, BME 2020 Conference Co-Chair on Industry Area	Room 1

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Keynote & Plenary Speakers

BME2020
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Keynote Speaker

Prof Paul KS CHAN

MBBS MSc(Virology) MD FRCPath FHKCPath FHKAM

Chairman, Department of Microbiology,
Faculty of Medicine, The Chinese University of Hong Kong

Professor Paul Chan is Clinical Professor and Chairman of the Department of Microbiology, Deputy Director of the Stanley Ho Centre for Emerging Infectious Diseases, and Associate Director of the Centre for Gut Microbiota Research, Faculty of Medicine, The Chinese University of Hong Kong. He is also Honorary Consultant in Microbiology for the New Territories East Cluster Hospitals of Hong Kong Hospital Authority. Professor Chan is a renowned clinical virologist with special interest in tumour virology, human respiratory viruses and microbiome. He serves many key professional bodies in Hong Kong, including as Chairman of Scientific Committee on Vector-borne Disease of the Centre for Health Protection, Chairman of Grant Review Board of the Medical and Health Research Fund, and Chief Examiner of Clinical Microbiology and Infection of the Hong Kong College of Pathologists. Professor Chan is also a partner of the Global Outbreak Alert and Response Network. He is Editor-in-Chief of the Journal of Virological Methods. Professor Chan has published 14 book chapters and more than 385 scientific papers, and attained an H-index of 66.

URL:	http://www.cuhk.edu.hk/med/mic/People/Paul.html
ORCID:	http://orcid.org/0000-0002-6360-4608
ResearcherID:	http://www.researcherid.com/rid/J-9360-2013

Keynote Presentation

COVID-19: FROM LOCAL TO GLOBAL

Room 1 | 02:45 PM to 03:15 PM | 27 November 2020

Abstract:

This talk presents the detailed epidemiological features of the first two waves of COVID-19 outbreaks with a total of 1038 cases experienced in Hong Kong, an international city in proximity to the first epicentre of COVID-19. Up to 25 April 2020, the incidence and mortality of COVID-19 in Hong Kong (135.5 and 0.5 per 1,000,000 population) was still amongst the lowest in the world. Aggressive escalation of border control was an important containment measure correlated with reductions in case reproductive numbers from 1.35 to 0.57 and 0.92 to 0.18, and an estimated aversions of 450 and 1,650 local infections during the first and second wave, respectively. Super-spreading events were rare, whereas small clusters were mainly family gatherings in the first wave, or youngster leisure activities in the second wave. Male gender of all age groups was associated with higher incidence, and men were more likely to have longer delay in diagnosis. Large-scale testing was a key to successful containment. The various options of self-collect specimens have their pros and cons, and a combination may be needed according to the target group and laboratory method being applied. As the pandemic is progressing, the culprit virus SARS-CoV-2 keeps evolving. A new lineage carrying a signature mutation over the surface protein, D614G, started to displace other older lineages in March 2020. The global spread of this new variant seems correlate with containment capacity of the country and could associate with higher transmissibility and severity.

Plenary Speaker

Prof James GOH

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

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). He chairs the Science and Technology Advisory Board of the Singapore Sports Institute. 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). 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.

Plenary Presentation 1

Trends in HealthTech Innovations Shaping Biomedical Engineering Education

Room 1 | 10:25 AM to 10:55 AM | 27 November 2020

Abstract:

Biomedical Engineering (BME) is one of the fastest growing disciplines in the past few decades. It has contributed tremendously to the medical field. However, healthcare industries landscape is changing rapidly due to multiple factors, ie healthcare economics leading to reformation in the healthcare system, major trends in public health, continuing advances in our understanding of human biology that has the potential impact on medical practice and the development of new innovative technologies for effective and precise diagnosis, treatment and monitoring. With advances in technology, in particular the development wearables, data analytics, IoT, artificial intelligence and coupled with industry 4.0, the future of medicine would be very different. The proliferation of health centric devices and digital health will certainly give rise to connected health with increased fitness awareness. Aside from the digital revolution, multi-scale bioengineering approaches are also making impact in healthcare and medicine. As such the field of medical and biological engineering can play a huge role in scientific innovation and translating invention to practice, so as to enhance the healthcare interventions. Therefore, while it is important for BME undergraduate degree program to produce engineers with a strong foundation in the relevant engineering, sciences and technology, it is perhaps as important to emphasize innovation, enterprise and leadership in the BME curriculum. Future BME program will need to have a high degree of flexibility that can provide a wide diversity of educational experiences. By providing graduates with a combination of broad-based fundamentals and specialized knowledge, the BME program strives to graduate versatile biomedical engineers that would be best positioned to lead and be an integral part of the BME industries. This can be facilitated by utilizing effective an efficient pedagogical approach in our teaching. BME program needs to address and respond to the rapid changes in technologies and ensuring our graduate remain relevant to the industry. Therefore, students need skills to understand complex issues of biomedicine and to develop and implement of advanced technological applications to these problems. BME program should provide opportunity for students to develop their marketability to employers, ie through internships, overseas exchange programs, and involvement in leadership-type activities. BME curriculum must be designed and developed with biomedical innovation in mind, that ensures relevance to the industry.

Plenary Speakers

Ir Raymond FU

Director and Engineering Manager
Vincent Medical Manufacturing Co., Ltd.

Ir. Raymond Fu obtained a bachelor's degree in Engineering from the University of Hong Kong in 1997 and a master's degree in Business Administration from the Hong Kong Polytechnic University in 2009. He currently serves as the Vice President of Engineering of Vincent Medical Manufacturing Co., Ltd. and is primarily responsible for overseeing the R&D and initiating product development through integrating technologies and techniques.

Mr Charles CHU

Engineering Supervisor
Vincent Medical Manufacturing Co., Ltd.

Mr. Charles Chu completed his Bachelor of Engineering in Medical Engineering from the University of Hong Kong in 2006. He currently serves as the Engineering Supervisor of Vincent Medical Manufacturing Co., Ltd., and handles various medical device development and manufacturing projects of the company.

Plenary Presentation 2

A sharing of medical device risk management and COVID-19 impact on medical device

Room 1 | 12:15 PM to 12:45 PM | 27 November 2020

Abstract:

Use of a medical device entails some degree of risk to patient, operator, other persons, other equipment and the environment, and can have impact on medical practitioners, the organizations providing healthcare, governments, industry, patients and members of the public. There is a ISO14971 standard published to guide medical device manufacturer to establish a process for managing risks, which consists of identify hazards associated with a medical device, estimate and evaluate the risks of the hazards, control the risks and monitor the effectiveness of the controls. The presentation aims to give an overview of the ISO14971 risk management process and discuss the impact of COVID-19 on medical devices.

Plenary Speaker

Mr Chee Keong LIM

Healthcare Solution Architect - East Asia & Japan Zone
Schneider Electric

Chee Keong LIM is a Solution Architect in healthcare and responsible for the East Asia and Japan region. His role is to enable the business to fully understand and meet the needs of the modern healthcare environment by developing the most appropriate and beneficial technology solutions for healthcare organizations across a broad portfolio of technologies and services. He brings over 20 years of experience in the controls industry and has been involved in many complex projects involving the design and operations of medical facilities, laboratory and clean room applications. CK has used this knowledge to develop innovative solutions and engineering standards for Schneider Electric's healthcare offer.

Plenary Presentation 3

Healthcare Infrastructure Resilience in time of Pandemics

Room 1 | 04:30 PM to 05:00 PM | 27 November 2020

Abstract:
Resilience acknowledges that massive disruptions can and will happen – in future, climate disruption will likely compound other shocks like pandemics – and it is essential that core systems have the capacity for recovery and adaptation to ensure their survival, and even take advantage of new or revealed opportunities following the crises to improve the system through broader systemic changes. The new approach to resilience will focus on the ability of a system to anticipate, absorb, recover from, and adapt to a wide array of systemic threats.

Invited Speakers

Invited Speaker

Dr Seil PARK

Assistant Director, Cardiovascular and Imaging Devices Division,
National Institute of Food and Drug Safety Evaluation,
Ministry of Food and Drug Safety, South Korea

Concurrent Session 1.1 | Room 1 | 11:15 AM to 11:35 AM | 27 November 2020

Artificial Intelligence Regulatory Requirements

Education

Ph.D. degree in Electrical engineering, specializing in plasma-bio display and earned his master's in electric engineering and bachelor's degree(BS) in electronic communication engineering.

Experience

He served AHWP as an AHWP Executive Deputy Secretary General for 3 years(2015-2017), and now has a role for Chair on AHWP WG1 which is General Medical Device(pre-market approval) for three years(2018-2020). He is an experienced engineer for 18 years. He has an advanced knowledge and also participated in standardization as a project leader for 4 years. Prior to working in Korea MFDS, he worked in one of testing laboratories in Korea as a senior researcher, in charge of various assignments related to international standards.

Publications

Many Guidelines related to Medical Device technical documents.

Invited Speaker

Mr Rupert MOK

Secretary General
Hong Kong Medical and Healthcare Device Industries Association

Rupert Mok graduated in the Master of BioMedical Engineering at University of New South Wales, Australia in 1984 and has developed his career in the field of medical devices with various roles as service engineer, sales & marketing executive, general manager and regional marketing manager in Asia Pacific for multinational companies.

His specialty is in cardiology with experience in diagnostic and monitoring equipment, ultrasound scanners, heart-lung machine for open heart surgery, vascular balloons & stents in percutaneous coronary intervention (PCI) and implantable pacemakers and defibrillators.

Rupert participated in pacemaker implants operations in catherization theatre and follow up clinics. He interacted with doctors and patients to optimize the functions of pacemakers.

Rupert introduced remote monitoring (Cloud based) of heart failure patients with implantable defibrillators in Grantham Hospital and other Asia countries in 2011-2012.

Currently, Rupert focuses to contribute to the medical device industry and hold the following positions

- Vincent Medical Holdings Limited: Independent Non-Executive Director
- Innovation and Technology Commission: Member of the Innovation and Technology Fund (ITF) Research Project Assessment Panel (Biotechnology) and Enterprise Support Scheme (ESS) Assessment Panel Assessor
- Hong Kong Medical and Healthcare Devices Industry Association: Secretary General and Executive Board Member
- Hong Kong University of Science and Technology: Industrial Advisor on Undergraduate Program in BioEngineering

Based on Rupert's research, he presented
Topic "Development of Healthcare & Medical IOT Ecosystem during and after COVID-19" in

- Cloud Expo Asia 2020- IOTA & HKMHDIA Seminar

Topic "The Smart Wearable Medical Devices- Clinical Applications and Challenges" in various occasions including

- Ophthalmology Futures Forum
- Smart City by Hong Kong Productivity Council
- Engineering Medical Innovation (EMedI) Summit: Medicine for the Future 2016, The Chinese University of Hong Kong

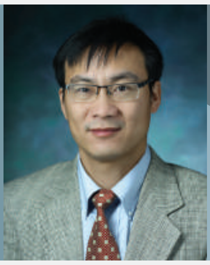
Concurrent Session 1.2 | Room 2 | 11:15 AM to 11:35 AM | 27 November 2020

The Role of Hong Kong Medical Device Industry in terms of OBM, ODM, OEM and distribution against COVID-19

Abstract:

Facing the COVID-19 pandemics, the medical device industry plays an important role to provide relevant products to the medical professions as well as the general public for the purposes of diagnosis, screening, quarantine, monitoring, treatment and prevention of the pandemics as soon as possible, such that the spread of disease can be minimised and the infected patients can be treated effectively. In this presentation, we select a few medical devices and healthcare related companies from Hong Kong and overseas which develop or enhance their products to suit this immediate need. Finally, we highlighted the attributes of mobile health and the challenges on developing mobile health medical devices.

Invited Speaker



Dr. Jiadi XU

Assistant Professor, Russell H. Morgan Department of Radiology and Radiological Science
FM Kirby Research Centre, Kennedy Krieger Institute
School of Medicine, Johns Hopkins University

Jiadi Xu, Ph.D., is an Assistant Professor at the Radiology Department, Johns Hopkins University as well as one MRI manager at Kennedy Krieger Institute. Dr. Xu received his PhD from the University of Manitoba, Canada, and completed a post-doctoral fellowship at the University of Michigan. He is a MR physicist who has been working in the MRI technical development and their applications in stroke, tumor and neurodegenerative diseases. He has published over 100 preferred papers at many well-known journals, such as Science, Nature Communications, Science Advances, Neuroimage, and so on. His publications have been cited more than 4800 times with a H-index of 35. He has received continues research funds from both National Institute of Health (NIH) and Department of Defense (DOD).

Concurrent Session 2.1 | Room 1 | 11:35 AM to 11:55 AM | 27 November 2020

Deep Learning Artificial Intelligence Applications in MRI

Abstract:

Deep learning artificial intelligence has emerged as the most potent technologies, that is transitioning the landscape of almost all engineering fields including magnetic resonance imaging (MRI). In this presentation, I would like to demonstrate the applications of deep learning technologies in several medical imaging areas such as disease detection, imaging reconstruction, and image synthesis. Particularly, I will introduce one novel sensitivity-enhancement MRI approach, chemical exchange saturation transfer (CEST) MRI for non-invasive mapping of energy metabolites such as creatine and phosphocreatine in the brain and muscle. How we will explore the artificial neural network approach to overcome many challenges of implementing the new technique on clinical MRI scanners. At last, the possible applications of MRI in fighting with the recent COVID-19 pandemic will be discussed.

Invited Speaker

Dr Johnson LAU

Adjunct Professor
Department of Applied Biology and Chemical Technology
The Hong Kong Polytechnic University

Dr LAU graduated from the Medical Faculty in the University of Hong Kong in 1984 and joined the University Medical Unit of the University of Hong Kong for Internal Medicine, Gastroenterology, and Hepatology training. He received MRCP in 1987 and received Croucher Foundation Fellowship to study Viral Hepatitis and Liver Transplantation at King's College London. Dr. LAU joined the faculty in the King's College London and later obtained in MD from the University of Hong Kong in 1992. In 1992, Dr LAU joined the faculty in the University of Florida and helped established one of the top Liver Transplantation programs in the US. He was also supported by National Institute of Health (NIH) for his research related to the pathogenesis of Hepatitis C and Dr LAU was also listed as a trainer on a number of the NIH training grants. He was also named the American Liver Foundation Hans Popper Liver Scholar and also an Investigator of the Glaxo Institute of Digestive Health. Dr LAU was also members of the editorial board of a number of scientific journals. In 1997, Dr LAU left academia and joined the pharmaceutical/biotechnology industry. Dr LAU was elected FRCP in 2004. Dr LAU has more than 250 scientific publications and editorials/reviews/chapters in peer reviewed scientific journals and has edited two books. Currently, Dr LAU is also an Adjunct Professor of the University of Hong Kong and Hong Kong Polytechnic University.

From the business side, Dr LAU is a successful pharmaceutical executive who has had extensive leadership experience in both scientific and business management. He has served as the Chairman of the Board of Athenex since its inception and assumed the role of CEO in 2011. Prior to Athenex, he launched the second largest biotech IPO in US history (USD 300 million) as Chairman and CEO of Ribapharm (NYSE). Prior, he served as the Head of Worldwide Research and Development for ICN Pharmaceuticals (NYSE) and the Senior Director of Antiviral Therapy at Schering-Plough. Lau was also recognized in 2010 as an Honoree for being an Asian American Visionary in the field of Pharmaceutical and Biotechnology by the Asia Society Southern California Chapter and also received Congressional, California Legislative Assembly, and the City of Los Angeles in the same year.

Concurrent Session 2.2 | Room 2 | 11:35 AM to 11:55 AM | 27 November 2020

A vaccine targeting the RBD of the S protein of SARS-CoV-2 induces protective immunity

Abstract:

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes a respiratory disease called coronavirus disease 2019 (COVID-19), the spread of which has led to a pandemic. An effective preventive vaccine against this virus is urgently needed. As an essential step during infection, SARS-CoV-2 uses the receptor-binding domain (RBD) of the spike protein to engage with the receptor angiotensin-converting enzyme 2 (ACE2) on host cells. Here we show that a recombinant vaccine that comprises residues 319–545 of the RBD of the spike protein induces a potent functional antibody response in immunized mice, rabbits and non-human primates (Macaca mulatta) as early as 7 or 14 days after the injection of a single vaccine dose. The sera from the immunized animals blocked the binding of the RBD to ACE2, which is expressed on the cell surface, and neutralized infection with a SARS-CoV-2 pseudovirus and live SARS-CoV-2 in vitro. Notably, vaccination also provided protection in non-human primates to an in vivo challenge with SARS-CoV-2. We found increased levels of RBD-specific antibodies in the sera of patients with COVID-19. We show that several immune pathways and CD4 T lymphocytes are involved in the induction of the vaccine antibody response. Our findings highlight the importance of the RBD domain in the design of SARS-CoV-2 vaccines and provide a rationale for the development of a protective vaccine through the induction of antibodies against the RBD domain.

Invited Speaker

Prof Philip CHIU

Associate Dean (External Affairs); Professor
Department of Surgery, Faculty of Medicine, The Chinese University of Hong Kong
Director, Multi-Scale Medical Robotics Center

Concurrent Session 3.1 | Room 1 | 11:55 AM to 12:15 PM | 27 November 2020

Latest Development on Endoluminal Robotic Assisted Surgery and Multi-Scale Medical Robotics Center

Philip Chiu is currently Professor of Division of Upper GI and Metabolic Surgery, Department of Surgery, Director of Multi-Scale Medical Robotics Center, Director of Endoscopy Center, Institute of Digestive Disease; Director of CUHK Jockey Club Minimal Invasive Surgical Skills Center; Director of CUHK Chow Yuk Ho Technology Center for Innovative Medicine and Associate Dean (External Affairs), Faculty of Medicine, Chinese University of Hong Kong. Professor Chiu graduated from Faculty of Medicine, Chinese University of Hong Kong in 1994 with two scholarships. He became a fellow of the Royal College of Surgeons of Edinburgh, Hong Kong Academy of Medicine in 2001 and received his Doctor of Medicine at CUHK in 2009. Prof. Chiu is first to perform endoscopic submucosal dissection (ESD) for treatment of early GI cancers in Hong Kong in 2004. In 2010, he performed first Per-oral Endoscopic Myotomy (P.O.E.M.) in Hong Kong as well as pioneering World first robotic gastric ESD in 2011. His research interests include esophageal cancer management, minimally invasive and robotic esophagectomy, novel endoscopic technologies for diagnosis of early GI cancers, endoscopic surgery as well as robotics for endoluminal surgery. He has published more than 200 peer reviewed manuscripts and 6 book chapters. He received numerous prestigious awards including State Scientific Technology and Progress Award from People's Republic of China in 2007, 2nd class award in Technological Advancement, Ministry of Education of the People's Republic of China in 2011. His research on POEM was awarded best of DDW 2011 and first prize of ASGE world cup of endoscopy 2012. He was selected as Asia Pacific Digestive Week JGHF Emerging Leader Lectureship in 2016 and Global Outstanding Chinese Youth 2016. He received the Gold Medal with Congratulations from Jury, 47th International Exhibitions of Inventions of Geneva in 2019 and Spirit of Hong Kong Award on Innovation in 2020. He is currently co-editor of Endoscopy and subject editor for Surgical Endoscopy.

