2021 15th International Symposium on Medical Information and Communication Technology (ISMICT 2021)

14-16, April, 2021

Xiamen, China

Edited by

Prof. Lin Wang

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Preface

On behalf of the Organizing Committee of 2021 IEEE 15th International Symposium on Medical Information and Communication Technology (ISMICT2021), we are very glad to welcome all of you for this exciting event together with many scientific researchers and professionals worldwide. ISMICT 2021 provides a high-level international forum for scientists, researchers, and educators to present the state-of-the-art studies in healthcare, wellness, clinical therapy, and surgery as well as ICT, mechanical, and biomedical engineering, and also discuss with colleagues worldwide on the major opportunities and challenges of future information science and technology research. Moreover, activities of standard, regulation, and business for medical ICT devices, systems and services will be promoted by national and international government and industry.

Based on the rigorous peer-reviews, 42 papers were accepted in the ISMICT 2021, which cover all major topics on theoretical research and empirical study. These 42 papers include wearable and implantable devices, communication systems for medical applications, AI/data analytics for medicine, healthcare and welfare, pervasive health care and patient monitoring, medical imaging and patient diagnostic systems, privacy and security issues, body area network (BAN) technologies, etc.

As the organizers, we would like to express our sincere thanks to IEEE Engineering in Medicine and Biology Society, to Information and Communication Engineering Department of Xiamen University, and to Xiamen Institute of Communications for their sponsorships. Besides, we sincerely thank numerous volunteers for their dedicated service to the symposium.

We also think this is the very occasion to express our deepest gratitude to the members of the International Program Committee and all reviewers for their professional reviews of the papers. Their expertise guaranteed the high quality of the technical program of the ISMICT 2021.

Last but not least, we thank you all for the contributions and supports to make

ISMICT 2021 a great success, and we sincerely hope that you will find your ISMICT 2021 experience both academically beneficial and culturally enjoyable.

ISMICT 2021 is organized by Xiamen University as one of important activities of its 100 anniversaries. Now I feel it a little bit necessary to say a few words to promote the city of Xiamen and Xiamen University. "City at sea, the sea in the city", Xiamen is a well-known tourist port city in the southeast coast of China. It is one of the cleanest cities of China, the garden cities of China, the national environmental protection model cities, and the best sightseeing cities in China. Xiamen University, known as "the strongest in the South", was the first university in the history of modern Chinese education founded by an overseas Chinese. Because of its neatness and beauty, the campus is regarded as one of the finest in China. Xiamen University is the only key comprehensive university directly affiliated with the Ministry of Education in the Special Economic Zones in China, and it is also listed among the key national high-level universities for the 21st century.

We look forward to seeing all of you.

Organizing Committee of ISMICT 2021

Keynote Speech 1

Virtual Clinic for Cyber-Physical Medical Healthcare against Pandemic and Daily Life with Standard WBAN, 5G, and AI Universal Platform

Prof. Ryuji Kohno

Yokohama National University

Abstract

COVID-19 has drastically changed a life style all over the world. Research and development of digital healthcare or remote medicine have been speeded up to make such a new medical healthcare services more realistic. Wireless medical body area network (BAN) which is a key for a new medical healthcare services has been connected with 5G mobile network and AI server for big data mining and applied for more general services preventing pandemic, disaster, etc. This speech introduces a new project using such a universal platform of integrated BAN, 5G, and AI mining server for virtual clinic which is keen for pandemic and daily life. Moreover, we have been promoting amendment of international standard of BAN with enhanced dependability in order to update its current standard to match with the universal platform. Its latest activities will be announced.

Ryuji Kohno received the Ph.D. degree from the University of Tokyo in 1984. Since 1998 he has been a Professor and the Director of Centre on Medical Information and Communication Technology, in Yokohama National University in Japan. In his currier he played a part-time role of a director of Advanced Telecommunications Laboratory of SONY CSL for 1998-2002, directors of UWB Technology and medical ICT institutes of NICT for 2002-2012, CEO of University of Oulu Research Institute Japan CWC-Nippon Co. for 2012-2019. Since 2007 he has been a distinguished professor in University of Oulu in Finland and since 2014 a director of Kanagawa Medical Device Regulatory Science Centre. He was a member of medical devices committee in PMDA for 2012-2014 and the Science Council of Japan since 2006. He was a member of the Board of Governors of IEEE Information Theory Society for 2000-2009, and editors of IEEE Transactions on Communications, Information Theory, and ITS. He was Vice-president of Engineering Sciences Society of IEICE for 2004-2005, Editor-in chief of the IEICE Trans. Fundamentals for 2003-2005. He is a founder and a chair of steering committee of international symposia of medical information and communication technologies (ISMICT) since 2006.

