Intelligent Ubiquitous Computing and Advanced Learning Systems for Biomedical Engineering

Chinmay Chakraborty[1], Mohammad Khosravi (GE)[2], Lalit Garg[3], M Shamim Kaiser[4], Xingwang Li (GE)[5], and Houbing Song[6]

[1]Birla Institute of Technology
[2]Persian Gulf University
[3]University of Malta
[4] Institute of Information Technology, Jahangirnagar University
[5]Henan Polytechnic University
[6]Embry-Riddle Aeronautical University

October 2, 2022

Abstract

The health monitoring for disease diagnosis and prognosis in a desired smart medical structure is realized by interpreting the health data. The advances in sensor technologies and biomedical data acquisition tools have led to the new era of big data, where different sensors collect massive medical data every day. This special issue explores the latest development in emerging technologies of biomedical engineering, including big medical data, artificial intelligence, cloud/fog computing, federated learning, ubiquitous computing and communication, internet of things, wireless technologies, and, security and privacy. The biological wearable sensors can enhance the decision-making and early disease diagnosis processes by intelligently investigating and collecting large amounts of biomedical data (i.e., big health data). Hence, there is a need for scalable advanced learning, and intelligent algorithms that lead to reliable and interoperable solutions to make effective decisions in emergency medicine technologies. The optimization algorithms can be used in order to acquire the sensor data from multiple sources for fast and accurate health monitoring.

Guest Editorial: Intelligent Ubiquitous Computing and Advanced Learning Systems for Biomedical Engineering

Introduction: The health monitoring for disease diagnosis and prognosis in a desired smart medical structure is realized by interpreting the health data. The advances in sensor technologies and biomedical data acquisition tools have led to the new era of big data, where different sensors collect massive medical data every day. This special issue explores the latest development in emerging technologies of biomedical engineering, including big medical data, artificial intelligence, cloud/fog computing, federated learning, ubiquitous computing and communication, internet of things, wireless technologies, and, security and privacy. The biological wearable sensors can enhance the decision-making and early disease diagnosis processes by intelligently investigating and collecting large amounts of biomedical data (i.e., big health data). Hence, there is a need for scalable advanced learning, and intelligent algorithms that lead to reliable and interoperable solutions to make effective decisions in emergency medicine technologies. The optimization algorithms can be used in order to acquire the sensor data from multiple sources for fast and accurate health monitoring.

Papers in the Special Issue: In this special issue, nine manuscripts are published, the papers directly or indirectly are related to advanced learning systems for biomedical engineering with intelligent computing. As follows, we briefly reviewed the main contribution of each manuscript.

Lin *et al*. present a novel approach based on Artificial Intelligence in Electronic Communication Engineering for medical applications. Authors highlight a new architecture with LPWAN technology to improve the security of wireless communication system of internet of things for health applications. Information transmission instructions of "temperature, light, air pressure and humidity" were recorded and analyzed.

Liu *et al*. present a study on the detection and defense of malicious code under network security over biomedical devices. The proliferation of massive varieties and unknown malicious viruses, it is difficult to achieve effective and timely defense by anti-virus technology with virus signature matching as the core. Thus, detection of malicious code under network security is done for biomedical devices and it was found that when the number of infected nodes reaches about half, the infection speed begins to slow down.

Li *et al.* present an approach on distributed lossless coding system based on cloud computing in video transcoding for MRI and Neuroimaging. The authors highlighted a distributed lossless coding system based on cloud computing to increase the video transcoding capacity of the new media interactive broadcasting.

Tie *et al.* highlight the optimal supply chain inventory information forecasting and control system in Biomedical Instruments. Biomedical informatics and computer vision techniques have been combined in a variety of inter-multidisciplinary disciplines during the past few decades. We are all aware that poor or insufficient cloud access management and controls can expose a company to a number of risks. The work that follows offers intelligent supply chain, upgraded service management, and control telephone network architecture.

Wang *et al.* explore the application of vibration compensation in track displacement monitoring using image processing. The authors proposed to use the principle of vibration compensation to test, use rail image feature points for vibration compensation. They used the biomedical image-based processing concept to realize the track displacement monitoring method, which meets the requirements of non-contact measurement, and the degree of automation is high, it can be monitored and alarmed in real time, and it has a good application prospect.