Invited Speaker

Prof. Andrew L. MILLER

Professor
Division of Life Science and State Key Laboratory for Molecular Neuroscience
Hong Kong University of Science and Technology

Education

1983-1986	Ph.D.: "Electrical Control of Root Development", with Prof. J.A. Raven, FRS, FRSE, University of Dundee, Dundee, Scotland, UK
1982-1983	Britannia Royal Naval College, Dartmouth, South Devon, England, UK. Royal Navy Direct Graduate University Entrant. Rank: Acting Sub-Lieutenant
1978-1982	B.Sc. (Hons.) 1st Class, Botany, University of Dundee, Dundee, Scotland, UK

Research and Professional Experience

2010-Present	Professor	Division of Life Science and State Key Laboratory for Molecular Neuroscience, HKUST
2006-2010	Professor	Department of Biology, HKUST
2000-2006	Associate Professor	Department of Biology, HKUST
1995-2000	Assistant Professor	Department of Biology, HKUST
1992-1995	Principal Investigator	Marine Biological Laboratory (MBL), Woods Hole, MA 02543, USA.
1991-1995	Assistant Scientist	MBL, Woods Hole, MA 02543, USA
1988-1991	Post Doctoral position	In the laboratory of Dr. Lionel F. Jaffe at the MBL, Woods Hole, MA 02543, USA
1986-1988	Post Doctoral position	In the laboratory of Prof. Neil Gow, FRSE, in the Department of Cell and Molecular Biology, Marischal College, University of Aberdeen, Scotland, UK

Adjunct Appointments

2011-2014	Adjunct Senior Scientist	MBL, Woods Hole, MA 02543, USA
2014-2019	Adjunct Senior Scientist	Eugene Bell Center for Regenerative Biology and Tissue Engineering, MBL, Woods Hole, MA 02543, USA
2015-2017	Honorary Professor	Marine Science Centre, North Atlantic Fisheries College, University of the Highlands and Islands, Shetland Isles, ZE1 0UN, Scotland, UK

Investigating the possible role of two-pore channels in SARS CoV-2 virus host cell infection using zebrafish as a model system

Abstract:
We have begun to investigate whether members of a new pleiotropic cation family, known as two-pore channels (TPCs), which are found in membranes of the endolysosomal system, play any role in the regulation of SARS CoV-2 virus host-cell infection, as they have been recently reported to do with the Ebola and MERS-CoV viruses. If this is the case, then TPCs might prove to be a possible target for drug treatment and/or therapeutic intervention to limit SARS CoV-2 infection. We are making use of zebrafish (Danio rerio) as our experimental system because this is an in vivo, genetically amenable, inexpensive vertebrate model, which has previously been used to study viral infections among a wide range of disorders and diseases. In this regard, we will make use of 5-day old zebrafish larvae in a high-throughput system for screening novel TCM-derived and synthetically developed TPC antagonists. We will also explore the re-purposing of currently available drugs that may have an efficacious effect via attenuation of TPC- associated signaling pathways. Thus, we will infect zebrafish larvae with a SARS CoV-2 pseudovirus that expresses a luciferase reporter gene. This will be used as an in vivo platform to support a proposed link between TPC-mediated signaling, SARS CoV-2 host-cell entry and endolysosomal-translocation. We plan to focus our attention on infection of the zebrafish swim bladder as this air-filled organ has phylogenetic links with the terrestrial tetrapod lung. Our preliminary data indicate that two isoforms of TPCs are expressed swim bladder epithelial tissue. To help in our investigation, we have already established lines of fish where TPCs have been knocked-out using CRISPR-Cas9-mediated gene editing and developed morpholino oligomers to knock-down TPC activity. Should a link between TPCs and SARS CoV-2 host-cell infection be established, we will then utilize the zebrafish platform to initiate a search for novel compounds and re-purposed drugs that attenuate TPC activity in an in vivo system. This might help in the identification of novel pharmacological approaches to moderate the spread of Covid-19. In summary, we expect to: (1) Identify TPCs as a new molecular target for therapeutic intervention with respect to SARS CoV-2 infection; (2) Help establish the zebrafish as a complementary model to study viral infection; and (3) Identify novel TPC-targeted compounds and repurpose existing drug candidates to attenuate the spread of Covid-19.
This work is funded by the Hong Kong Health and Medical Research Fund award: HMRF20SC07.

Invited Speaker

Prof King Lun YEUNG

Professor, Department of Chemical and Biological Engineering
Division of Environment and Sustainability
The Hong Kong University of Science and Technology

Professor King Lun Yueng is a Professor of the Department of Chemical and Biological Engineering and Division of Environment and Sustainability at The Hong Kong University of Science and Technology. He obtained his Ph.D. in Chemical Engineering from the University of Notre Dame.

He is the Director of the HKUST-CIL Joint Laboratory of Innovative Environmental Health Technologies, the HKUST ENVF-INA/LMA Joint Laboratory of Environment, and the France-HKUST Innovation Hub. He was the Associate Dean of the School of Engineering and Director of the Technology Leadership and Entrepreneurship Program (2014-2018).

He is a recipent of the 2020 Chief Executive's Commendation for Community Service for the Outstanding Contribution to the Fight Against COVID-19. The 2018 Gold Medal in the 36th International Exhibition of Inventions in Geneva and the 2015 Google Solve for X Moonshot.

Concurrent Session 4.1 | Room 1 | 03:15 PM to 03:35 PM | 27 November 2020

Smart antimicrobial technologies for a healthy environment

Abstract:
Airborne respiratory diseases cause some of the most devastating epidemics and pandemics of the last century. Today, the world is in the grip of COVID-19 pandemic, with more than 58 million people infected with the disease and close to 1.4 million hospitalized deaths since it was declared a pandemic by the World Health Organization. Besides its human toll, the economic cost of the pandemic is staggering with an estimated cost upward of US$8 to US$16 trillion. There is an urgency to develop new and effective technologies to mitigate the spread of COVID-19 and other infectious respiratory diseases. New technologies that address the spread of pathogens by aerosols, droplets, and fomites are addressed using a new generation of smart antimicrobials that response to contamination by rapid disinfection attacking different biological compartments of the microorganisms along different inactivation pathways. This approach also prevents microbial tolerance and resistance.

Invited Speaker

Prof Terence LAU

Interim Associate Vice President (Innovation and Technology Development) |
Director of Innovation and Technology Development
The Hong Kong Polytechnic University

Prof. Terence Lau is the Interim Associate Vice President (Innovation and Technology Development) and Adjunct Professor at the Department of Applied Biology and Chemical Technology at PolyU, where he promotes high-impact research and their translation and application through bridging the gap in technology readiness between academic inventions and real life applications. He has been serving a number of Governmental and organizational committees such as Expert Committee on Antimicrobial Resistance, Small and Medium Enterprise Committee, Enterprise Support Scheme of HKSAR Government and also National Committee on Biometrology of China. He is appointed Senior Advisor of a food safety project in China led by the United Nations Office for Project Services, Advisor of Infectious Disease Centre of Peking University, Adjunct Investigator of Jilin Academy of Agricultural Science.

Prof. Lau has dedicated over 20 years in the development and commercialization of innovative technological products especially in the area of testing and molecular diagnostics. He started his career in a renowned Swiss-based multinational company, and was then involved in setting up biotechnology companies offering innovative products and services for clinical, food and veterinary applications in relevant industries. He directed the first laboratory in Asia to obtain ISO 17025 accreditation for qualitative and quantitative genetically modified organism (GMO) analysis in the early 2000s and has developed over 100 products that are available globally. He also led the development of molecular avian influenza virus (AIV) detection products (including subtype H5) which were the first molecular AIV test kits that received official regulatory approval from Japan. Terence has co-authored a number of peer-reviewed scientific articles and is the co-inventor of over 60 patents. He has also co-developed 5 Chinese National Standards. Prof. Lau is the recipient of Beijing Municipal Technology Award and Chinese Medical and Technological Award.

Rapid Automated Multiplex Diagnostic System for Testing Infectious Respiratory Diseases

Abstract:
Infectious respiratory diseases represent an important portion of global public health concerns, in particular with regard to the global outbreak of novel coronavirus (SARS-CoV-2). The challenge of frontline diagnosis in hospitals, clinics and ports is that a number of infectious respiratory diseases could exhibit similar symptoms or can be asymptomatic.

Prof. Terence Lau will share on the development of the world's most comprehensive automated multiplex diagnostic system which includes a fully automated machine and a multiplex full-screening panel for point-of-care genetic testing (POCT) of up to 40 infectious respiratory pathogens including SARS-CoV-2. The System adopts patent-pending microfluidic and biochemical technologies that achieve ultra-sensitive detection and simultaneous differentiation of various pathogens with extremely high specificity. It is user-friendly which could relieve the challenge of frontline diagnostics in hospitals, clinics and ports with early and accurate detection of pathogens for effective and efficient disease control and management, and prevent spreading of contagious pathogens.

In the past year, the research team has optimized the System and conducted trials on different clinical samples. In the midst of the SARS-CoV-2 outbreak, the team has also conducted tests on clinical samples using the system. It is a highly versatile technology platform which can be extended to other needs as well.

Invited Speaker

Dr CH WONG

Director of Science of Avalon Steritech

Concurrent Session 5.1 | Room 1 | 03:35 PM to 03:55 PM | 27 November 2020

Restoring Public Confidence Back to Normal

CH has over 15 years of research experience in different chemistry areas including molecular design, chemical synthesis, materials sciences, and drug discovery. After obtaining his PhD degree from the University of Illinois, he shifted gears to advance his career in the medical industry. Working with a team of scientists and engineers, he has developed a line of hydrogel-based products, NMPA-approved and launched in 2015, for the treatment of hypertrophic scar-related pruritus. CH has recently developed a LED-based medical device (Kanga-care™) for treating neonatal jaundice and the product has obtained the NMPA approval, CE registration, and FDA 510(k) clearance. Currently, CH is leading a team of chemists and engineers, in collaboration with various Universities, to develop a series of healthcare products in response to the alarming public health issues.

Invited Speaker

Ir Dr Anthony CHAN

Program Head
Biomedical Engineering Technology Program
British Columbia Institute of Technology Canada

Ir Dr Anthony Chan is the Head of the Biomedical Engineering Technology Program at the British Columbia Institute of Technology and an Adjunct Professor of the School of Biomedical Engineering at the University of British Columbia. He was Director of Biomedical Engineering at a number of hospitals in Canada. Anthony holds a bachelor degree in electrical engineering from the University of Hong Kong, a master's degree in clinical engineering, a PhD in biomedical engineering from the University of British Columbia, and a certificate in health services management. He is a Professional Engineer, a Chartered Engineer, Certified Clinical Engineer, and a member of the HKIE. He was the recipient of the "Outstanding Canadian Biomedical Engineer Award" in 2007 and is a fellow of CMBES. Anthony is the author of 2 books – "Medical Technology Management Practice" and "Biomedical Device Technology, Principles and Design, 2nd Ed.". Anthony is active in professional activities and community services. He is a founding board of director of "Technology for Living", a non-profit organization providing technology and support for people with disabilities in BC, Canada.

Concurrent Session 5.2 | Room 2 | 03:35 PM to 03:55 PM | 27 November 2020

Design and development of a ventilator for low resource countries

Abstract:

Covid-19 has created a worldwide surging demand for mechanical ventilators. A mechanical ventilator is a complex medical device, requires specially trained users, and often expensive especially for low income jurisdictions. This presentation describes a project to design and build an open source mechanical ventilator for low resource countries. The work started in September 2020 by two UBC biomedical engineering graduate students who were locked down in their home towns in India. There are four phases in this project: 1. Develop requirement specifications, 2. Assess available ventilator designs, 3. Design and build prototype, and 4. Verify and validate prototype ventilator. The design assurance process and documentation in compliance with the standard ISO13485:2016-Medical device quality management systems are described. The results in phase 1 including a survey of ventilator users in India are reported.

Invited Speaker

Mr Kevin ORR

Group Vice President & CIO
Winner Medical Group

Concurrent Session 6.1 | Room 1 | 03:55 PM to 04:15 PM | 27 November 2020

Healthcare Innovations on Medical Face Masks & Respirators

Mr. Kevin Orr joined Winner Medical Group in 2002 and he has appointed as the Group Vice President and Chief Investment Officer, and General Manager of Winner Medical (Hong Kong) Limited.

Mr. Orr has cooperated with a high-end retail chain corporate in overseas during his university study prior joining the conglomerate, and he has substantial experience in corporate management, public health, med-tech, biotech & phygital-tech development, smart value chain, O2O Omni-channel new retailing management, and multiple national leading medical device & consumer healthcare lifestyle brands development including “Winner Medical”, “PurCotton”, and “PureH2B”.

Mr. Orr holds his Bachelor of Arts degree in Faculty of Social Science at University of Victoria, Master of Business Administration degree at The Hong Kong Polytechnic University, Master of Public Health degree in Faculty of Medicine at The Chinese University of Hong Kong; and he has received various Executive Education at Chinese Academy of Governance, Harvard Business School, Tsinghua University, Hong Kong University, and National University of Singapore.

Mr. Orr received the Gold Medal Award of "Eureka Brussels" The 54th World Exhibition of Innovation, Research and New Technology in Belgium at the age of 26 in 2005, Distinguished Alumni Award of University of Victoria, Young Industrialist Award of Hong Kong in 2019, and Distinguished Young Entrepreneur Award of Guangdong-HK-Macao Bay Area in 2020.

Mr. Orr is the Committee Member of All-China Youth Federation, Standing Youth Committee Member of All-China Federation of Returned Overseas Chinese, Vice Chairman of Hong Kong United Youth Association, Committee Member of Beijing Youth Federation, Vice Chairman of Centum Charitas Foundation, Vice Chairman of Hong Kong Medical & Healthcare Device Industries Association, Founding Advisor of Hong Kong O2O E-commerce Federation, Honorary Vice President of Hong Kong China Korfball Federation, a Co-opted Member of The Social Innovation and Entrepreneurship Development Fund Task Force under the Commission on Poverty of the Hong Kong SAR Government, a Standing Committee Member of Public Partnership & Engagement of Hong Kong Council of Social Service, and Departmental Advisory Committee Member of Department of Biomedical Engineering at City University of Hong Kong.

Winner Medical is one of the leading medical device supplier in COVID-19 anti-epidemic actions, and appointed as the National Medical PPE Reserve Supplier since 2003 SARS outbreak which proactively supported the global pandemic relief for national & global healthcare system, and greatly honoured to receive recognition by Medical Supplies Relief Section in Preventive & Control Response for Anti-epidemic under State Council of PR China, moreover we joined the Sustainable Healthcare Development for BRI Countries Action Platform of UN Global Compact as Founding Corporate Member; PurCotton has been respectively named as Greater China Unicorn and Global Unicorn by Hurun Research Institute with a market capitalization at RMB 10 Billion in year 2019 and 2020 respectively.

Invited Speaker

Prof Chenjie XU

Associate Professor
Department of Biomedical Engineering
City University of Hong Kong

Dr. XU Chenjie is dedicated to the development of transdermal drug delivery formulations and devices (especially nucleic acid-based nanoparticles and microneedle-based skin patch). He is well known for the development of skin patch for keloid treatment, anti-obese skin patch, skin patch for skin interstitial fluid extraction etc. He has published more than 120 peer-reviewed articles, edited two books, and holding 10 international patents. His research is supported by a wide range of public and private foundations including Singapore Minister of Education, Singapore A*Star, Continental Corp (German), Bill & Melinda Gates Foundation, National Natural Science Foundation of China, Hong Kong University Grants Committee etc.

Concurrent Session 6.2 | Room 2 | 03:55 PM to 04:15 PM | 27 November 2020

Transdermal delivery of Receptor-Binding Domain of SARS-CoV-2 Spike protein with dissolvable microneedle skin patch

Abstract:

The S1 subunit of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Spike protein contains an immunogenic receptor-binding domain (RBD), which is a promising candidate for the development of a potential vaccine. This study demonstrated the transdermal delivery an S-RBD vaccine using a dissolvable microneedle skin patch. We successfully showed the vaccine induced specific immune responses in mice, including significant B cell antibody responses against S-RBD and significant T cell responses. Importantly, the outcomes were comparable to that of conventional bolus injection.

Invited Speaker

Mr Stephen LOH

Chief Development Officer
Tan Tock Seng Hospital, Singapore

Mr Stephen LOH is the Chief Development Officer of Tan Tock Seng Hospital, one of the largest multi-disciplinary public hospitals in Singapore. He oversees the development of the HealthCity Novena, Singapore's first integrated health campus as well as the Facilities Management and Estate offices. He was previously the Hospital's Deputy Chief Operations Officer. Mr Loh received the Public Administration Medal (Bronze) National Day Awards 2020, and the National Healthcare Group Outstanding Citizenship Award 2017.

Prior to joining Healthcare in 2006, Mr Loh held senior management positions in the Publishing & Printing, and the Transportation & Logistics sectors.

Concurrent Session 7.1 | Room 1 | 09:30 AM to 09:50 AM | 28 November 2020

Development of Singapore's National Centre for Infectious Diseases (NCID)

Abstract:
Following the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003, Tan Tock Seng Hospital (TTSH) was tasked by the Ministry of Health, Singapore to develop the National Centre of Infectious Diseases (NCID). The new facility was to be integrated with TTSH for clinical operations and support. The H1N1 Influenza outbreak in 2009 further taught us that no 2 outbreaks would be the same. With novel pathogens and what was known about outbreaks, the hospital had to build NCID for the "known unknown" with flexibility in the capacity and design of the new outbreak facility. NCID was officially opened on 7 September 2019. Shortly after, Singapore reported her first case of imported COVID-19 on 23 January 2020. NCID had opened just in time.

Invited Speaker

Mr Kevin CAI

Chief Information Officer
Hospital Authority

Mr. Kevin CAI serves as the Chief Information Officer of Hospital Authority Hong Kong since 2015, leading the digital transformation of a world-leading public healthcare organization. In particular, he envisioned and led strategic digital directives such as Smart Hospital, Digital Workplace and Artificial Intelligence, supported by a modernized cloud-based, mobile-first and data-driven IT capabilities, and successfully transformed the 1,500-strong professional IT organization into an innovative and future-ready team.

Prior to that Kevin assumed the CIO role in China Eastern Airlines for over 5 years. He rebuilt the entire IT capability and enabled China Eastern to become the 5th largest and one of the most profitable airlines in the world. He received China's Best CIO Award for 3 years consecutively since 2010.

Prior to China Eastern, Kevin assumed various IT roles in Cathay Pacific Airways, Dragonair, Hong Kong Airport Authority and IBM Australia. Kevin also advised IBM as Board of Advisors for 4 years since 2011, and took up Board Directorship in global companies such as SITA and Travelsky. He holds an Executive MBA degree from China Europe International Business School, and received a Master degree from Australia's Monash University.

Concurrent Session 7.2 | Room 2 | 09:30 AM to 09:50 AM | 28 November 2020

Innovation, the Smart Hospital and COVID 19

Abstract:
With the growing hospital bed demand and increasing strain on healthcare services due to aging population and prevalence of chronic disease among younger age groups, the Hospital Authority (HA) responds by transforming service model and delivery via innovative technology. A core component of HA's digital transformation is "Smart Hospital". Information technology will play an enabling role to support smart service delivery and infrastructure via integration with operational technology (OT), transform business process and workflow, as well as to provide real-time intelligence-driven insights and actions. Various innovative technology solutions have been explored and trialed with the aim to eventually productize them under HA's 5 Smart Hospital portfolios, namely Smart Care, Smart Hospital Support, Smart Hospital Management, Smart Staff, and Smart Facility and Infrastructure. The recent battle against the COVID-19 pandemic has also helped accelerate the innovation and adoption of many Smart Hospital initiatives, and facilitated the building of an interconnected ecosystem of digital health for Hong Kong.

Invited Speaker

Dr Binseng WANG

Vice President
Program Management
Sodexo Health Technology Management

Binseng Wang is Vice President, Program Management, with Sodexo Healthcare Technology Management (HTM), a leading medical equipment independent service organization (ISO) under the umbrella of Sodexo USA. He is responsible for the strategic alignment of medical equipment management and maintenance services provided by Sodexo HTM to numerous healthcare delivery organizations with the quality and regulatory standards established by federal and state agencies.

Previously, Dr. Wang was Director, Quality & Regulatory Affairs for Greenwood Marketing LLC (formerly WRP32 Management, Inc.), a holding company that manufactures orthoses and infection-prevention medical devices. Prior to joining Greenwood, he was Vice President, Quality & Regulatory Affairs, for Sundance Enterprises, Inc., a manufacturer of pressure ulcer prevention and therapy devices. He was also Vice President, Quality and Regulatory Compliance, for Aramark Healthcare Technologies (another ISO) for over a decade, as well as Vice President, Quality Assurance and Regulatory Affairs, for MEDIQ/PRN Life Support Services, a medical equipment rental company that also produced medical device for over a dozen years. In addition, he worked as a visiting scientist at the National Institutes of Health and had teaching, research and management roles in Brazil.