Keynote Speech 2

Implantable Brain Machine Interfaces

Prof. Masayuki Hirata

Osaka University

Abstract

Implantable brain machine interfaces (BMI) enable severely disabled people high-performance real-time robot control and communication, high-quality intracranial neural signals. Until now, we established ECoG-based robot control and communication. Also, we are developing a fully-implantable BMI device for long-term home-use with 24/7 supports. The next step is a clinical trial to confirm safety and efficacy of the implantable BMI.

M. Hirata received the B.E. and M.E. degrees from the Faculty of Engineering, the University of Tokyo, Tokyo, Japan, in 1985 and 1987, respectively, and the M.D. and Ph.D. degrees from Osaka University Medical School, Osaka, Japan, in 1994 and 2001, respectively. He is a board-certified Neurosurgeon who specializes in functional neurosurgery. He was promoted to Professor at the Department of Neurosurgery and Neurological Diagnosis and Restoration, Osaka University Graduate School of Medicine. He was a member of Clinical BMI Society since 2015. He was a member of Japanese Society for Medical Engineering since 2017. He was Vice-president of Japan

Biomagnetism and Bioelectromagnetics Society since 2018. He was a member of Brain-Computer Interface Society since 2018. He was President of International Society for the Advancement of Clinical Magnetoencephalography.

Keynote Speech 3

Deep Learning for Motif Mining in Biological Sequences and Beyond

Prof. De-Shuang Huang

Tongji University

Abstract

Transcription factor (TF) plays a central role in gene regulation. Knowing the binding specificities of TFs is essential for developing models of the regulatory processes in biological systems and for deciphering the mechanism of gene expression. In this talk, we will introduce several novel computational models of TF binding data by combining various types of high-throughput data. Firstly, we will introduce a tensor decomposition model for collaborative prediction of ChIP-seq data, which could overcome its current limitation for integrative analysis. Secondly, we will present a de novo motif learning method based on the area under the receiver-operating characteristic curve (AUC) criterion, which has been widely used in the literature to evaluate the significance of extracted motifs. Finally, based on Fisher Exact Test score (FETS), we propose DirectFS, which is (to our best knowledge) the first FETS-based approach that allows direct learning of the motif parameters in continuous space. Experimental results based on real world high-throughput datasets illustrate that DirectFS outperforms competing methods for refining motifs found by de novo motif elicitation methods, while being one order of magnitude faster. In addition, we also present the possibility for using deep learning technique combining motif mining in biological sequences to address the medical image processing issue.

De-Shuang Huang is a Professor in Department of Computer Science and Director of Institute of Machine Learning and Systems Biology at Tongji University, China. He is currently the Fellow of the International Association of Pattern Recognition (IAPR Fellow), Fellow of the IEEE (IEEE Fellow) and Senior Member of the INNS, Bioinformatics and Bioengineering Technical Committee Member of IEEE CIS, Neural Networks Technical Committee Member of IEEE CIS, the member of the INNS, Co-Chair of the Big Data Analytics section within INNS, and associated editors of IEEE/ACM Transactions on Computational Biology & Bioinformatics, and Neural Networks, etc. He founded the International Conference on Intelligent Computing (ICIC) in 2005. ICIC has since been successfully held annually with him serving as General or Steering Committee Chair. He also served as the 2015 International Joint Conference on Neural Networks (IJCNN 2015) General Chair, July 12-17, 2015, Killarney, Ireland, the 2014 11th IEEE Computational Intelligence in Bioinformatics and Computational Biology Conference (IEEE-CIBCBC) Program Committee Chair, May 21-24, 2014, Honolulu, USA. His main research interest includes neural networks, pattern recognition and bioinformatics.

Keynote Speech 4

Blockchain technology for health: current and future trend between industry and academia

Prof. Lorenzo Mucchi, University of Florence

Prof. Duccio Micela, JSB Solutions

Abstract

Blockchain is a technology which has raised much attention in the last years in the field of cryptocurrency applications, but not only. The use of this technology is today envisioned in many applications, including health. The keynote will give a synthesis of how blockchain is today applied by the industrial world, with real use cases as examples. The keynote will then give a synthesis on how scientific research envisions the use of blockchain in medical ICT sector. Is academic vision of blockchain following the industrial trend or will it be viceversa?