Dr. Wang is a fellow of the American College of Clinical Engineering (ACCE) and American Institute of Medical & Biological Engineering (AIMBE), a senior member of American Society for Quality (ASQ) and Institute of Electrical and Electronics Engineers (IEEE), and a member of Association for the Advancement of Medical Instrumentation (AAMI), and Health Technology Technical Advisory Group of the World Health Organization (WHO). He is also a member of the Underwriters' Laboratory's Standards Technical Panel 60601-1. He received the 2010 AAMI Clinical/Biomedical Engineering Achievement Award and the 2015 ACCE Lifetime Achievement Award, was inducted to the Clinical Engineering Hall of Fame by ACCE in 2017 and received the inaugural AAMI-TRIMEDX John D. Hughes Iconoclast Award in 2019. He frequently publishes in trade magazines and peer-reviewed journals, and delivers lectures in national and international conferences.

He holds Bachelor of Science degrees in both Physics and Electronics Engineering from the University of Sao Paulo, Brazil, a MSEE from the State University of Campinas, Brazil, and earned a Doctor of Science (ScD) degree from the Massachusetts Institute of Technology (MIT). Dr. Wang is also a Certified Clinical Engineer (CCE).

Invited Speaker

Concurrent Session 8.1 | Room 1 | 09:50 AM to 10:10 AM | 28 November 2020

Evidence-Based Maintenance of Medical Equipment

Abstract:

After dispelling the initial false claims of medical equipment harming patients through electric shocks, the clinical engineering (CE) community spent decades attempting to develop rational methods for implementing cost-effective equipment maintenance programs. Analyses of data collected in the USA and UK have proven that the amount of patient incidents caused by improper maintenance is much lower than the Six Sigma quality level sought by world-class manufacturing companies. Nevertheless, some government agencies and manufacturers are still skeptical that it is possible to maintain equipment safely and effectively without following strictly manufacturers' recommendations. Several methods of planning and evaluating maintenance strategies have been proposed and tested with limited success, such as Risk-Based Criteria and Reliability-Centered Maintenance (RCM). A new method, called Evidence-Based Maintenance (EBM), has been developed in the last several years. It is defined as "[a] continual improvement process that analyzes the effectiveness of maintenance resources deployed in comparison to outcomes achieved previously or elsewhere, and makes necessary adjustments to maintenance planning and implementation." EBM treats each piece of medical equipment as a "black box" and uses the classical scientific method of detecting different outcomes caused by varying inputs to establish the most appropriate maintenance strategy. By comparing the statistics of failures causes found in repairs and scheduled maintenance (outcomes) generated by the adoption of different maintenance strategies (inputs), CE professionals can find the least resource intensive maintenance strategy without sacrificing equipment safety and reliability. This process is analogous to the "cohort studies" used in Evidence-Based Medicine, thus the similar name. Results of EBM studies in the USA and Europe have confirmed that most manufacturers' recommendations are overburdensome and unnecessary, while sometimes they are not sufficient to keep equipment safe and reliable.

Invited Speaker

Mr Eric CHAN

Chief Architect of Open Platform
WeBank

Eric Chan, the Chief Architect of Open Platform at WeBank, is responsible for the virtual bank's Open Platform architecture, establishes and maintains platform-wise IT governance framework, and provides expert advice on adoption of cloud computing, blockchain, big data technologies and other fintech initiatives. Prior to WeBank, he has served as senior architect at global investment banks for more than 10 years.

Concurrent Session 8.2 | Room 2 | 09:50 AM to 10:10 AM | 28 November 2020

Post-pandemic Travel with a Blockchain Immunity Passport

Abstract:
COVID-19 pandemic has been upending our daily life - restricting international travel, banning reunions and hindering business growth. Waiting and waiting until regions have no new cases, there finally is light when Guangdong and Macao re-opens border. Thanks to the blockchain-based solution "WeIdentity" based on FISCO BCOS, convertible health codes are making cross-border travel without quarantine possible again. With digital identity registration, authentication and data credentials sharing, WeIdentity has successfully enabled more than 9 million people to travel freely between Guangdong and Macao since May 2020, and this trendy new solution has just kicked off its revolutionized journey under COVID-19, leading the path to help more people, government and business.

Curious about how WeIdentity is facilitating the cross-border travel? Wish to know more about how blockchain is changing our life without even realizing it? E-join our blockchain sharing event to find out more!

Invited Speaker

Mr Eric WOO

Regional Director
Asia Pacific ECRI

Eric Woo is the Regional Director of ECRI Institute, Asia Pacific office. He is responsible for the development and operations of ECRI Institute in this region.

Eric brings with him 22 years of experience in healthcare industry, having learnt and built various businesses for medical technology organizations in Asia Pacific; managing a private hospital, and research involvement in Stem Cells therapy for regenerative medicine.

His healthcare management knowledge and experience has contributed to notable successes in his career, i.e. improvement in operational workflow in the hospital, and introduction of new technology in Asia healthcare market, improved methodology for technology adoption utilizing evidence based approach, to name a few.

In recent years, he has provided consultation, trainings and presentations related to healthcare technology management (HTM) to various groups such as healthcare authorities and regulators, hospitals, associations and conferences in Asia Pacific. Eric has been advocating the need in managing healthcare provider's risk of patient safety by managing it's People, Process & Technology.

Invited Speaker

Concurrent Session 9.1 | Room 1 | 10:10 AM to 10:30 AM | 28 November 2020

Management of Medical Devices in Clinical Setting in Combatting Infectious Diseases

Abstract:

COVID-19, an infectious desease caused by novel coronavirus that transmits through droplets has significantly impacted the global healthcare systems. Many new challenges emerge impacting the regular management/operations of medical equipment and supply, healthcare services and hospital management. This presentation shall briefly discuss on certain challenges such as suppliers, maintainance, infection control risk management etc. This are notably common challenges across many health facility globally.

We shall also discuss some enhanced processes that we adopted in order to manage the medical equipment during such challenging time. The need to be creative by the operation team has seen to be the key success factor when there isn't any guide for such unwarranted situation.

In summary, we are all caught off-guard, it may be a lesson for us to be more prepared

Telehealth refers to a broad scope of remote healthcare services whereas telemedicine is narrower in scope and is typically associated with direct clinical services. Telemedicine leverages on the healthcare provider's interoperable system in providing consultation/services to patients without the need of physical interaction. This presentation provides a perspective of the importance in managing risk associated with the system and processes that may impact the quality and safety of care provided through telemedicine. In the pursue of great possibilities with telemedicine, the journey are towards success are mounted with various challenges. This discussion can include the readiness or consistency of current system interoperability, design of the system, process improvement including liability mitigation, technical skills of relevant stakeholders involved, patient acceptance, regulatory compliance, cybersecurity prevention, etc.

In summary, concerns and unknowns persist in the complicated network systems and challenging the effectiveness and efficacy of interoperability, telemedicine requiring other services of care must be carefully reviewed.

Invited Speaker

Prof Gary CHAN

Professor
Department of Computer Science and Engineering
The Hong Kong University of Science and Technology

Dr. S.-H. Gary Chan is currently Professor in Department of Computer Science and Engineering, The Hong Kong University of Science and Technology (HKUST), Hong Kong. He is also Chair of the Committee on Entrepreneurship Education Program at HKUST, and Board Director of Hong Kong Logistics and Supply Chain MultiTech R&D Center (LSCM). He received MSE and PhD degrees in Electrical Engineering from Stanford University (Stanford, CA) with a Minor in Business Administration. He obtained his B.S.E. degree (highest honor) in Electrical Engineering from Princeton University (Princeton, NJ), with certificates in Applied and Computational Mathematics, Engineering Physics, and Engineering and Management Systems.

Professor Chan has co-founded and transferred his research results to several startups. Due to their innovations and commercial impacts, his startups and research projects have received local and international awards (2012-2020). Notably, he received Hong Kong Chief Executive's Commendation for Community Service for "outstanding contribution to the fight against COVID-19" in 2020. A Chartered Fellow of The Chartered Institute of Logistics and Transport (FCILT), his research interest includes smart sensing and IoT, cloud and fog/edge computing, indoor positioning and mobile computing, video/location/user/data analytics, and IT entrepreneurship.

Concurrent Session 9.2 | Room 2 | 10:10 AM to 10:30 AM | 28 November 2020

IoT Geofencing and Contact Tracing to Fight Against Covid-19

Abstract:

In order to curb the spread of Covid-19, prevention is always better than cure. Home quarantine using geofencing technology is an effective preventive measure to confine many distributed low-risk people for the incubation period of the virus. Contact tracing is another preventive measure to identify those who have been exposed to the virus for sustained amount of time, so that these close contacts can be properly attended to and isolated.

In this talk, I will share the research and development of our novel IoT geofencing technology. The idea has been implemented with a wristband as StayHomeSafe to enforce Home Quarantine Orders in Hong Kong. I will also discuss our current work on private automated contact tracing technology based on IoT wearables. In contrast to the current state-of-the-art, our multimodal contact tracing approach can trace effectively both direct (face-to-face) and indirect (environmental) contacts anywhere and any time.

Invited Speaker

Prof Matthew MCKAY

Professor, Department of Electronic & Computer Engineering |
Department of Chemical & Biological Engineering
The Hong Kong University of Science and Technology

Matthew McKay received his Ph.D. degree in Electrical Engineering from the University of Sydney in 2007. He is currently a Professor in the Department of Electronic and Computer Engineering at the Hong Kong University of Science and Technology (HKUST), and also in the Department of Chemical and Biological Engineering. Matthew previously held the Hari Harilela Associate Professor title at HKUST. He was a Research Scientist with the Institute for Medical Engineering & Science (IMES) at the Massachusetts Institute of Technology in 2014, and with the Department of Statistics at Stanford University in 2015. His research interests include computational biology and immunology, evolutionary biology, signal processing and high-dimensional statistics.

In 2020, Matthew he has been recognized as an IEEE Fellow (effective Jan. 2021), and he was selected as a Young Scientist of the World Laureates Forum. Previously, he was selected as a Young Scientist of the World Economic Forum. Matthew and his co-authors have received multiple best paper awards, including a Young Author Best Paper Award by the IEEE Signal Processing Society, and the Stephen O. Rice Prize by the IEEE Communication Society. He has received the Young Investigator Research Excellence Award by the School of Engineering at HKUST, and the Best Young Researcher Award (Asia Pacific Region) by the IEEE Communication Society. He serves as Area Editor for the IEEE Signal Processing Magazine, and previously served on the editorial board of the IEEE Transactions on Wireless Communications and the mathematics journal, Random Matrices: Theory and Applications.

Invited Speaker

Concurrent Session 10.1 | Room 1 | 10:45 AM to 11:05 PM | 28 November 2020

Guiding COVID-19 vaccine design using genetic data analysis

Abstract:
Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative agent of COVID-19, has led to a global public health crisis. An effective vaccine is urgently needed to control its spread, and many vaccine candidates have been proposed and are undergoing clinical trials. This talk will describe research being performed at HKUST, where we have applied data analysis to help guide and speed up vaccine development efforts, as well as to inform immunological assays for COVID-19.

We will describe how our analysis of SARS-CoV-2 genetic sequence data, initiated in the early phase of the pandemic, predicted a preliminary set of immune targets, called epitopes, by exploiting the genetic similarity between SARS-CoV-2 and SARS-CoV, the virus that caused the 2003 SARS epidemic. These epitopes were proposed as recommended targets for a potentially effective vaccine, and they have also been used to guide multiple experimental studies to understand immune responses in COVID-19 patients. We further describe a web-based platform (www.covidep.ust.hk) that we have developed to provide epitope predictions based on the most recently available genetic data. A number of emerging experimental studies have reported immune responses targeting the predicted epitopes in recovered COVID-19 patients.

An effective vaccine should have a broad population coverage, but so far experimental studies have reported responses against SARS-CoV-2 epitopes in a limited number of individuals. This makes it difficult to determine what proportion of the population can mount an immune response against a specific epitope. We demonstrate that this limitation can be addressed in part by augmenting the SARS-CoV-2 epitope data with immunological information of genetically similar SARS-CoV epitopes. Overall, we show that genetic sequence data analysis can help to identify targets for a COVID-19 vaccine with the potential to be effective in a large percentage of the global population.

Invited Speaker

Dr Gilman SIU

Associate Professor
Department of Health Technology and Informatics
The Hong Kong Polytechnic University

Dr. Gilman Siu is passionate in microbial genomic research for about 13 years. His major research areas cover from the development of molecular tools for rapid diagnosis of infectious diseases, phylogenetic analysis of emerging pathogens as well as unveiling genetic mechanisms of drug resistance and virulence in deadly bacteria and viruses, particularly Mycobacterium tuberculosis, respiratory viruses and HIV. He trained as medical laboratory technologist in his bachelor degree in PolyU and then infectious disease scientist in HKU Microbiology for his PhD degree. He is currently associate professor in the Department of Health Technology and Informatics, The Hong Kong Polytechnic University.

He published over 30 peer-reviewed research articles related to emerging infectious diseases in high-impact journals, such as Lancet Respiratory Medicine and Clinical Chemistry. In the past two years, he had received the Faculty research and teaching award (individual) from PolyU based on his outstanding performance in research and teaching activities. The total amount of competitive external grants directly arising from his projects in PI capacity has been over HK$16.8M. Additionally, he has supervised 6 PhD since 2014. Dr. SIU has also become an active member and actively served different executive positions in local and international academic bodies.

Concurrent Session 10.2 | Room 2 | 10:45 AM to 11:05 AM | 28 November 2020

Phylogeny and Transmission tracing of SARS-CoV-2 in Hong Kong

Abstract:

Our research team has conducted whole-genome sequencing (WGS) using Nanopore MinION platform for over 500 SARS-CoV-2 strains isolated from COVID-19 cases in Hong Kong since January 2020. Seven phylogenetic variants of SARS-CoV-2 were identified. Variant “S” and “L” were predominant in late January, by that time most cases were imported from mainland China. In February, all locally-acquired infections were caused by variant “V”. The predominance was then shifted to variant “G” when most cases were attributed to citizens returned from other countries since mid-March. In June- August, a large COVID-19 outbreak occurred in Hong Kong. WGS analysis identified that at least 3 lineages of variant “GR” were circulating in the community. Imported cases from sailors were believed to be source of the 3rd wave of outbreak in Hong Kong. Our recent study identified that a new variant “GH” originated from Nepal imported cases has sparked the fourth wave of community in November.

Invited Speaker

Prof Kang ZHANG

Faculty of Medicine
Macau University of Science and Technology

Concurrent Session 11.1 | Room 1 | 11:05 AM to 11:25 PM | 28 November 2020

AI Diagnostic System for COVID-19 Pneumonia

Research Areas: Genetics, epigenetics, stem cells, and artificial intelligence

Kang Zhang, MD, PhD is the Professor of the Faculty of Medicine, Macau University of Science and Technology (MUST). Dr. Zhang obtained his M.D. with Magna Cum Laude honors from Harvard Medical School and MIT joint MD program and his PhD in genetics from Harvard University. He did his postdoctoral training also at Harvard. He completed his residency in ophthalmology at Johns Hopkins University and his retina surgery fellowship at University of Utah. He was a faculty member at Johns Hopkins University, Cleveland Clinic Foundation, University of Utah, and University of California San Diego.

Among his honors include AAAS fellow, fellow of American Institute for Medical and Biological Engineering, memberships in Association of American Physicians and American Society of Clinical Investigation; Outstanding Achievement Award of Chinese Ophthalmological Society, Burroughs Wellcome Clinical Scientist Award in Translational Research; Lew R. Wasserman Merit Award and Senior Investigator Award from Research to PreventBlindness; Charles Schepens Award for Excellence in Retina Research; and Johns Hopkins Medical Institutions Clinician Scientist Award, the Ophthalmologist 100 Powerlist, American's Top Ophthalmologists.

Dr. Zhang has published over 200 peer-reviewed manuscripts in top peer-reviewed journals- covering a wide range of topics in genetics, epigenetics, stem cells, nano-engineering and 3D printing, clinical trials, and artificial intelligence. He has more than 26,000 citations and an h- index of 80. His discovery that HTRA1 is a major susceptibility gene for age-related macular degeneration is listed as one of "top-ten breakthroughs in 2006" in Science Magzine.

Invited Speaker

Mr Yiu Chau TAM

Master of Philosophy Student
Department of Biomedical Engineering
The Hong Kong Polytechnic University

Mr Yiu Chau TAM is currently a MPhil student in Medical Imaging and Biosensing at The Hong Kong Polytechnic University Department of Biomedical Engineering, supervised by Dr James Cheung. His research area is in cyber physical system and biosensing. He received his degree in BSc (Hons) in Computing in 2020. He actively participates in algorithmic graph theory and deep learning in computer vision research during undergraduate studies. He has won 2nd runner up in PolyU EIE Microcontroller Application Design Contest and studies "Fast Computation of the rooted binary triplet distance" for phylogenetic trees in Final Year Thesis.

Concurrent Session 11.2 | Room 2 | 11:05 AM to 11:25 AM | 28 November 2020

Wearable device supporting smart social distancing in hostel

Abstract:

INTRODUCTION

In the days of covid-19 pandemic, suppression measure, such as social distancing, has played a vital role in containing the virus and reducing the effective reproduction rate. Wearable wristbands have demonstrated successful usage in supporting home-based quarantine in Hong Kong. The elderly residential hostel is one of the high-risk place, which is densely populated and contributed to several outbreaks in Hong Kong during the pandemic. Arrangement for implementing social distance in the hostel is challenging because of insufficient personnel, overpopulated, warranted constant sanitization and limited personal protective equipment. Effective soft quarantine procedure is difficult to be implemented for the resident. A wearable device is developed for the purpose.

METHOD

A wearable watch comprised with a temperature, buzzer, Bluetooth and indoor localization system has been under development for enforcing social distancing measures. It provides a real-time monitor of body temperature and provide distance measure between closest wearer via signal strength.

Measuring distance between every watch would require O(n²) communication. When densely deployed, there might be excessive traffic and packet loss. Continuous broadcasting would also reduce battery life. A modified Raft[1] consensus algorithm is used for electing leaders in clusters, which is responsible for broadcast at a fixed time interval for distance measurement. Clustered device wearers are detected with Canopy Clustering[2], and limitation on the wearer gathering can be enforced by limiting the maximum number of Raft Followers in a cluster. When a Raft Candidate is approaching a full cluster, the watches will produce a warning sound and vibration to signal wearers. Prolonged crowding between the wearers will be reported to the nursing station for taking intervention.

Continuous body temperature monitoring could provide early detection of low-grade fever and prevent the elderly from approaching other residents in time. The collected data will be uploaded via a single-board computer to a centralized database for post-analysis. When resident detected with fever, the list of close contact resident and visited locations can be generated.

RESULT AND DISCUSSION

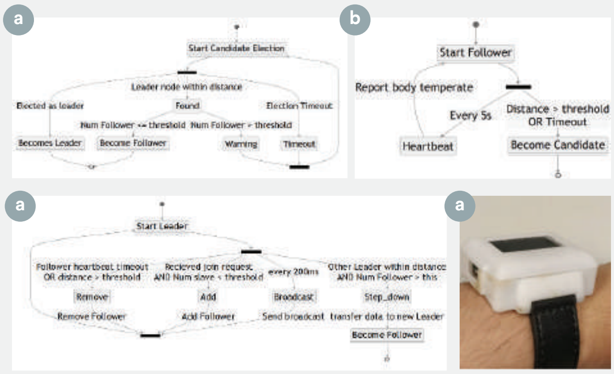


Figure 1:Watch states. a) Candidate state. The candidate will be warned if near to cluster and cannot join b) Follower state. Follower becomes a candidate if too far from Leader. c) Leader state. The leader is responsible for broadcasting signals for distance measurement. d) Prototype of the wearable watch

A prototype system with two watches and connection nodes has been under development. The algorithm has been implemented in the system. Laboratory test and evaluation of prototype in an NGO hostel are under planning. The future work includes zone control, heart rate measurement, activities recognition and sleep monitoring for analysis and enhancing physical well-being.

CONCLUSION

The paper introduces a wearable device for smart distancing and soft quarantine. The algorithm has been developed to control the number of wearers in a group gatherings, reduce communication between devices to O(n), and prolong battery life.

REFERENCES

[1] D. Ongaro and J. Ousterhout, “In Search of an Understandable Consensus Algorithm,” USENIX Annual Technical Conference, 2014, pp. 305–319,

[2] A. McCallum, K. Nigam, and L. H. Ungar, “Efficient clustering of high-dimensional data sets with application to reference matching,” in Proceedings of the sixth ACM SIGKDD international conference on Knowledge discovery and data mining, New York, NY, USA, Aug. 2000, pp. 169–178.

Invited Speaker

Ms Junchen LIAO

Ph.D. candidate
Department of biomedical engineering
City University of Hong Kong

Mr Yiu Chau TAM is currently a MPhil student in Medical Imaging and Biosensing at The Hong Kong Polytechnic University Department of Biomedical Engineering, supervised by Dr James Cheung. His research area is in cyber physical system and biosensing. He received his degree in BSc (Hons) in Computing in 2020. He actively participates in algorithmic graph theory and deep learning in computer vision research during undergraduate studies. He has won 2nd runner up in PolyU EIE Microcontroller Application Design Contest and studies "Fast Computation of the rooted binary triplet distance" for phylogenetic trees in Final Year Thesis.

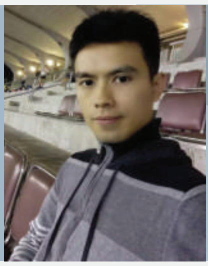
Concurrent Session 12.1 | Room 1 | 11:25 AM to 11:45 PM | 28 November 2020

Closed-loop inertial microfluidics for deformability-based sorting under continuous flow

Abstract:

Liquid blood biopsy is a rapid, low cost, and less invasive method for clinical diagnosis. The development of portable disease detection platforms based on liquid biopsy has thus gained considerable attention in the clinical community. Here, we developed a one-step label-free microfluidic blast cell biochip (BCB) sorting system to retrieve diseased leukemia blasts from healthy white blood cells based on deformability. Diseased blast cells were stiffer than healthy leukocytes due to a high cell cytoplasmic to nuclei (N/C) ratio. Due to different inertial forces experienced by various cell populations within the BCB, healthy cells and blast cells could be focused in different regions within the channel cross-section, allowing the retrieval of target blast cells. In order to improve the purity of recovered blast cells, the device output can be recirculated to form a closed-loop processing platform. The sorting procedures were validated with blood samples of various leukemia types, including acute lymphoblastic leukemia (ALL), myelodysplastic syndrome (MDS), acute myeloid leukemia (AML), acute monocytic leukemia (AMoL), and acute myelomonocytic leukemia (AMMoL). The BCB demonstrated a high detection sensitivity of 1 in 106 cells, which is comparable to blast cell rates in minimal residual disease. Our technology has the potential for multiplexing and can be adapted to detect other diseased cells, such as activated immune cells in COVID-19 patients, using a small volume of blood, through changes in deformability.

Invited Speaker



Dr. Huang-Jing LIN

Program Head
Director of Research & Development
Imsight Medical Technology Co. Ltd

Dr. Huang-Jing Lin received Ph.D. from The Chinese University of Hong Kong in 2020. His research interests including computational pathology, medical image analysis and deep learning. He has published more than 10 papers in top-tier conferences and journals including JAMA, MICCAI, TMI, MIA, WACV, Trans. on Cybernetics, etc. He serves as the reviewer of several premium conference including TMI, MICCAI, IEEE ACCESS, etc. Currently, he serves as R&D Director of Imsight AI Research Lab to explore the novel AI technology for improving health care.

Concurrent Session 12.2 | Room 2 | 11:25 AM to 11:45 AM | 28 November 2020

Automated analysis of COVID-19 from CT images via Semi-supervised Deep Learning

Abstract:
Coronavirus disease 2019 (COVID-19) has been spread all over the world since the end of 2019. Computed tomography (CT) inspection is an effective way for fast prognosis. Automated analysis of COVID-19 pneumonia from CT images has the potential to reduce the misdiagnosis rate and workload from radiologists.

We propose a novel framework for automated detection and segmentation of COVID-19 infected areas. First, a deep convolutional neural network was proposed to find the CT images which contains the suspicious COVID-19 infections. Second, a convolutional neural network with semi-supervised mechanism is proposed for semantic segmentation, which is trained based on the positive CT images. The main-encoder and the main-decoder of the network is pre-trained with labeled data first. And then the unlabeled data are used to calculate the consistency between the auxiliary decoder and the main decoder, so as to further improve the representation capability of the main-encoder.

Our method can accurately classify COVID-19 images and delineate the contours of lesion areas based on a small training dataset with labels. For case level classification, we achieved an accuracy of 0.86 and a recall of 0.92. For the pneumonia area segmentation, dice of 0.78 was achieved, tremendously helpful in applying clinical workflow for quantitative diagnosis.

Poster Presentations

BME2020

Biomedical Engineering Conference

P01 | Kwong Chiu FUNG | The Hong Kong University of Science and Technology

A Cloud-based Body Temperature Screening System

BME2020
Biomedical Engineering Conference

A Cloud-based Body Temperature Screening System

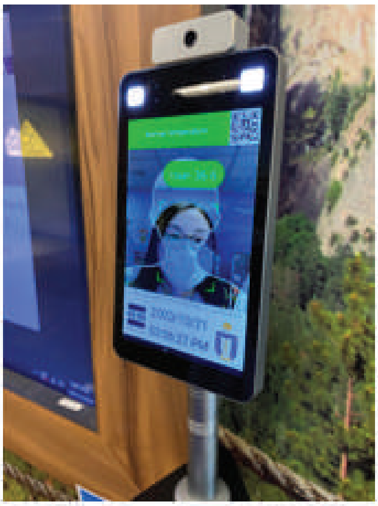
Kwong Chiu Fung
The Hong Kong University of Science and Technology, Hong Kong, China

Abstract:

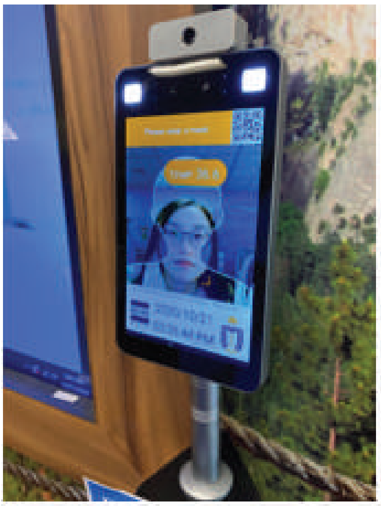
In response to the pandemic, fever detection is one of the most common symptoms of the coronavirus. Temperature screening is one of the crucial measures to mitigate risks of virus in public spaces. However, performing temperature check with forehead thermometer involves physical proximity and is inefficient in high foot traffic areas. The current fever monitoring systems in the market can recognize the unwell person by infrared cameras walking in a crowd. Nevertheless, existing solutions are bulky, expensive with low resolution, the screening system also requires professional technicians to setup, thus it is unaffordable by general organizations. In this work, we present a handy, low cost and easy to setup remote body temperature measurement system based on widely available hardware, including Raspberry Pi, Google Coral USB accelerator and FLIR One Pro USB dongle. Our system consists of RGB and infrared cameras, by applying visible and thermal images merging, facial detection and pose estimation, the system can identify person's forehead temperature in real-time. Audio alarm will go off and the person would be bracketed when it detects a temperature higher than normal range or a person not wearing a mask. A cloud-based management platform is also developed for managing multiple systems. The platform synchronizes with each system in real time and performs data analysis.

Smart Health Self-Monitoring Station

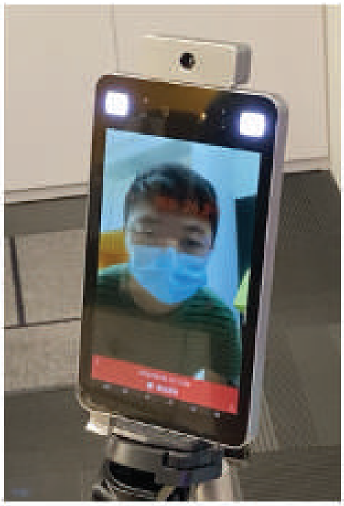
Normal Scenario



Mask Detection



Elevated Temperature



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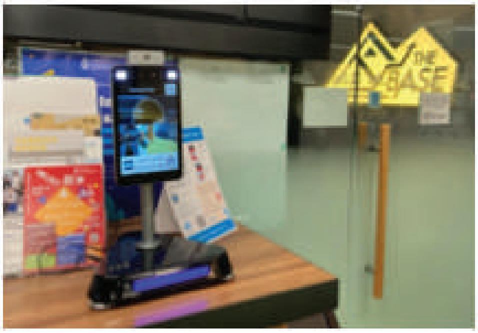
Smart Cloud Analytics System

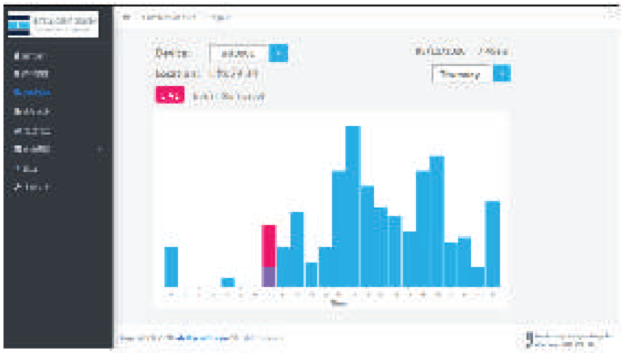
Station

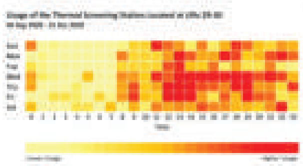


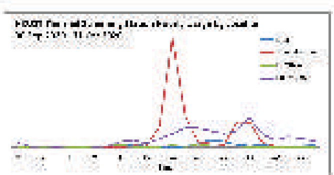
Active Monitoring

INTELLIGENT DESIGN
TECHNOLOGY LIMITED

Data Analytics







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P02 | Ivy, Hei Man WONG
Translational and Advanced Bioimaging Laboratory, Department of Chemical and Biological Engineering, Hong Kong University of Science and Technology

Rapid Histopathological Imaging by Microscopy with Ultraviolet Surface Excitation using Speckle Illumination

BME2020
Biomedical Engineering Conference

Rapid Histopathological Imaging by Microscopy with Ultraviolet Surface Excitation using Speckle Illumination

Ivy H. M. Wong, Yan Zhang, Lei Kang, Xiufeng Li, Terence T. W. Wong*
Translational and Advanced Bioimaging Laboratory, Department of Chemical and Biological Engineering, Hong Kong University of Science and Technology, Hong Kong, China
**Corresponding author: ttwwong@ust.hk*

Abstract:

Thick tissue imaging remains a challenge for conventional optical microscopy, which is commonly used in clinical histology, because light scattering from multiple layers decreases image contrast. Therefore, current histological workflow often involves a series of lengthy and laborious procedures when preparing thin tissue slides to achieve good image contrast. Not only does it require specialized and costly machines for sectioning, it could also take a week to generate a reliable pathology report, possibly delaying treatments for patients. Microscopy with ultraviolet surface excitation (MUSE) [1] has recently been proven as a promising technique for slide-free thick tissue surface imaging. It utilizes the short penetration depth of ultraviolet (UV) light to restrict the excitation of fluorophores only on the thick tissue surface.

As a wide-field microscope, however, MUSE also has its limitation in achieving sub-cellular resolution while maintaining good image contrast. In the conventional histology, although an objective lens with 2X–4X magnifications are sometimes enough for making a decision in surgical margin analysis, 10X–20X magnifications (with a numerical aperture (NA) equals to ~0.25–0.4) are normally used to observe the sub-cellular features, including the morphology of cells, for accurate medical diagnosis. However, the depth of focus of these objective lenses ranges from 3 to 6 µm, which is shorter than the imaging thickness (~10 µm). This reduces the image contrast and fundamentally limiting the possibility to achieve high resolution by the use of high NA objective lenses. Using an objective lens with a short depth of focus will also increase sensitivity to tissue flatness, posing a hurdle in examining thick and rough tissue samples that are prepared by a common blade.

In this project, we proposed to implement MUSE using speckle illumination (MUSES), followed by iterative reconstruction derived from Fourier ptychography [2] to break the trade-off between imaging resolution and depth of focus in a diffraction-limited microscope. In brief, by preserving the long depth of focus, MUSES relieves the tissue flatness constraint, encourages the use of a common blade in sample preparation, and benefits the histological workflow by eliminating the lengthy thin tissue slide preparations.

References

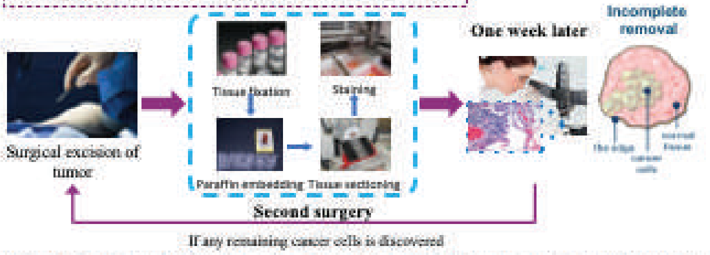
[1] F. Fereidouni et al., "Microscopy with ultraviolet surface excitation for rapid slide-free histology," *Nat. Biomed. Eng.*, vol. 1, no. 12, pp. 957–966, 2017.

[2] S. Dong, P. Nanda, R. Shiradkar, K. Guo, and G. Zheng, "High-resolution fluorescence imaging via pattern-illuminated Fourier ptychography," *Opt. Express*, vol. 22, no. 17, p. 20856, 2014.

Rapid Histopathological Imaging by Microscopy with Ultraviolet Surface Excitation using Speckle Illumination

Ivy H. M. Wong, Yan Zhang, Lei Kang, Xiufeng Li, Terence T. W. Wong*
Translational and Advanced Bioimaging Laboratory, Department of Chemical and Biological Engineering, Hong Kong University of Science and Technology, Hong Kong, China
*Corresponding author: ttwwong@ust.hk

Clinical demand for intraoperative histology

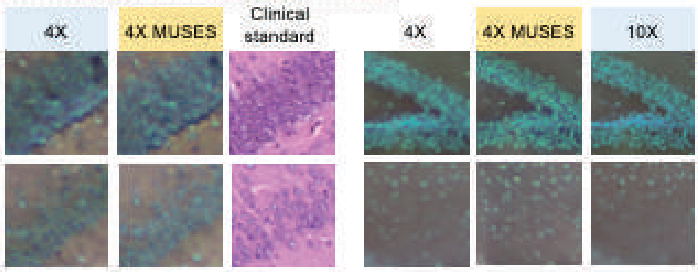


- Current histological workflow takes almost a week to tell whether cancer cells are completely removed.
- Thin tissue slide preparation is necessary to achieve high-contrast images, leading to a lengthy workflow.

Microscopy with ultraviolet surface excitation using speckle illumination (MUSES)

(1) Short penetration depth of ultraviolet light enables high-contrast surface imaging without tissue slicing.
(2) Speckle illumination allows the detection of fine sample features beyond the diffraction-limit, high-resolution images can be reconstructed by an iterative algorithm.

Slide-free imaging for rapid histology



- MUSES achieved 2.4 times improvement in spatial resolution, providing ~1 µm resolution using a low numerical aperture (NA) objective lens (4X/0.1 NA).
- Fast scanning with a large field of view and high-resolution images can be provided.
- High tolerance of tissue surface irregularities is enabled by the long depth of focus.

Conclusions

- By integrating ultraviolet surface excitation with speckle illumination, MUSES achieves high-contrast thick tissue imaging, potentially obviating the need of the time-consuming workflow.
- Breaking the trade-offs between lateral resolution, field of view, and depth of focus in a diffraction-limited optical microscopy, MUSES can provide histological images with 1 µm resolution within 10 minutes for a brain biopsy sample with a size of 5 mm x 5 mm.

P03 | Kai YUAN | The Chinese University of Hong Kong

Interhemispheric Functional Reorganization and Its Structural Base after BCI-Guided Upper-Limb Training in Chronic Stroke

BME2020
Biomedical Engineering Conference

Interhemispheric Functional Reorganization and Its Structural Base after BCI-Guided Upper-Limb Training in Chronic Stroke

Kai Yuan
The Chinese University of Hong Kong, Hong Kong, China

Abstract:

Brain-computer interface (BCI)-guided robot-assisted upper-limb training has been increasingly applied to stroke rehabilitation. However, the induced long-term neuroplasticity modulation still needs to be further characterized. This study investigated the functional reorganization and its structural base after BCI-guided robot-assisted training using resting-state fMRI, task-based fMRI, and diffusion tensor imaging (DTI) data. The clinical improvement and the neurological changes before, immediately after, and six months after 20-session BCI-guided robot hand training were explored in 14 chronic stroke subjects. The structural base of the induced functional reorganization and motor improvement were also investigated using DTI. Repeated measure ANOVA indicated long-term motor improvement was found ($F[2,26]=6.367$, $p=0.006$). Significantly modulated functional connectivity (FC) was observed between ipsilesional motor regions (M1 and SMA) and some contralesional areas (SMA, PMd, SPL) in the seed-based analysis. Modulated FC with ipsilesional M1 was significantly correlated with motor function improvement ($r=0.6455$, $p=0.0276$). Besides, increased interhemispheric FC among the sensorimotor area from resting-state data and increased laterality index from task-based data together indicated the re-balance of the two hemispheres during the recovery. Multiple linear regression models suggested that both motor function improvement and the functional change between ipsilesional M1 and contralesional premotor area were significantly associated with the ipsilesional corticospinal tract integrity. The results in the current study provided solid support for stroke recovery mechanisms in terms of interhemispheric interaction and its structural substrates, which could further enhance the understanding of BCI training in stroke rehabilitation.

Interhemispheric Functional Reorganization after BCI-Guided Upper-Limb Training in Chronic Stroke

Kai Yuan, Xin Wang, Cheng Chen, Cathy Lau, Raymond Tong

Department of Biomedical Engineering, The Chinese University of Hong Kong, Hong Kong.

INTRODUCTION

- BCI-guided robot-assisted upper-limb training has been increasingly applied to stroke rehabilitation. However, the induced long-term neuroplasticity modulation still need to be further characterized. There is a growing awareness that disrupted functional interactions, especially interhemispheric interactions, are highly correlated with motor behavioral deficits and poststroke recovery (Cater et al. 2010)
- This study investigated the long-term functional reorganization 14 stroke individuals after twenty sessions of BCI-assisted upper-limb training, using resting-state fMRI, task-based fMRI.

METHODOLOGY

- **Training system and performances**

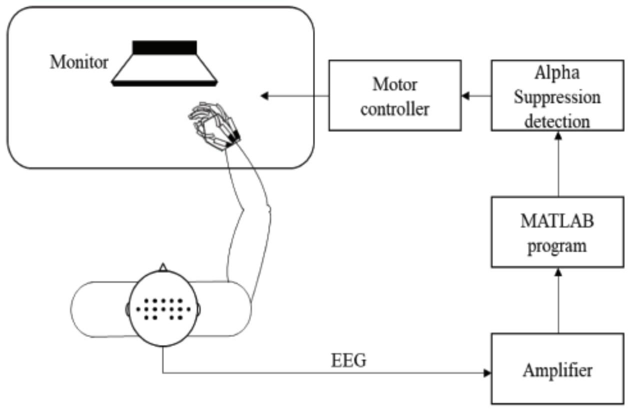


Figure 1. The BCI motor training system was developed as shown above. An exoskeleton robot hand was used to assist the paretic hand to grasp/open. All subjects received a 20-session BCI robot hand training with an intensity of 3-5 sessions per week and completed the whole process within 5-7 weeks. During each training session, the subject was required to perform 100 repetitive hand opening/closing tasks.