Keypoints of the presentation: What is blockchain, What you do with blockchain, Use cases of blockchain, Trend of use of blockchain from company's point of view, How blockchain can help security of e-health services, How blockchain and IoT can be integrated to boost future healthcare, Trend of use of blockchain (for health) from academia's point of view, Academic vision of blockchain is following the industrial trend or it will be viceversa?

Lorenzo Mucchi is an Associate Professor of the University of Florence (Italy), Dept. of Information Engineering, since 2018. He received the Dr. Eng. Degree (Laurea) in Telecommunications Engineering from the University of Florence (Italy) in 1998 and the Ph.D. in Telecommunications and Information Society in 2001. From 2001 to 2018 he has been with the Department of Information Engineering of the University of Florence as a Research Scientist. In 2000 he spent a 12-months period of research at the Centre for Wireless Communications, University of Oulu, Finland. He is professor of Information Technologies at the University of Florence, Italy, since 2008. His main research areas include theoretical modelling, algorithm design and real measurements, mainly focused in the following fields: physical-layer security, visible light communications, spread spectrum techniques (UWB), localization, body area networks, biometric encryption, molecular communications, diversity techniques and interference management. Currently, he has published 8 book chapters, 37 papers in international journals and more than 80 papers in international conference proceedings during his research activity. Dr. Mucchi is senior member (2012) of the Institute of Electrical and Electronics Engineers (IEEE), member (2009) of the IEEE Communications and Information Security Technical Committee (CISTC) and permanent member (2000) of the International Association of Science and Technology for Development (IASTED) Technical Committee on Telecommunications. He has been lead organizer and general chair of international conferences: the IEEE ISMICT 2014 and the EAI BodyNets 2019. He served as reviewer for IEEE and IET journals and as Technical Program Committee Member for numerous IEEE conferences. He is associate editor of IEEE

Communications Letter (2016) and IEEE Access (2018). He has been Editor-in-chief for ELSEVIER ACADEMIC PRESS LIBRARY and for the International Journal of Ultra Wide Band Communication Systems (IJUWBCS) and Guest Editor for many international journals. Dr. Mucchi is member of the European Telecommunications Standard Institute (ETSI) Smart Body Area Network (SmartBAN) group (2013) and team leader of the special task force 511 (2016) "SmartBAN Performance and Coexistence Verification".

Duccio Micela is a Software Team Leader and Project Manager at JSB Solutions, an Italian Pharma consultancy company. He received the Master's Degree (Laurea) cum laude in Physics and Astrophysics from the University of Florence (Italy) in 2010. From 2012 he works together with JSB Solutions in the Pharma consultancy world. As a Product Specialist, he deepens on Manufacturing and Logistics processes within the most important Italian and International pharmaceutics providing business analysis, process mapping and gap/risk assessment services. As a Project Manager he achieves ITIL certification for the IT service management in the three core areas of Service Operation, Service Transition and Service Design. He collaborates with the most important Italian and International pharmaceutics, providing software project of the highest value, always striving for innovation. A real blockchain passionate, he has been exploring the technical point of view and also the enormous potential in terms of applications in industry, health & pharma. As a blockchain project manager he manages the design, development and delivery of operative Proof of concepts, continuously gaining expertise from touching every aspect of this technology in the whole

applications lifecycle management. He is involved in international projects based on blockchain involving the most important Italian and International pharmaceutics.

Keynote Speech 5

Molecular Communication Theory in Living Substrates for Future Medical Applications

Prof. Massimiliano Pierobon

University of Nebraska-Lincoln

Abstract

Ever since the discovery of the Deoxyribonucleic Acid (DNA) as the genetic material, it is widely understood that information and communications are at the basis of living organisms. Even the most simple and fundamental organisms, the biological cells, not only store, express, and propagate their genetic content to their offspring, but also incessantly receive and process information from the external environment, and modify their behavior accordingly. This keynote talk explores the importance of information and communication theory applied to molecules and biochemical reactions in understanding the mechanisms of life, the origin of diseases, and design medical devices and therapies, together with current potential limitations in addressing some peculiarities shown in living substrates. In particular, the talk will explore molecular communication theory at the intersections between electrical circuits and biological systems, to elucidate the role of information in sustaining life and how this can be harnessed for medical diagnosis and therapeutic purposes. The talk will then introduce novel ways to study biochemical pathways involved in cancer progression and drug discovery through the lenses of information and communication theory, as well as explore the foundational potential of this novel discipline within the scientific community, with highlights from systems and synthetic biology, neuroscience, and bioinformatics.