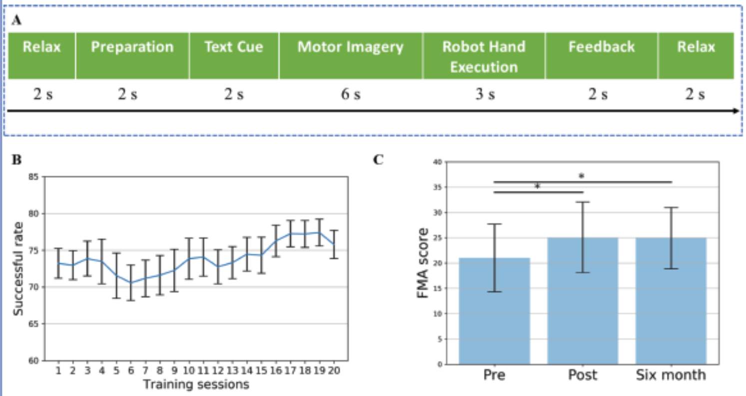


Figure 2: (A) The sequence of training paradigm. (B) Successful rate of training trials across 20 sessions for all the subjects. Error bars stand for standard errors. (C) Significant improved motor function was observed immediately after intervention and six months follow-up.

RESULTS AND DISCUSSION

- **Resting-state FC modulation results**

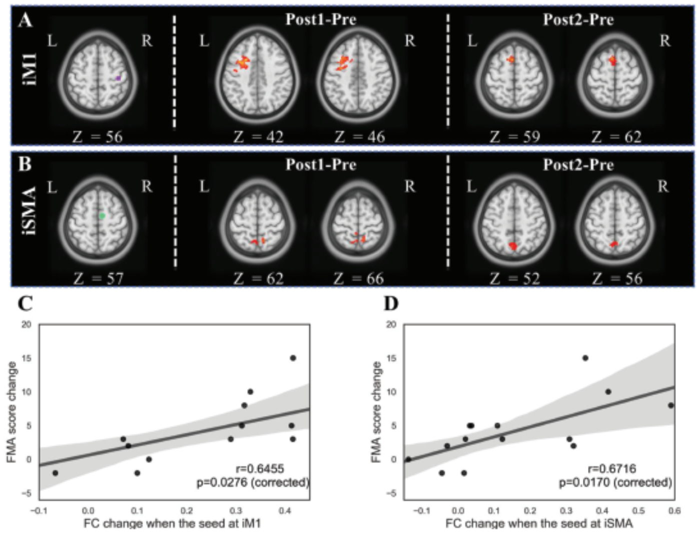


Figure 3: (A) Comparison of interhemispheric FC among Pre, Post1 and Post2 sessions. Significant effect of time was observed according to repeated measure ANOVA. Pair-wise comparisons show that significant changes were seen between Pre and Post1, between Pre and Post2. (B) Significant correlation was found between interhemispheric FC and FMA score change.

- **Task-based lateralization results**

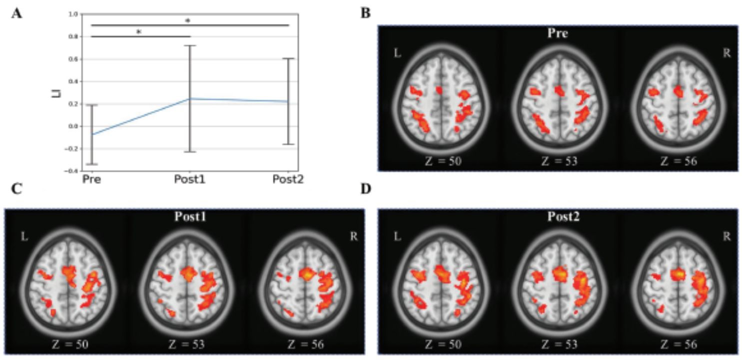


Figure 4: (A) Comparison of LI among Pre, Post1 and Post2 sessions. Significant effect of time was observed according to repeated measure ANOVA. Pairwise comparisons show that significant changes were seen between Pre and Post1, between Pre and Post2 . (B)(C)(D) Illustration of activation map during motor imagery task at three sessions of Pre and $Post1$ and Post2, respectively.

REFERENCE

[1] Carter, A.R. et al. (2010), "Resting interhemispheric functional magnetic resonance imaging connectivity predicts performance after stroke," Annals of Neurology, vol. 67, no. 3, pp. 365–375.

ACKNOWLEDGEMENT

This research study was supported by Research Grants Council of the Hong Kong Special Administrative Region (GRF-CUHK14207617).

P04 | Jing Wei Nick CHIN | The Hong Kong University of Science and Technology

Rapid temperature screening and suspect tracking in a moving crowd

Rapid temperature screening and suspect tracking in a moving crowd

Chin, J.W.[1], Wong, K.L.[2], Suhartono, K.[1], Chan, T.T.[1], Lau, H.F.[3]., So, R.H.Y.[1,2], Wong, S.M.[4] and Pan, D.[4]

[1]Department of Industrial Engineering and Decision Analytics, HKUST

[2]Department of Chemical and Biological Engineering, HKUST

[3]Department of Electronics and Computer Engineering, HKUST

[4]Electrical and Mechanical Services Department, HKSAR Government

Fever is the most common symptom associated with COVID-19. Routine monitoring for elevated body temperature can aid the identification and subsequent segregation of symptomatic persons, which serves as an effective preliminary screening tool to prevent the spread of infectious diseases. The use of traditional handheld infrared thermometers for temperature screening is a tedious and resource-intensive task. AI-enabled automated systems involving thermal cameras have emerged as a popular alternative for a more efficient, non-contact temperature screening method. However, the performance of such systems, especially in high-traffic areas, are hindered by the following challenges: 1) identification of faces under heavy occlusion and at a distance; 2) tracking of fever suspects under heavy occlusion; and 3) the limited field-of-view (FOV) of a single thermal camera. We present a multi-camera AI-driven solution that achieves real-time temperature screening and suspect tracking in a moving crowd. Our system performs multi-person whole-body keypoint detection in parallel with data analytics of body proximity and thermal information. We integrate wide-FOV scene cameras with multiple thermal cameras to cover a large area of detection and demonstrate the effectiveness of fast deep-learning networks for cross-modality person re-identification. Different versions of our technology have been deployed for test trials in more than 30 places, including border control points, major government offices, schools, libraries, and elderly centers. Since January 2020, we estimate that our technology has screened millions of people. The talk will discuss the challenges we faced in our implemented solutions as well as future work beyond thermal screening.

Rapid temperature screening and suspect tracking in a moving crowd

Chin, J.W.[1], Wong, K.L.[2], Suhartono, K.[1], Chan, T.T.[1], Lau, H.F.[3], So, R.H.Y.[1,2], Wong, S.M.[4] and Pan, D.[4]

[1]Department of Industrial Engineering and Decision Analytics, HKUST

[2]Department of Chemical and Biological Engineering, HKUST

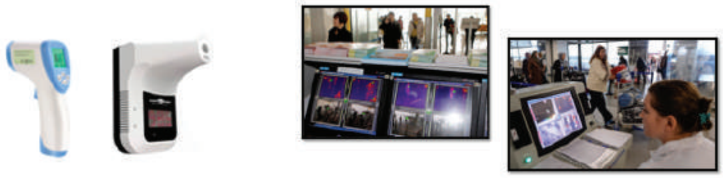
[3]Department of Electronics and Computer Engineering, HKUST

[4]Electrical and Mechanical Services Department, HKSAR Government

1

Challenges

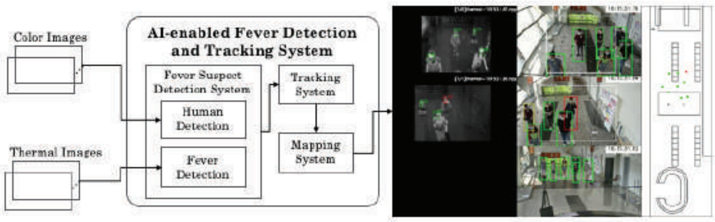
- 1) Identification of faces under heavy occlusions
- 2) tracking of fever suspects under heavy occlusions
- 3) limited FOV of single camera



Reference: http://europe.chinadaily.com.cn/china/2016-03/23/content_24014298.htm
http://america.aljazeera.com/articles/2014/10/14/health-experts-questioneffectivenessofairportebolascreening.html

2

System Diagram

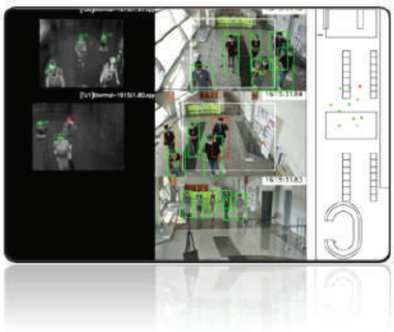


3

Conclusion & Future Works

Fever suspect Detection and Tracking with AI ✓

Efficient way of temperature screening for moving crowds ✓



Future Works

Optimization in accuracy, time and computational resources

4

P05 | Xiangqian SHI | The Chinese University of Hong Kong

Verification of Finger Joint Stiffness Estimation Method with Soft Robotic Actuator

BME2020
Biomedical Engineering Conference

Verification of Finger Joint Stiffness Estimation Method with Soft Robotic Actuator

Xiangqian SHI
The Chinese University of Hong Kong, Hong Kong, China

Abstract:

Stroke has been the leading cause of disability due to the induced spasticity in the upper extremity. Finger flexor spasticity, usually characterized by hyper-resistance in the finger joint, which is a result of pathological neuromuscular activation and biomechanical changes in muscles and soft tissues overlying the joint. However, the constant flexion of spastic fingers following stroke has not been well described. Accurate measurements for joint stiffness help clinicians have better access to the level of impairment after stroke. Previously, we conducted a method for quantifying the passive finger joint stiffness based on the pressure-angle relationship between the spastic fingers and the Soft-Elastic Composite Actuator (SECA). However, it lacks a ground-truth to demonstrate the compatibility between the SECA-facilitated stiffness estimation and standard joint stiffness quantification procedure. In this study, we compare the passive MCP joint stiffness measured using the SECA with the results from our designed standalone mechatronics device, which measures the passive metacarpophalangeal (MCP) joint torque and angle during passive finger rotation. Results obtained from the fitting model that concludes the stiffness characteristic is further compared with the results obtained from the SECA-Finger model, as well as the clinical score of Modified Ashworth Scale (MAS) for grading spasticity. These findings suggest the possibility of passive MCP joint stiffness quantification using the soft robotic actuator during the performance of different tasks in hand rehabilitation.

Verification of Finger Joint Stiffness Estimation Method with Soft Robotic Actuator

Xiangqian Shi[1], Holam Heung[1], Zhiqiang Tang[1], Kaiyu Tong[1] and Zheng Li[2]

[1]Department of Biomedical Engineering, The Chinese University of Hong Kong, Hong Kong.
[1]Department of Surgery, The Chinese University of Hong Kong, Hong Kong.

1. INTRODUCTION

Stroke has been the leading cause of disability due to the induced spasticity in the upper extremity. The constant flexion of spastic fingers following stroke has not been well described. Quantification of finger joint stiffness help clinicians better observe the level of finger impairment after stroke. Previously, we developed a method of quantifying the passive finger joint stiffness based on the pressure-angle relationship between the spastic fingers and our pneumatic Soft-Elastic Composite Actuator (SECA). Furthermore, the compatibility of the stiffness estimation between the SECA-facilitated method and standard quantification procedure still needs to be demonstrated.

2. METHODOLOGY

2.1 Description of Stiffness Evaluation Method

SECA-Finger Modeling System

- 3D printed SECA: actively control flexion and extension of a spastic finger.
- MCP segment:
  Pressurization (joint flexion),
  Depressurization (joint extension)
- Flex sensor: measuring the bending angle

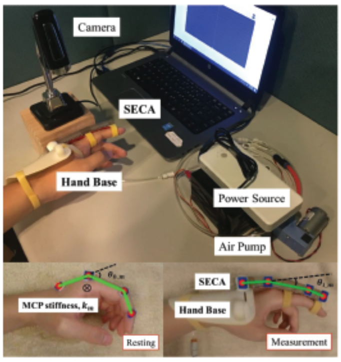


Figure 1. Attachment of the SECA to finger during the MCP joint stiffness measurement

Static Modeling

- Pressure-angle relationship:

$$P = \frac{2w_m aL^2(a + \pi(a+b) + 2r) + EI\theta^2 - kL(\theta - \theta_0)^2}{2L\left(\frac{\pi}{2}\left(\frac{t}{2} + a + b\right)r^2 + eb\left(\frac{t}{2} + a\right) + \frac{eb^2}{2} + \frac{2r^3}{3}\right)\theta}$$

- Joint stiffness equation ($\theta \in [0°, \theta_0)$):

$$k_m = \frac{A + EI{\theta_m}^2 - B\theta_m}{L(\theta - \theta_0)^2}$$

which

$$A = 2w_m aL^2(a + \pi(a+b) + 2r)$$
$$B = 2PL\left(\frac{\pi}{2}\left(\frac{t}{2} + a + b\right)r^2 + eb\left(\frac{t}{2} + a\right) + \frac{eb^2}{2} + \frac{2r^3}{3}\right)$$

a – actuator wall thickness
b – internal rectangular height
e – internal chamber width
r – internal circular radius
t – layer thickness
L – actuator wall thickness
w_m – strain energy density function
P – input pressure
E – layer Young's modulus
I – layer scecond moment of area
k – joint stiffness
θ – joint angle (θ_m: MCP joint angle)

Standard Stiffness Evaluation System

- To obtain the ground-truth value for verifying the accuracy of SECA-Finger modeling
- Passive tip force of Finger Splint:

$$\tau_{passive} = l_{fin} \times F_{passive}$$

- Double exponential function-based model:

$$\tau_{passive}(\theta_m) = A\left(e^{-B(\theta_m - E)} - 1\right) - C\left(e^{D(\theta_m - F)} - 1\right)$$

That

$$\theta_m \in [\theta_{i\_m}, \gamma\theta_{0\_m}], \gamma = 0.7$$

- Derivatized MCP joint stiffness equation:

$$k_m = \left|-CDe^{-D(\theta_m - F)} - ABe^{-B(\theta_m - E)}\right|$$

l_{fin} – distance bewteen MCP joint and finger splint tip
$F_{passive}$ – measured tangential force
r – internal circular radius
A to F – Fitting parameters

Results Comparison:

SECA-Finger modeling **vs.** standard stiffness evaluation system

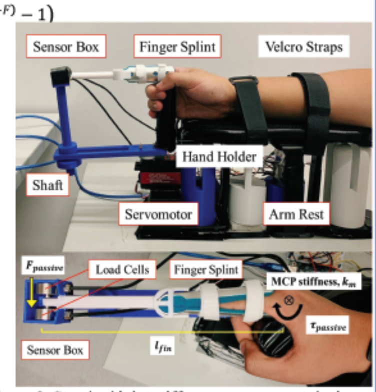


Figure 2. Standard joint stiffness measurement device

2.2 Verification Methods

Subjects:

Four chronic stroke subjects who had demonstrated weak hand strength with moderated level of finger flexor spasticity was recruited. Four healthy subjects from the laboratory also participated in the study to serve as the control.

Protocol:

1. Index finger is selected as a stiffness indicator of the hand for both SECA-Finger modeling and ground-truth stiffness evaluation. The SECA is placed on the index finger in an unpressurized state. Pressure is then increased step by step from zero by 20 kPa one at a time to move the MCP joint to different angles, which the measured angles and the corresponding pressure values are recorded. Three repetitions are performed to measure the passive MCP joint angle.
2. During the ground-truth stiffness evaluation, the DIP and PIP joints in the index finger are clamped by the finger splint, allowing solely the MCP joint to be rotated by the servomotor in horizontal plane. The test range of motion is from 0° to 90° . Joint stiffness is further obtained by derivative of the measured passive moment.

3. RESULTS AND DISCUSSION

TABLE I. Summarization of MCP joint stiffness characteristic with different measurement approaches

	MAS	θ_{0_m}	$[\theta_{i\_m}, \gamma\theta_{0\_m}]$	M1 k_m (Nm/rad)	M2 k_m (Nm/rad)	Difference
S1	1+	54°	[18° , 38°]	0.085	0.081	0.004
S2	3	51°	[30° , 36°]	0.636	0.626	0.011
S3	2	64°	[30° , 36°]	0.522	0.501	0.021
S4	1+	35°	[30° , 36°]	0.093	0.086	0.007
H1	-	45°	[10° , 32°]	0.038	0.032	0.006
H2	-	46°	[9° , 32°]	0.033	0.028	0.005
H3	-	40°	[10° , 28°]	0.047	0.041	0.006
H4	-	58°	[11° , 41°]	0.039	0.030	0.009

- The results from two different approaches are similar with each other. From our data, it is also observed that the stiffness from our SECA would be slightly smaller than the actual joint stiffness.
- Here, we believe that the stiffness evaluation method using our SECA is feasible for finger joint stiffness quantification during any rehabilitation training. It would be possible to extend the quantification to the proximal interphalangeal (PIP) or distal interphalangeal joints (DIP) joints as well using our SECA, which has been hard to be accomplished by the standard stiffness measurement device.

REFERENCES

[1] Heung, H.L., et al., *Soft Rehabilitation Actuator With Integrated Post-stroke Finger Spasticity Evaluation.* Frontiers in Bioengineering and Biotechnology, 2020. **8**: p. 111.

[2] Kamper, D.G. and W.Z. Rymer, *Quantitative features of the stretch response of extrinsic finger muscles in hemiparetic stroke.* MUSCLE & NERVE, 2000. **23**(6): p. 954-961.

[3] Heung, K.H., et al., *Robotic glove with soft-elastic composite actuators for assisting activities of daily living.* Soft Robotics, 2019. **6**(2): p. 289-304.

[4] Kuo, P.-H. and A.D. Deshpande, *Muscle-tendon units provide limited contributions to the passive stiffness of the index finger metacarpophalangeal joint.* Journal of Biomechanics, 2012. **45**(15): p. 2531-2538.

ACKNOWLEDGEMENT

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P06 | Cathy CY LAU | The Chinese University of Hong Kong

Exoskeleton Knee Robot-assisted Gait Training for persons after stroke

Exoskeleton Knee Robot-assisted Gait Training for persons after stroke

Cathy CY Lau[1], Ling-Fung Yeung[1], Charles WK Lai[2], Yannie OY Soo[3], Man-Lok Chan[4], and Raymond KY Tong[1*]

[1]Department of Biomedical Engineering, The Chinese University of Hong Kong
[2]Physiotherapy Department, Shatin Hospital
[3]Department of Medicine and Therapeutics, Prince of Wales Hospital
[4]Physiotherapy Department, Tung Wah Hospital
*Corresponding author: Raymond KY Tong, phone: +852 3943 8454; email: kytong@cuhk.edu.hk

Abstract – Recent developments in lower limb rehabilitation robotics are heavy and bulky. The rehabilitation system consists of a wearable knee-ankle-foot robot, a treadmill, a safety suspending device and a robot body weight support device.[1] In this study, we present a lightweight (1.5kg) portable exoskeleton knee robot developed for persons after stroke. It provides immediate powered knee assistance via servomotor driven by subject's walking intention identified using embedded force and motion sensors. This robot can walk on level ground and stairs.

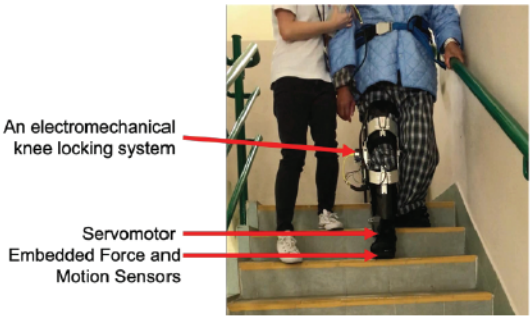


Figure 1. The exoskeleton knee robot.

Six male subjects with early left/right (3:3) ischemic/hemorrhagic (5:1) stroke onset (22±11 days), aged 64±8.5 years old were recruited. They underwent 20-session (five days per week for four weeks) robot-assisted gait training wearing the exoskeleton knee robot. Each gait training session included 20-minute level ground walking and 10-minute stair training. The robot provided power assistance in knee flexion and extension during swing phase of level walking and stair ascend/descend while the rotatory servomotor provides ankle dorsiflexion and plantarflexion assistance at maximum torque 16.7 Nm.[2] During stance phase, the knee robot prevented knee joint collapse using an electromechanical knee locking mechanism. The main purpose was to enable better foot clearance and to compensate for foot drop problem and/or knee weakness, while offering upright standing support.

Clinical assessments were performed before and after the 20-session training and 3-month follow up, including Functional Ambulatory Category, Berg Balance Scale, Six-minute Walk Test and Ten-meter Walk Test, which assessed the gait independency, balance, walking endurance, and walking speed respectively. Nonparametric Wilcoxon Signed Ranks Test and Paired t-test were used to compare changes at different timepoints: before training, after training, and 3-month follow up.

After 20-session, subjects had significantly improvement on all lower limb functionality. The functional improvement could even significantly sustain at 3-month follow up, which suggested this robot-assisted gait training might have long-term therapeutic effects on walking for persons early after stroke.

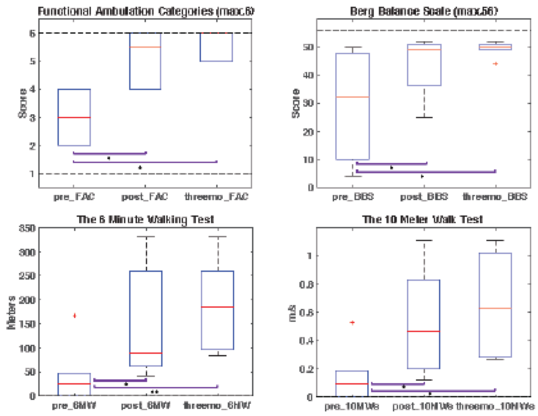


Figure 2. Clinical Assessment Score at baseline, after the training and 3-month follow up. *p<0.05, **p<0.01

Previous meta-analysis showed robot-assisted gait training increased subject's independent walking but did not find significantly increase walking velocity and capacity.[3] In this study, our intervention with stair training may bring an add-on benefit to the subject's walking ability (speed and endurance), hence, increase their confidence. These promising results show that this exoskeleton knee robot can be a potential rehabilitation tool for persons after stroke at an early stage though a randomized controlled trial should be conducted to further confirm the effectiveness of this intervention.

Reference:

[1] Tomida K, Sonoda S, Hirano S, et al. Randomized Controlled Trial of Gait Training Using Gait Exercise Assist Robot (GEAR) in Stroke Patients with Hemiplegia. J Stroke Cerebrovasc Dis. 2019;28(9):2421-2428.

[2] Yeung LF, Ockenfeld C, Pang MK, et al. Randomized controlled trial of robot-assisted gait training with dorsiflexion assistance on chronic stroke patients wearing ankle-foot-orthosis. J Neuroeng Rehabil. 2018;15(1):51. Published 2018 Jun 19. doi:10.1186/s12984-018-0394-7

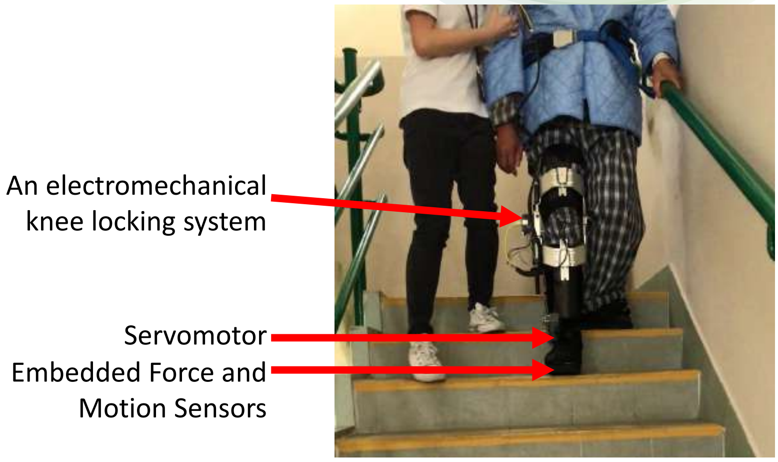
[3] Mehrholz J, Thomas S, Werner C, Kugler J, Pohl M, Elsner B. Electromechanical-assisted training for walking after stroke. Cochrane Database Syst Rev. 2017;5(5):CD006185. Published 2017 May 10.

Methods

Table 1. Demographic. Six stroke subjects were participated in this study.

Characteristics	Knee Group (n=6)
Age (years)	64±8.5
Gender (Male)	6
Affected limb (Right/Left)	3/3
Stroke type (ischemic/haemorrhagic)	5/1
Stroke duration before screening (days)	22±11
Training Duration (days)	52±22

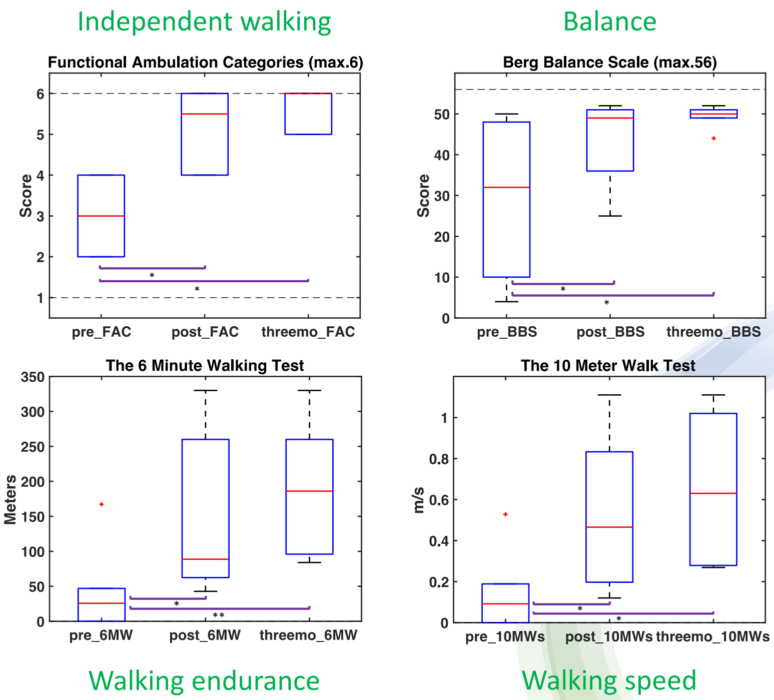
- A lightweight (1.5kg) portable exoskeleton knee robot
- It provides immediate powered knee assistance via servomotor driven by subject's walking intention identified using embedded force and motion sensors. This robot can walk on level ground and stairs
- Six stroke subjects underwent 20-session (five days per week for four weeks) robot-assisted gait training wearing the exoskeleton knee robot
- Each gait training session included 20-minute level ground walking and 10-minute stair training



The main purpose was to enable better foot clearance and to compensate for foot drop problem and/or knee weakness, while offering upright standing support.

Results

- After 20-session, subjects had significantly improvement on all lower limb functionality. The functional improvement could even significantly sustain at 3-month follow up
- This suggested the robot-assisted gait training might have long-term therapeutic effects on walking for persons early after stroke
- These promising results show that this exoskeleton knee robot can be a potential rehabilitation tool for persons after stroke at an early stage



P07 | Lok Chun CHAN
Department of Biomedical Engineering, The Hong Kong Polytechnic University

A Machine-Learning-Based Predictor for the Multi-Aetiological Knee Osteoarthritis with Clinical Data

BME2020
Biomedical Engineering Conference

Title: A Machine-Learning-Based Predictor for the Multi-Aetiological Knee Osteoarthritis with Clinical Data

Lok Chun CHAN[1], Ho Hin Toby LI[1], Chunyi WEN[1]*

1.Department of Biomedical Engineering, The Hong Kong Polytechnic University, Hong Kong

*Corresponding author: Dr. Chunyi Wen

Department of Biomedical Engineering, Faculty of Engineering, The Hong Kong Polytechnic University, Hong Kong

E-mail: chunyi.wen@polyu.edu.hk

Tel: +852-34008898

Abstract

Background: Currently, the knee osteoarthritis (KOA) consultation in Hong Kong public hospitals adopts the first-come-first-serve principle, owing to the lack of accurate KOA progression prediction method. Hence, the absence of an efficient triage system, therapeutic plans are only constructed regarding the current disease severity, which may not be optimum for KOA treatment outcome.

Objectives: By dissecting the multi-aetiology of KOA via a data-driven approach, we aimed to compare contributions of each local (mechanical) or systemic risk factor(s), to either the disease onset or deterioration.

Methods: A machine-learning-based KOA progression prediction model was developed using the data from the National Institute of Health Osteoarthritis Biomarkers Consortium. According to Kellgren Lawrence (KL) grade at baseline, the subjects were divided into either KOA onset (KL-grade 0 and 1) or deterioration (KL-grade 2 and 3) study groups. Changes in both joint space width and WOMAC pain score defined KOA progressors or non-progressors. Together with radiographic and symptomatic data of KOA, the anthropological particulars, injury and surgery history, metabolic syndrome and living habits were inputted into a deep neural network to predict disease progression in each study group. The relative contributions of individual risk factors were weighted by DeepLIFT gradient. Meanwhile, interaction detection algorithm was employed to reveal statistical interactions among the input features.

Results: Our models achieved AUC of 0.843 (95% CI 0.824, 0.862) and 0.765 (95% CI 0.756, 0.774) in prediction of KOA onset and deterioration, respectively. Moreover, in the case of onset prediction, history of mechanical injury has attained high DeepLIFT gradient of 39.1; while for deterioration prediction, the gradients of diabetes and habit of smoking are 21.5 and 14.4 respectively, surpassing the mechanical factors.

Study Implication and Conclusion: The discrepancy in the aetiology between the onset and deterioration of KOA was revealed wherein mechanical injury predominantly triggers the onset of KOA, whilst diabetes and smoking are playing prominent roles and exerting greater influence than the mechanical factors in disease deterioration. The findings would facilitate multidisciplinary healthcare practitioners to establish a personalised treatment protocol.

Project Achievements: 1) Publication to *Osteoarthritis and Cartilage* Journal, 2) Invited presentation at the 2020 OARSI World Congress on Osteoarthritis, 3) Invited exhibition at the 2020 Fall TechConnect Innovation Summit & Showcase, 4) PolyU Micro Fund 2020 Awardee, 5) PolyU Lean LaunchPad Programme 2020 Awardee, 6) HKSTP Science and Technology Entrepreneurship Programme Grantee

A Machine-Learning-Based Predictor for the Multi-Aetiological Knee Osteoarthritis with Clinical Data

Lok Chun CHAN[1], Ho Hin Toby LI[1], Chunyi WEN[1*]

[1] Department of Biomedical Engineering, The Hong Kong Polytechnic University, Hong Kong

[*] Department of Biomedical Engineering, Faculty of Engineering, The Hong Kong Polytechnic University, Hong Kong / chunyi.wen@polyu.edu.hk / +852 3400 8898

OBJECTIVE

We aim to investigate the **contributions of each individual local or systemic risk factors to knee osteoarthritis (KOA) onset and deterioration** using a machine learning approach.

METHODS

FNIH

- Living Habit
- Radiographic Info.
- Demographic Info.
- Symptomatic Particulars
- Metabolic Syndrome
- Mechanical Factors

1. Our machine-learning-based KOA progression prediction model is developed using the data from National Institute of Health Osteoarthritis Biomarkers Consortium.

Data Preprocessing
- Class Labelling
- Missing Data Handling
- Class Imbalance Handling
- Primary Feature Selection

Baseline KL Grade 0 or 1 → **Deep Neural Net Model 1 [KOA Onset]** → KOA Onset Progression Prediction

Identify important features for KOA Onset by DeepLIFT

Baseline KL Grade 2 or 3 → **Deep Neural Net Model 2 [KOA Deterioration]** → KOA Deterioration Progression Prediction

Identify important features for KOA Onset by DeepLIFT

2. The subjects are first divided into either KOA onset or deterioration study groups. The disease progression is defined as the changes in both joint space width (JSW) and WOMAC pain score.

3. Wide array of risk factors were deployed in a deep neural network to predict disease progression in each study group.

4. The relative contributions of each individual risk factors were measured.

RESULTS

Model Performance		
Progression Status	F1	AUROC
Onset	0.837 (0.816-0.858)	0.843 (0.824-0.862)
Deterioration	0.810 (0.79-0.83)	0.765 (0.756-0.774)

Figure 1. Comparison of the statistical models' performance with ROC curves.

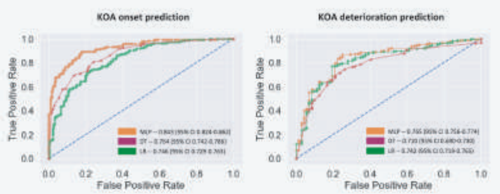


Figure 2. DeepLIFT gradient plots of the input risk factors of KOA onset and deterioration predictions.

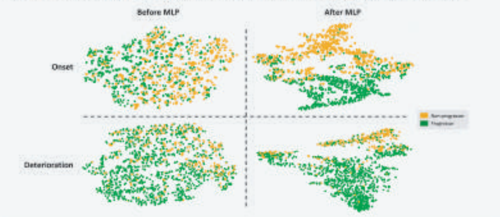
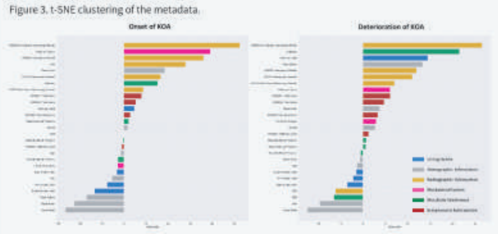


Figure 3. t-SNE clustering of the metadata.



RESULTS

1. For KOA onset prediction, history of injury has is the most contributive factor except joint space narrowing

2. While for KOA deterioration prediction, diabetes and habit of smoking the most impactful risk factors, surpassing the impact of injury.

KOA onset prediction: history of injury

KOA deterioration prediction: diabetes; habit of smoking

CONCLUSION

We developed a deep learning workflow which effectively **dissects the risk factors' contributions and their mutual interactions for onset and deterioration of KOA** respectively.

ACHIEVEMENTS

- Publication to Osteoarthritis and Cartilage Journal
- Invited presentation at the 2020 OARSI World Congress on Osteoarthritis
- Invited exhibition at the 2020 Fall TechConnect Innovation Summit & Showcase
- PolyU Micro Fund 2020 Awardee
- PolyU Lean LaunchPad Programme 2020 Awardee
- HKSTP Science and Technology Entrepreneurship Programme Grantee
- TechConnect Innovation Award
- Invited presentation in Meet Taipei 2020 Arising Vision: A New Horizon of Startups

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CLAIRE Clinical AI Research

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www.claireairesearch.com
claire_hk@outlook.com

November 2020

P08 | Assel ISSABEKOVA

National Center For Biotechnology, Nur-Sultan, Kazakhstan

Determination of optimal way to dendritic cells' priming with tumor antigens for enhanced cytotoxic activity of CIK cells

Determination of optimal way to dendritic cells' priming with tumor antigens for enhanced cytotoxic activity of CIK cells

Assel Issabekova, Madina Zhunussova, Marzhan Zhumabekova, Vyacheslav Ogay

National Center For Biotechnology, Nur-Sultan, Kazakhstan

Correspondence to Authors' Assel Issabekova, National Center For Biotechnology, Nur-Sultan, Kazakhstan, +7(7172)70-75-21, issabekova@biocenter.kz

Adoptive immunotherapies have a clinically proven efficacy, safety and flexibility in application. Combinational treatment with dendritic cells (DCs) and cytokine-induced killer (CIK) cells deserves special attention. DCs act as "intermediary" between innate and adaptive immunity by capturing tumor-associated antigens, processing and presenting them to effector cells on MHC class I molecules. CIK cells are heterogeneous effector cells subset which possess Natural Killer's MHC-unrestricted cytotoxicity and T-cell's CD3 marker. DCs were differentiated from C57BL/6 mouse bone marrow monocytes with IL-4 and GM-CSF. CIK cells were expanded from splenocytes by IFN-gamma, anti-CD3 (Oct3) and IL-2. For DCs' priming heat-shocked cancer cells' (CMT-93) antigens were obtained by freeze-thawing cycles or exposing to chemo drugs (staurosporine, oxaliplatin, oxaliplatin with MTX, oxaliplatin with 5-fluorouracil) or total tumor RNA for 24 hours. DCs maturation were stimulated 2 hours with 50 ng/ml TNF-α, 1 μg LPS. Mature DCs were incubated with CIK cells for 48 hours and then cytotoxicity were investigated on CMT-93 at effector-to-target ratio 5:1. According to assessed results the highest lytic activity belonged to CIK cells activated by DCs primed with antigens of MTX+oxaliplatin treated tumor by polyethylene glycol 51 % (p value ≤ 0.0001) in comparison to CIK cells without activation - 3.57%. MTX+oxaliplatin induce immunogenic tumor cell death and give promising strategy for DCs loading for combinational therapy with CIK cells.

Supported by a grant AP05135467 "Development of production technology of dendritic vaccines and cytokine-induced killer cells for combination therapy in colorectal cancer" from the MES RK.

Determination of optimal way to dendritic cells' priming with tumor antigens for enhanced cytotoxic activity of CIK cells

Assel Issabekova, Madina Zhunussova, Marzhan Zhumabekova, Vyacheslav Ogay

Stem cells laboratory, National Center for Biotechnology, Nur-Sultan, Kazakhstan

Abstract

Adoptive immunotherapies have a clinically proven efficacy, safety and flexibility in application. Combinational treatment with dendritic cells (DCs) and cytokine-induced killer (CIK) cells deserves special attention. DCs act as "intermediary" between innate and adaptive immunity by capturing tumor-associated antigens, processing and presenting them to effector cells on MHC class I molecules. CIK cells are heterogeneous effector cells subset which possess Natural Killer's MHC-unrestricted cytotoxicity and T-cell's CD3 marker. Supported by a grant AP05135467 "Development of production technology of dendritic vaccines and cytokine-induced killer cells for combination therapy in colorectal cancer" from the Ministry of Education and Science of the Republic of Kazakhstan.

Background

- A number of studies indicate adoptive immunotherapy is a perspective method of cancer treatment.
- CIK cells characterized by MHC-unrestricted cytolytic activity.
- DCs are proficient antigen-presenting cells which capture and process tumor-associated antigens.
- Variety of techniques for obtaining antigens have been described
- DCs were differentiated from C57BL/6 mouse bone marrow monocytes with IL-4 and GM-CSF. CIK cells were expanded from splenocytes by IFN-gamma, anti-CD3 and IL-2. For DCs' priming heat-shocked cancer cells' antigens were obtained by freeze-thawing cycles or exposing to chemo drugs (staurosporine, oxaliplatin, oxaliplatin with MTX, oxaliplatin with 5-fluorouracil) or total tumor RNA for 24 hours. DCs maturation were stimulated 2 hours with 50 ng/ml TNF-α, 1 μg LPS. Mature DCs were incubated with CIK cells for 48 hours and then cytotoxicity were investigated on CMT-93 at effector-to-target ratio 5:1. According to assessed results the highest lytic activity belonged to CIK cells activated by DCs primed with antigens of MTX+oxaliplatin treated tumor by polyethylene glycol 51 % (p value ≤ 0.0001) in comparison to CIK cells without activation - 3.57%. MTX+oxaliplatin induces immunogenic tumor cell death and gives promising strategy for DCs loading for combinational therapy with CIK cells.