Massimiliano Pierobon received his Ph.D. degree in Electrical and Computer Engineering from the Georgia Institute of Technology, Atlanta, GA, USA, in 2013. He is currently an Associate Professor with the Department of Computer Science and Engineering, University of Nebraska-Lincoln (UNL), NE, USA, where he also holds a courtesy appointment at the Department of Biochemistry. He is the co-Editor in Chief of Nano Communication Networks (Elsevier) since July 2017, and an Associate Editor of the IEEE Transactions on Mobile Computing since August 2020. Previously, he was an Associate Editor of the IEEE Transactions on Communications. Selected honors: 2011 Georgia Tech BWN Lab Researcher of the Year Award, 2013 IEEE Communications Letters Exemplary Reviewer Award, UNL CSE Upper and Graduate Level Teaching Award in 2016 and 2017, 2017 IEEE INFOCOM Best Paper Runner-up Award and Best In-session Presentation Award. Dr. Pierobon is currently the PI of the NSF project "WetComm: Foundations of Wet Communication Theory", co-PI of the NSF project "Redox-enabled Bio-Electronics for Molecular Communication and Memory (RE-BIONICS)", and has been the lead PIs of the NSF project "TelePathy: Telecommunication Systems Modeling and Engineering of Cell Communication Pathways." His research interests are in molecular communication theory, nanonetworks, intra-body networks, communication engineering applied to synthetic biology, and the Internet of Bio-Nano Things.

Keynote Speech 6

Computational Nanobiosensing Biosensing by Learning

Prof. Yifan Chen

University of Electronic Science and Technology of China

Abstract

We will present the emerging field of computational nanobiosensing under the umbrella of in vivo computation, where agile searching strategies to manipulate swarms of externally controllable or autonomous nanorobots are proposed to improve the success rate of nanobiosesing by orders of magnitude. For example, in the case of externally manipulable nanorobots, an external system can be used to probe the tissue environment by analyzing the observable characteristics of these nanorobots, such as their trajectories and vitality during their interaction with the tissue. This information can be mapped to a specific biological gradient field around the diseased site, and this gradient field detected by the nanorobots can be analyzed in a centralized manner, which also steers the nanorobots towards the prospective target location via the shortest possible physiological routes and with minimum systemic exposure. This novel framework has a great potential in improving the performance of early tumour diagnosis and targeted drug delivery, which may potentially revolutionize the existing nanomedicines practice.

Professor Yifan Chen is the Dean of School of Life Science and Technology in the

University of Electronic Science and Technology of China. He has pioneered the emerging field of computational nanobiosensing where information and communications technologies meet nanomedicines. He has also made an instrumental contribution to the technological, clinical and commercialisation advancement in the area of microwave medical imaging and sensing. He is the Coordinator of the European FP7 "CoNHealth" project on intelligent medical ICT, an elected Working Group Co-leader of the European COST Action TD1301 "MiMed" project on microwave medical imaging, an Advisory Committee Member of the European Horizon 2020 "CIRCLE" project on molecular communications, an Associate Investigator of the New Zealand Consortium for Medical Device Technologies (CMDT) and MedTech Centre of Research Excellence (MedTech CoRE), a Voting Member of the IEEE Standards Development Working Group 1906.1 on nanoscale and molecular communications, an Editor for IEEE Communications Society Best Readings in Nanoscale Communication Networks, IEEE Access Special Section in Nano-antennas, Nano-transceivers, and Nano-networks/Communications, and IEEE Journal of Biomedical and Health Informatics Special Issue on Flexible Sensing and Medical Imaging for Cerebro-cardiovascular Health, and the Vice Chair of the IEEE Communications Society Technical Committee for Molecular, Biological and Multi-Scale Communications. He also served as a General Chair, Technical Program Chair, Tutorial and Special Session Chair, and Local Organization Committee Chair for several premier IEEE conferences such as ICC, ICCE-China, ICCC, ICCS, APCAP, APEMC, EDAPS, etc. He is a Fellow of Engineering New Zealand (FEngNZ) and a Fellow of IET (FIET).