Methods

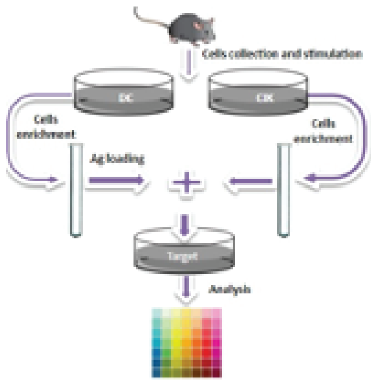

Figure 1. Methods description. Mouse rectum carcinoma cell line CMT-93 was used as a target. CIK cells and DCs were expanded from spleen and bone marrow and stimulated by IFN-gamma, anti-CD3,IL-2 and IL-4, GM-CSF respectively. After cultivation CIK cells and DC isolation was performed by positive magnetic separation with CD8 biotinylated mAb and double negative separation with dendritic cells cocktail. Further DCs were loaded with CMT-93 antigens obtain by different techniques. Antigen loaded DCs were co-cultured with CD8+ CIK at a cell ratio of 1:10 for 24 h. *In vitro* CIK cells cytotoxicity was determined by MTT-assay.

Results and Discussion

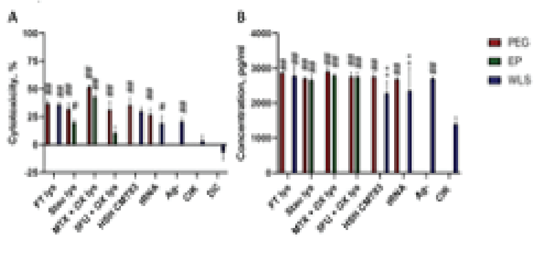

Figure 2 - Cytolytic activity of the CD8a-positive fraction after stimulation with MoDCs after different methods of antigen loading and IFN-gamma production. *P<0.05, **P<0.005, #P≤ 0.001, ##P ≤ 0.0001.

Conclusion

The optimal delivery strategy and type of tumour antigens are one of the most important factors for the success of DC-based anticancer vaccines. As shown in our results, MTX-OX-induced immunogenic apoptotic tumour cell-stimulated DCs exhibit the largest activation potential of CIK cell cytotoxicity.

P09 | Chun Kwan CHEN and Bee Luan KHOO | City University of Hong Kong

Reliable Detection of Low Abundance Diseased Cells from Urine Biopsy Using Inertial Microfluidics

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Reliable Detection of Low Abundance Diseased Cells from Urine Biopsy Using Inertial Microfludics

Chun Kwan CHEN, Bee Luan KHOO
City University of Hong Kong, Hong Kong, China

Abstract:

Urine biopsy is a promising alternative to tissue biopsy in disease diagnosis and surveillance and offers a real-time non-invasive approach that is ideal for long-term patient monitoring. Urine biopsy has been utilized to detect streptococcus pneumonia infection, diabetes, tuberculosis, prostate cancer, and bladder cancer (BC). Among them, BC has a high recurrence rate, which requires routine monitoring and high costs. Low concentration of BC cells (EBCCs) can be spontaneously exfoliated into urine at low concentrations. However, current EBCC-based BC detection methods, such as enumeration and urinary cytology, are limited by low sensitivity. Here, we present an inertial focusing based microfluidic technology to detect low-abundance EBCCs from urine biopsy. Despite the heterogeneous composition of urinary constituents, larger EBCCs could still be efficiently separated from other urinary components based on size differences. The microfluidic technique enables the detection of EBCCs at high sensitivity (93.3 ± 4.8%) and high processing rates (1 ml per min) with ease in handling and operation. The isolated EBCCs were highly viable and complementary for downstream analysis. Considering the advantages of our technology, the microfluidic platform has great potential in point-of-care COVID-19 testing and will be able to complement existing strategies (such as immunolabeling) to enhance the sensitivity and specificity of COVID-19 testing.

Reliable Detection of Low Abundance Diseased Cells from Urine Biopsy Using Inertial Microfluidics

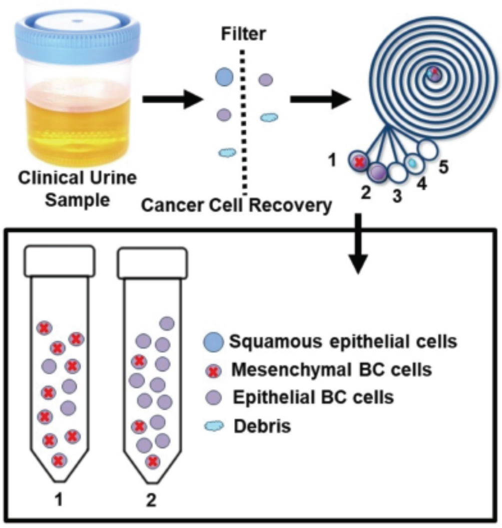
Chun Kwan CHEN[1], Chwee Teck LIM[2], Khoo Bee Luan[1]*

1 Department of Biomedical Engineering, CityU, 2 Department of Biomedical Engineering, NUS

*Contacts: blkhoo@cityu.edu.hk

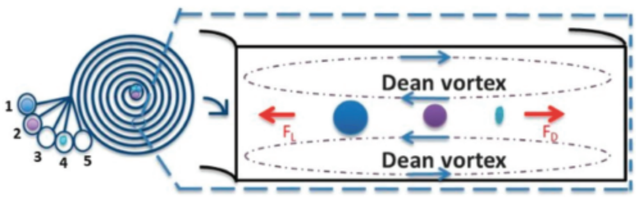
ABSTRACT

Bladder cancer (BC) requires lifelong monitoring due to its high recurrence rate. Since a low amount of BC cells will be spontaneously exfoliated into patient urine, these exfoliated bladder cancer cells (EBCCs) can be utilized for urine biopsy. However, current EBCC-based BC detections are limited by low sensitivity. Here, we present an inertial based microfluidic technology to separate EBCCs from urine biopsy, based on cell size differences [1]. The technique can rapidly isolate EBCCs at high sensitivity (93.3 ± 4.8%) with ease in handling, and those isolated EBCCs were highly viable for downstream analysis.



METHODS

The separation of EBCCs is achieved as a result of the combination of inertial lift force (F_L) and Dean drag force (F_D) in curvilinear channel [2]. The particle size-depending of F_L and F_D enables larger EBCCs (~13 μm) encountering a larger F_L to balance F_D at the position closer to the inner channel compared to other smaller components (≤13 μm).



IMPACT AND SIGNIFICANCE

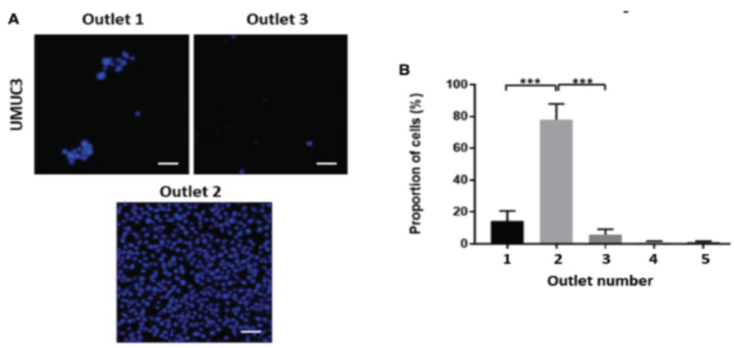
High sensitivity of target cells collected (93.3 ± 4.8%)

High viability of target cells (> 85.3%)

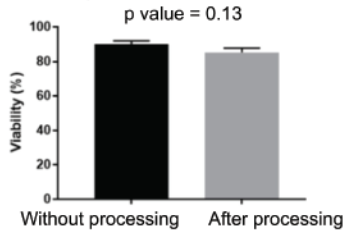
Fast processing time (1 ml/min)

Simplicity in handling and operation, without antibodies involved.

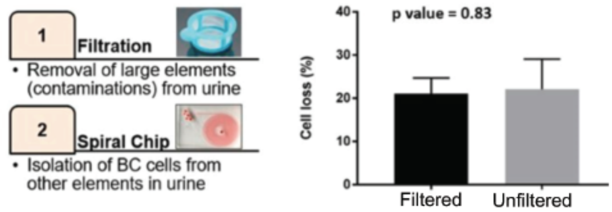
RESULTS



Most of the target cells (blue) go in the outlet 2 (77.4 ± 6.2%), while almost no cells found in the least two outlets (2.54 ± 1.0%). The first three outlets were utilized for maximizing recovery (93.3 ± 4.8%).



No significant difference in cell viability was observed between the pre-sorted group (90 ± 2.5%) and the sorted group (85.3 ± 2.5%).



No significant difference in cell counts between before and after filtration. The pre-filtration step would not cause significant cell loss.

CONCLUSIONS

The microfluidic platform demonstrates a great potential to complement existing COVID-19 testing techniques to improve the **portability**, **sensitivity** and **specificity** of COVID-19 testing.

REFERENCES

1. Khoo, Bee Luan, et al. "Detection of clinical mesenchymal cancer cells from bladder wash urine for real-time detection and prognosis." *Cancers* 11.9 (2019): 1274.
2. Chen, C. K., & Khoo, B. L. (2020). A density-based threshold model for evaluating the separation of particles in heterogeneous mixtures with curvilinear microfluidic channels. *Scientific reports*, *10*(1), 1-12.

P10 | Jianpan HUANG | City University of Hong Kong

Deep neural network-based CEST MRI detects protein changes in the brain for sensitive identification of Alzheimer's disease

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Deep neural network-based CEST MRI detects protein changes in the brain for sensitive identification of Alzheimer's disease

Jianpan Huang[1#], Joseph H. C. Lai[1#], Xiongqi Han[1], Kannie W. Y. Chan[1-3*]

[1]Department of Biomedical Engineering, City University of Hong Kong, Hong Kong, China; [2]City University of Hong Kong Shenzhen Research Institute, Shenzhen, China; [3]Russell H. Morgan Department of Radiology and Radiological Science, The Johns Hopkins University School of Medicine, Baltimore, MD, USA

[#]Authors contributed equally

[*]Corresponding author: Kannie W. Y. Chan; Phone: 852-34429141; Email: KannieW.Y.C@cityu.edu.hk

Introduction

Identification and stratification of Alzheimer's disease (AD) play are essential because many treatments are effective to slow-down disease progression only at an early stage (1,2). Chemical exchange saturation transfer (CEST) magnetic resonance imaging (MRI) is a new imaging technique which can detect low-concentration metabolites with exchangeable protons, such as protein and glucose (3-7). The so-called Z-spectrum containing these molecular information is used to characterize CEST contrasts (3,8). We have demonstrated that CEST MRI can detect abnormal glucose uptake and clearance in AD mouse brain (9-11). Here, we applied deep neural network (DNN) for Z-spectrum analysis to detect the amide protein transfer (APT) signal changes related to protein aggregation in AD mouse brain.

Methods

All animal experiments were approved by the Animal Ethics Committee and followed the institutional guidelines of Institutional Laboratory Animal Research Unit of City University of Hong Kong. Five AD mice (APP/PS1, 12M, male, Jackson Laboratory, Maine) and ten age-matched WT mice were used in this study. All CEST MRI data were acquired on a horizontal bore 3T Bruker BioSpec system (Bruker, Germany). The DNN was a fully connected neural network with three hidden layers (100, 200 and 100 neurons, respectively), as shown in Fig. 1, where the inputs were full Z-spectra and the outputs were the predicted values for multiple CEST contrasts, including APT, relayed nuclear Overhauser enhancement (rNOE) and magnetization transfer contrast (MT). Multi-pool Lorentzian fitting (MLF) results were used as targets during training and as references during testing (12).

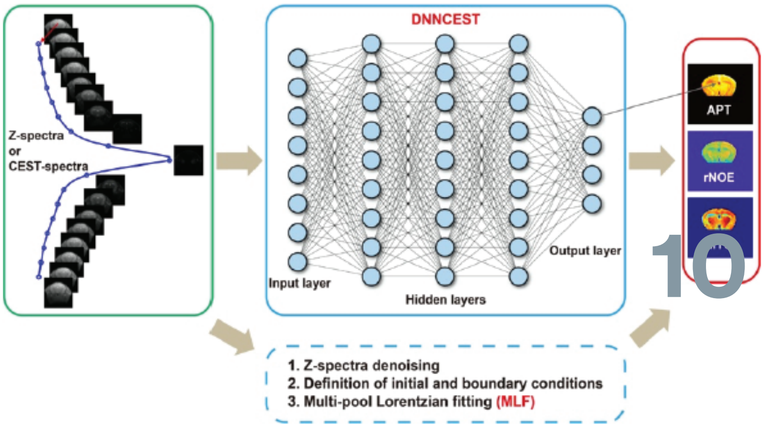

Fig. 1. Schematic diagram of the DNNCEST with inputs of Z-spectra and outputs of multiple CEST contrasts (APT, rNOE and MTC). Multi-pool Lorentzian fitting results were used as targets during training and as references during testing.

Results

Multiple CEST contrast maps were rapidly obtained by a well-trained DNNCEST within 1s on a general computer. We applied the trained DNN on the CEST data acquired from AD mice. Results showed that the APT signal of AD mice are significantly lower than that of age-matched WT mice (7.9±0.5%versus 8.8±0.5%, P<0.001), indicating the protein aggregation in AD mouse brains (Fig. 2).

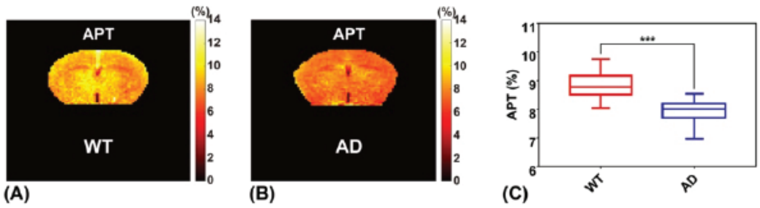

Fig. 2. APT results detected by DNNCEST. Representative APT maps of WT (A) and AD (B) mouse brains. (C) Multiple comparison results of APT signal from whole brain regions of WT (n = 10) and AD (n = 5).

Conclusion

We applied an DNN-based CEST MRI to detect protein-related changes in AD mouse brain at clinical-field-strength 3T scanner. Results showed that DNNCEST can generate multiple CEST contrast maps with high accuracy faster than the state-of-the-art MLF method. Moreover, DNNCEST detected a significant lower protein-related APT signal in AD mouse brain than age-matched WT mouse brain, which could provide valuable information for noninvasive AD diagnosis.

Acknowledgements: RGC [11102218], NSFC [81871409], CityU [9680247, 7005210, 9667198, 6000660].

References

1. Mangialasche F, et al. Lancet Neurol 2010:9(7):702-716. 2. Goedert M, et al. Science 2006:314(5800):777-781. 3. van Zijl PC, et al. Magn Reson Med 2011:65(4):927-948. 4. Ward K, et al. J Magn Reson 2000:143(1):79-87. 5. Zhou J, et al. Magn Reson Med 2003:50(6):1120-1126. 6. Chan KWY, et al. Magn Reson Med 2012:68(6):1764-1773. 7. Walker-Samuel S, et al. Nat Med 2013:19(8):1067-1072. 8. Zaiss M, et al. Phys Med Biol 2013;58(22):R221-R269. 9. Chen L, Chan KW, Huang J, et al. J Cereb Blood Flow Metab 2020:0271678X20941264. 10. Huang J, Chan KWY, et al. Sci Adv 2020;6(20):eaba3884. 11. Huang J, Chan KWY, et al. Alzheimers Dement 2019:15(7):P747. 12. Zaiss M, et al. J Magn Reson 2011;211(2):149-155.

Deep neural network-based CEST MRI detects protein changes in the brain for sensitive identification of Alzheimer's disease

Jianpan Huang[1#], Joseph H. C. Lai[1#], Xiongqi Han[1], Kannie W. Y. Chan[1,2,3*] (E-mail: KannieW.Y.C@cityu.edu.hk)
[1]Department of Biomedical Engineering, City University of Hong Kong, Hong Kong, China
[2]Russell H. Morgan Department of Radiology and Radiological Science, The Johns Hopkins University School of Medicine, Baltimore, MD, USA
[3]City University of Hong Kong Shenzhen Research Institute, Shenzhen, China

Introduction

Identification and stratification of AD play are essential because many treatments are effective to slow-down disease progression only at an early stage [1]. Chemical exchange saturation transfer (CEST) magnetic resonance imaging (MRI) is a new imaging technique which can detect low-concentration metabolites with exchangeable protons, such as protein and glucose [2-5]. The so-called Z-spectrum containing these molecular information is used to characterize CEST contrasts [2,6]. We have demonstrated that CEST MRI can detect abnormal glucose uptake and clearance in AD mouse brain [7-9]. Here, we applied deep neural network (DNN) for CEST (DNNCEST) analysis to detect the amide protein transfer (APT) signal changes related to protein aggregation in AD mouse brain.

Methods

For DNNCEST, the inputs were Z-spectra and outputs were multiple CEST contrasts (APT, rNOE and MTC). Multi-pool Lorentzian fitting (MLF) [10] results were used as targets during training and as references during testing (Fig. 1).

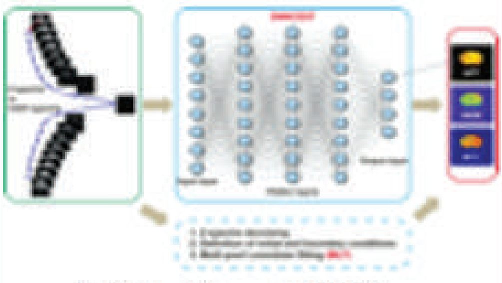

Fig. 1. Schematic diagram of the DNNCEST.

Results

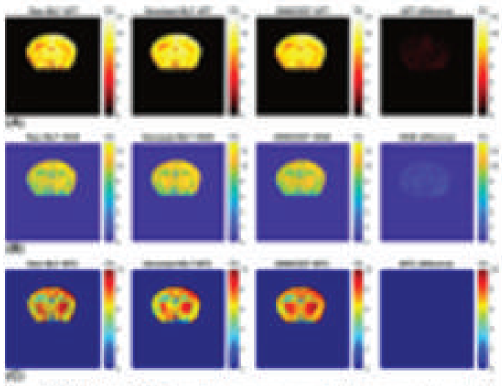

Fig. 2. Multiple CEST contrast maps generated by raw or denoised MLF and DNNCEST.

Fig. 3. APT results on wild type (WT) and AD mouse brains detected by DNNCEST.

Discussion

Multiple CEST contrast maps can be easily obtained by a well-trained DNNCEST within 1s on a general computer. Moreover, CEST contrast maps generated by DNNCEST were intrinsically denoised while maintaining more structures compared to the raw MLF and denoised MLF. (Fig. 2). We applied the trained DNN on the CEST data acquired from AD mice. Results showed that the APT signal of AD mice are significantly lower than that of age-matched WT mice (7.9±0.5%versus 8.8±0.5%, P<0.001), indicating the protein aggregation in AD mouse brains (Fig. 3).

Conclusion

We applied an DNN-based CEST MRI to detect protein-related changes in AD mouse brain at clinical-field-strength 3T scanner. Results showed that DNNCEST can generate multiple CEST contrast maps with high accuracy faster than the state-of-the-art MLF method. Moreover, DNNCEST detected a significant lower protein-related APT signal in AD mouse brain than age-matched WT mouse brain, which could provide valuable information for noninvasive AD diagnosis.

Acknowledgement

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References

1. Mangialasche F, et al. Lancet Neurol 2010:9(7):702-716. 2. van Zijl PC, et al. Magn Reson Med 2011:65(4):927-948. 3. Ward K, et al. J Magn Reson 2000:143(1):79-87. 4. Zhou J, et al. Magn Reson Med 2003:50(6):1120-1126. 5. Chan KWY, et al. Magn Reson Med 2012:68(6):1764-1773. 6. Zaiss M, et al. Phys Med Biol 2013;58(22):R221-R269. 7. Chen L, Chan KW, Huang J, et al. J Cereb Blood Flow Metab 2020:0271678X20941264. 8. Huang J, Chan KWY, et al. Sci Adv 2020;6(20):eaba3884. 9. Huang J, Chan KWY, et al. Alzheimers Dement 2019:15(7):P747. 10. Zaiss M, et al. J Magn Reson 2011;211(2):149-155.

P11 | Guangyuan CHEN | Shandong University

A Novel EEG Signal Feature Extraction Method Based on Visibility Graph for Epilepsy Detection

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A Novel EEG Signal Feature Extraction Method Based on Visibility Graph for Epilepsy Detection

Guangyuan Chen[1], Raymond Kai-yu Tong[2] and Guoliang Lu[1]

[1] Key Laboratory of High Efficiency and Clean Mechanical Manufacturing of MOE, National Demonstration Center for Experimental Mechanical Engineering Education, School of Mechanical Engineering, Shandong University, Jinan, China

[2] Department of Biomedical Engineering, The Chinese University of Hong Kong, Hong Kong, China

Email: sducgy@outlook.com; kytong@cuhk.edu.hk; luguoliang@sdu.edu.cn.

***Abstract*—Recently, Epilepsy detection through Electroencephalogram (EEG) has become a long-standing problem. The essential problem of epilepsy detection is to classify and recognize the EEG signals. In order to classify the EEG signals, many feature extraction methods have been proposed. This paper proposes a new method to extract the potential information of EEG signals based the correlation of frequency components. The power spectrum of the EEG signal is used for visibility graph construction. Then the probability distribution function is calculated via the similarity of graphs, so as to classify and diagnose the candidate EEG signal. In order to verify the effect of our feature extraction method, the experiment was implemented based on the CHB-MIT Scalp EEG Database. The normal and abnormal testing data are classified, and the final result proves the effectiveness of our method.**

Keywords—visibility graph, EEG signal, feature extraction, similarity measure, kernel density estimation

I. METHOD

A. Time-frequency transform

Firstly, $X=\{x_1,x_2,\cdots,x_N\}$ is assumed to represent a EEG signal segment with length *N*. For propose of describing the condition essentially, the graph is constructed based on spectral analysis. Therefore, discrete Fourier transform (DFT) [1] is the first step which is calculated by,

$$Y(k)=\sum_{n=0}^{N-1}x(n)e^{-j(2\pi/N)kn} \tag{1}$$

where $Y(k)$ is the amplitude of X in frequency domain at *k*Hz. It should be noted that the main frequency components of a epilepsy are [0.1, 30] Hz [2]. Therefore, a sub-band pass filter of [0.1, 30] Hz is utilized to capture these frequencies.

For the sake of performing spectral analysis strictly, the power spectrum is utilized to describe the frequency domain information instead of frequency spectrum. It can be obtained through the periodogram method [3], which can be calculated by

$$\hat{P}(k)=\frac{1}{T}|Y(k)|^2 \tag{2}$$

where $\hat{P}(k)$ is the power spectrum amplitude at *k*Hz.

B. Visibility graph model construction

In order to express the relevant information of each component in the signal $P(k), k=1,2,\cdots,K$, it is mapped into a weighted complex network [4]. Therefore, the visibility graph is adopted in this method. The construction of visibility graph model is described as following steps (as depicted in Fig. 1):

1) For the purpose of transforming the signal $P(k)$ into a weighted complex network, a matrix $G(K,K)$ is first constructed. There are K^2 nodes in the graph, and $G(i,j)=w_{i,j}$ represents the edge weight between the *i*th and *j*th nodes.
2) Whether there is an edge between the *i*th and *j*th nodes depends on the following formula

$$P(k)<P(i)+[P(j)-P(i)]\frac{P(k)-P(i)}{P(j)-P(i)}, i<k<j \tag{3}$$

where *i*, *j* and *k* are the nodes corresponds to the data sample points $P(i)$, $P(j)$ and $P(k)$. If for any $k\in[i+1,\cdots,j-1]$, the Eq.3 holds, then the edge between the *i*th and *j*th nodes exists.

3) Then the edge weight between the ith and jth nodes will be calculated as

$$w_{i,j}=\frac{P(j)-P(i)}{j-i}, j>i \tag{4}$$

where, $w_{i,j}$ is the edge weight between node i and j and also directional in nature from i to j.

4) Therefore, the visibility graph G can be constructed based on the edges weight values.

Through the above steps, the signal $P(k)$ will be converted into a visibility graph G. The correlation information can be extracted by visibility graph in one-dimensional data to describe the structured characteristics of the signal.

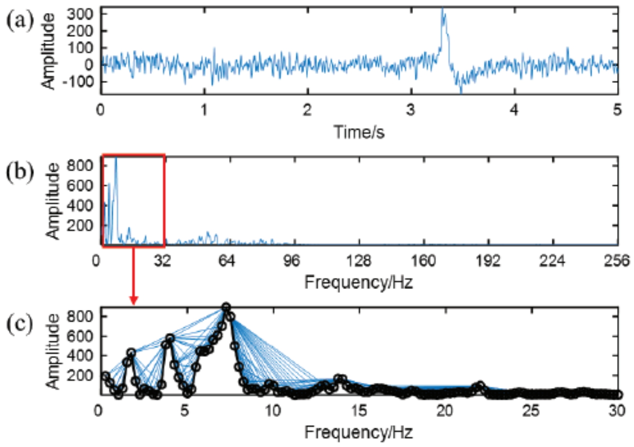

Fig. 1 The process of visibility graph model construction.

C. Similarity quantification

In graph analysis, choosing an appropriate metric to measure the distance of graphs is an important issue. The common used distance metrics have been tested in [5], which proves the superiority of the edge-weight values (DEWV) metric. Therefore, DEWV is also adopted in this paper as similarity score s. The calculation of it is given as,

$$\mathrm{L}(G,G')=\sum_{i=1}^{K}\sum_{j=1}^{K}\left|w_{i,j}-w'_{i,j}\right|. \tag{5}$$

D. Decision making

First, the graphs calculated based on normal data segments are organized as template set. Then, for a graph model of a data segment, the sum of the similarity scores with all template segments is regarded as the similarity with the template set. In this way, the similarity scores of the same type of data (normal or abnormal) can be considered to conform to the same distribution. The kernel density estimation method is used to calculate its probability distribution function [6]

$$\hat{f}(s)=\frac{1}{mh}\sum_{i=1}^{m}K(\frac{s-s_i}{h}) \tag{6}$$

where h is a smoothing parameter which is called bandwidth and calculated through the rule of thumb. $K(\cdot)$ represents the kernel function. In this paper, it is assumed that the similarity scores satisfy the Gaussian distribution, so the Gaussian kernel is used as the kernel function $K(\cdot)$, which can be calculated as

$$K(s)=\frac{1}{\sqrt{2\pi}}\exp(-\frac{1}{2}s^2). \tag{7}$$

As described above, two corresponding probability distribution functions can be obtained for both normal data and abnormal data. Therefore, the probabilities of normal and abnormal for the candidate segment can be obtained based on the probability distribution functions to classify.

II. Experiment

A. Testing Data Preparation

The data used in this experiment comes from CHB-MIT Scalp EEG Database [7]. The data in the database is divided into segments with 5s. The composition of the experimental data is shown in Table 1. 100 pieces of normal data are used as a template data set. 100 normal segments and abnormal segments are used as the training data set to calculate the probability distribution functions. Another 100 segments of normal data and abnormal data are used for testing.

Table 1 The number of data in the experimental dataset.

	Normal	Epilepsy
Template set	100	
Training set	100	100
Testing set	100	100

B. Experiment Implement and Result

For an experiment, the training data sets are used to calculate the probability distribution function, as shown in Fig. 2. It can be seen that the shapes of two functions are obviously different, which shows that our feature extraction method is very effective. In addition, the left side of the two functions is relatively steep, in contrast, the right side extends farther. This proves that there are outliers in both data sets, which are less similar to the template dataset. This fully illustrates the complexity of EEG signals.

Fig. 2 An example of the probability distribution functions.

Then the probability of each testing data is calculated for classification. The results are shown in Table 2. It can be seen that the Accuracy of normal and epilepsy are both 89%.

Table 2 The result of classification.

	Normal	Epilepsy
True	89	89
False	11	11

In order to count the Accuracy more scientifically, 10 data preparations are conducted and the experiment is implemented 10 times. The experimental results are shown in Table 3. It can be seen that for the two types of data, the classification Accuracy is concentrated between 80% and 90%, and the average total Accuracy is 85.85%, which proves the effectiveness of our method.

Table 3 The statistic results.

	Normal	**Epilepsy**	**Total**
No.1	88%	84%	86%
No.2	87%	80%	83.5%
No.3	90%	85%	87.5%
No.4	86%	81%	83.5%
No.5	87%	87%	87%
No.6	84%	85%	84.5%
No.7	87%	81%	84%
No.8	89%	85%	87%
No.9	88%	85%	86.5%
No.10	89%	89%	89%
Average	**87.5%**	**84.2%**	**85.85%**

For the sake of proving the superiority of our proposed method, it is compared with the complete graph method (proposed in [8]) and commonly used features such as Mean, Root Mean Square (RMS), Kurtosis and Skewness. The Accuracy for each method is shown in Table 4.

Table 4 The result of comparative experiment.

	Normal	Epilepsy	Total
Our method	87.5%	**84.2%**	**85.85%**
Complete graph	70%	81%	75.5%
Mean	82%	51%	66.5%
RMS	**97%**	39%	68%
Kurtosis	77%	70%	73.5%
Skewness	61%	78%	69.5%

It can be seen that for normal data, RMS is the most effective method, with an accuracy of 97%. However, due to its poor recognition effect on Epilepsy, its total Accuracy is low which means that its distinguishing ability is not strong. In contrast, our method is second only to the RMS method in recognition of normal conditions, and it has the highest Accuracy in Epilepsy recognition. Therefore, its Accuracy surpasses all comparison methods including complete graph method. This fully reflects the superiority of our method.

III. Conclusion

The objective of this paper is to design a feature extraction method for EEG classification in epilepsy detection. The graph model is constructed based on the power spectrum of the EEG signal. Then the probability distribution functions are obtained through kernel density estimation method to classify the EEG. The experimental results prove the effectiveness of our proposed feature extraction method.

The proposed feature extraction method is based on visibility graph, which can effectively extract the potential structured information of EEG. But in the similarity measurement, only the most common metric is considered. In the future, more effective similarity metrics will be designed in the future.

References

[1] Hassan, A. R., Siuly, S., & Zhang, Y. (2016). Epileptic seizure detection in EEG signals using tunable-Q factor wavelet transform and bootstrap aggregating. *Computer methods and programs in biomedicine*, 137, 247-259.

[2] Subasi, A., & Gursoy, M. I. (2010). EEG signal classification using PCA, ICA, LDA and support vector machines. *Expert systems with applications*, 37(12), 8659-8666.

[3] Liu, Q., Zhao, X. G., & Hou, Z. G. (2014, September). Metric learning for event-related potential component classification in EEG signals. In *2014 22nd European Signal Processing Conference (EUSIPCO)* (pp. 2005-2009). IEEE.

[4] Lacasa, L., Luque, B., Ballesteros, F., Luque, J., & Nuno, J. C. (2008). From time series to complex networks: The visibility graph. *Proceedings of the National Academy of Sciences*, 105(13), 4972-4975.

[5] Lu, G., Chen, G., Shang, W., & Xie, Z. (2020). Automated detection of dynamical change in EEG signals based on a new rhythm measure. *Artificial Intelligence in Medicine*, 107, 101920.

[6] Baranowski, J., Piątek, P., Kawala-Janik, A., Pelc, M., & Anthony, R. J. (2012, December). Application of Kernel density estimators for analysis of EEG signals. In *International Conference on Ubiquitous Computing and Ambient Intelligence* (pp. 403-406). Springer, Berlin, Heidelberg.

[7] Shoeb, A. H. (2009). *Application of machine learning to epileptic seizure onset detection and treatment* (Doctoral dissertation, Massachusetts Institute of Technology).

[8] Lu, G., Chen, G., Shang, W., & Xie, Z. (2020). Automated detection of dynamical change in EEG signals based on a new rhythm measure. *Artificial Intelligence in Medicine*, 107, 101920.

A Novel EEG Signal Feature Extraction Method Based on Visibility Graph for Epilepsy Detection

Guangyuan Chen[1], Raymond Kai-yu Tong[2] and Guoliang Lu[1]

[1] Key Laboratory of High Efficiency and Clean Mechanical Manufacturing of MOE, National Demonstration Center for Experimental Mechanical Engineering Education, School of Mechanical Engineering, Shandong University, Jinan, China
[2] Department of Biomedical Engineering, The Chinese University of Hong Kong, Hong Kong, China

Abstract

Recently, Epilepsy detection through Electroencephalogram (EEG) has become a long-standing problem. The essential problem of epilepsy detection is to classify and recognize the EEG signals. In order to classify the EEG signals, many feature extraction methods have been proposed. This paper proposes a new method to extract the potential information of EEG signals based the correlation of frequency components. The power spectrum of the EEG signal is used for visibility graph construction. Then the probability distribution function is calculated via the similarity of graphs, so as to classify and diagnose the candidate EEG signal. In order to verify the effect of our feature extraction method, the experiment was implemented based on the CHB-MIT Scalp EEG Database. The normal and abnormal testing data are classified, and the final result proves the effectiveness of our method.

Method

1. Time-frequency transform

The EEG signal is represented as $X = \{x_1, x_2, \cdots, x_N\}$. Firstly, it is transformed into frequency domain through

$$Y(k) = \sum_{n=0}^{N-1} x(n) e^{-j\left(\frac{2\pi}{N}\right)kn}$$

Here, a sub-band pass filter of [0.1, 30] Hz is utilized to capture these frequencies.

Then the power spectrum is utilized to describe the information instead of frequency spectrum

$$\hat{P}(k) = \frac{1}{T}|Y(k)|^2$$

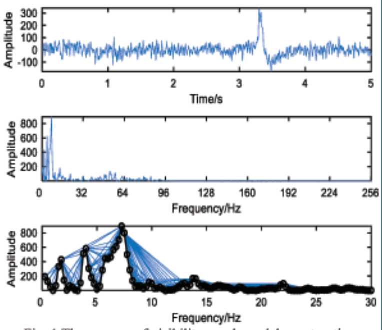

Fig. 1 The process of visibility graph model construction.

2. Visibility graph construction

In order to express the relevant information of each component in the signal, it is mapped into a visibility graph.

3. Similarity quantification

DEWV is also adopted in this paper as score s to measure the similarity of visibility graphs. The calculation of it is given as,

$$\mathcal{L}(G, G') = \sum_{i=1}^{K}\sum_{j=1}^{K} |w_{i,j} - w'_{i,j}|$$

4. Decision making

First, the graphs calculated based on normal data segments are organized as template set. Then, for a graph model of a data segment, the sum of the similarity scores with all template segments is regarded as the similarity with the template set. In this way, the similarity scores of the same type of data (normal or abnormal) can be considered to conform to the same distribution. The kernel density estimation method is used to calculate its probability distribution function

$$\hat{f}(s) = \frac{1}{mh}\sum_{i=1}^{m} Q\left(\frac{s - s_i}{h}\right)$$

Where $Q(s)$ represents the Gaussian kernel function calculated as

$$Q(s) = \frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2}s^2\right)$$

Therefore, two corresponding probability distribution functions can be obtained for both normal data and abnormal data. So the probabilities of normal and abnormal for the candidate segment can be obtained based on the probability distribution functions to classify.

Visibility Graph Construction

1. Node

Each data point of the sequence is regarded as a node of the graph.

2. Edge

The existence condition of edge

$$x(t_c) < x(t_a) + (x(t_b) - x(t_a))\frac{t_c - t_a}{t_b - t_a}, a < c < b$$

3. Weight

Calculate weight based on

$$\omega_{ab} = \frac{x(t_b) - x(t_a)}{t_b - t_a}$$

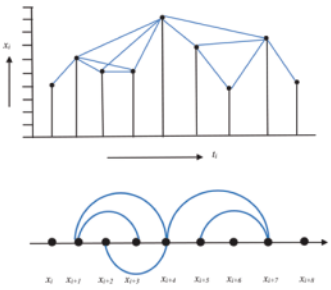

Fig. 2 The diagram of visibility.

Experiment

The data used in this experiment comes from CHB-MIT Scalp EEG Database. The composition of the dataset is shown in the table.

	Normal	Epilepsy
Template set	100	
Training set	100	100
Testing set	100	100

Table. 1 The composition of the experimental data.

An example of the probability distribution functions is shown in Fig.3. The shapes of two functions are obviously different, which shows that our feature extraction method is very effective.

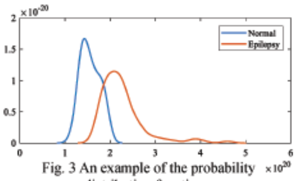

Fig. 3 An example of the probability distribution functions.

The left side of the two functions is relatively steep, in contrast, the right side extends farther. This proves that there are outliers in both data sets, which are less similar to the template dataset.

For the sake of proving the superiority of our proposed method, it is compared with the state-of-the-art methods. The results shows that our method performs good in the recognition of normal conditions and has the highest Accuracy in Epilepsy recognition and total dataset. This fully reflects the superiority of our method.

	Normal	Epilepsy	Total
Our method	87.5%	**84.2%**	**85.85%**
Complete graph	70%	81%	75.5%
Mean	82%	51%	66.5%
RMS	**97%**	39%	68%
Kurtosis	77%	70%	73.5%
Skewness	61%	78%	69.5%

Table. 2 The result of comparative experiment

Conclusion

The objective of this paper is to design a feature extraction method for EEG classification in epilepsy detection. The graph model is constructed based on the power spectrum of the EEG signal. Then the probability distribution functions are obtained through kernel density estimation method to classify the EEG. The experimental results prove the effectiveness of our proposed feature extraction method.

The proposed feature extraction method is based on visibility graph, which can effectively extract the potential structured information of EEG. But in the similarity measurement, only the most common metric is considered. In the future, more effective similarity metrics will be designed in the future.

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CASE STUDY

WISE ALLY

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MEDICAL IOT DEVICE: 24/7 WEARABLE HEARTWATCH

WISE ALLY expert team and manufacturing excellence drive heartwatch to market

Company	HelpWear Inc.
Country	Toronto, Canada
Industry	Medical Tech.
Website	http://www.helpwear.ca
Product	HeartWatch

Noticing the limitations of existing heart monitoring devices, HelpWear developed a 24/7 clinical grade heart monitor worn on the patient's bicep: the ***HeartWatch***. The devices not only detects heart attacks but also minor heart palpitations and arrhythmias

CHALLENGES
Faced by HelpWear

- Bio-compatible material sourcing is difficult
- The design has to be refined for manufacturability
- The product has to reach clinical quality
- Strict FDA requirements

WISE ALLY'S SOLUTIONS

- Improve the product structure, usability and design ergonomics
- Provide the DFM and DFT of HeartWatch
- Manufacturing and supply chain optimization
- Reliability testing to ensure the product meets clinical standards
- Traceability from component level & UDI control

"WISE ALLY has been a vital partner in HelpWear's manufacturing process. Their team has demonstrated outsanding capabilites for both design and manufacturing(...) Their support has been professional and provides meaningful contribution under tight timelines during global health pandemic crisis."

Frank Nguyen

Chief Technical Officer, HelpWear

GMP Quality · SGS · FDA U.S. FOOD & DRUG ADMINISTRATION

Design of HeartWatch
(Photo credit: HelpWear webpage)

Under the consistent collaborations and hard works between HelpWear and Wise Ally, the appearance and usability of the HeartWatch were significantly improved to become much more lightweight and user-friendly. This life-saving device will bring heart disease patients a high-quality and affordable monitoring experience.

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