Zhang *et al.* present anti-cracking performance test under vibration fatigue load for critical health infrastructure. This paper considers the relevant cement-based solid metal structures fire- retardant coatings available on the market as the test object and performs high-cycle fatigue stress experiments on steel structural elements painted with cement-based thick steel structure fire-retardant varnishes.

Yongbo *et al*. propose a manufacturing vibration monitoring system using Hilbert-Huang transformation feature extraction, to monitor the running state of the spindle of an electrocardiogram machine. Real-time monitoring of the time-frequency characteristic quantity of the spindle vibration signal for ECG signals has been made possible due to the online empirical mode decomposition method. The system is capable of not only accurately monitoring the characteristic quantity in the frequency domain of the vibration signal produced by the machine tool spindle, but also of successfully implementing the monitoring of the time-frequency characteristic quantity in real time.

Zhao *et al*. present an approach based on heart rate monitoring of physical fitness training load based on wavelet transform. The detection of fluctuations is a crucial step in the process of isolating heart rate oscillation signals. A method of R-wave identification for heart rate monitoring of physical fitness training load based on wavelet transform is proposed.

Sun *et al*. present an intelligent ubiquitous compression technique for DNA sequencing. The major objective of designing the proposed method is to find a solution to the challenge of lowering the quantity of data storage required for practical applications of large amounts of biomedical data and making effective use of the storage devices. It effectively reduces redundant information by using the local correlation of data and uses the computing resources of a cloud platform that is used for biological information processing to support the efficient storage, transmission, and sharing of data.

Summary: All the papers selected for this Special Issue show that the field of computing and learning systems in biomedical engineering is steadily moving forward. This continuous and exponential growth is facilitated by investments and research activities originating from industry, academia, and governments while the penetration of these technologies is also driven by the high-technology acceptance rates of both consumers and technologists across disciplines.

Acknowledgments: Firstly, we wish to express our thanks to Ms. Emily Summerbell, Managing Editor, for her continuous assistance throughout this process. We wish to express our gratitude to all the contributors who submitted novel scientific results in this forum, and to our anonymous reviewers, whose expert work helped us to have the realization of this endeavor. We hope that this effort will contribute to the further development of innovative works and raise the scientific and technological community's interest in the relevant area. As the last point, we should not forget to express our appreciation to the journal's Editors-in-Chief and all the members of the Journal Editorial Office (JEO) for their support throughout this adventure.

Chinmay Chakraborty, (SMIEEE) is an Assistant Professor in Electronics and Communication Engineering, Birla Institute of Technology, Mesra, India and he completed Post-doctoral fellow from Federal University of Piauí, Brazil. He worked at the Faculty of Science and Technology, ICFAI University, Agartala, Tripura, India as a Sr. Lecturer. He worked as a Research Consultant in the Coal India project at Industrial Engineering & Management, IIT Kharagpur. He worked as a Project Coordinator of the Telecommunication Convergence Switch project under the Indo-US joint initiative. He also worked as a Network Engineer in System Administration at MISPL, India. His main research interests include the Internet of Medical Things (IoMT), Wireless Body Sensor Networks, Telemedicine, m-Health/e-health, and Medical Imaging. Dr. Chakraborty has published 190+ articles at reputed international journals, conferences, book chapters, 22+ books and 20+ special issues. He is an Editorial Board Member in the different Journals and Conferences. He serves as a Guest Editor of MDPI-FI Journal, Wiley-ITL, BSR, Springer-ANT, IJSAEM, EDS, and Lead Guest Editors of IEEE-JBHI, IEEE-TII, ACM-TALIP, ACM-JDIQ, IEEE-TCSS, Hindawi- JHE, Mary Ann Liebert - Big Data J., IGI-IJEHMC, Springer – MTAP, INSCL, TechScience CMC, Inderscience- IJNT, BenthamScience -Current Medical Imaging, Journal of Medical Imaging and Health Informatics, Lead Series Editor of CRC- Advances in Smart Healthcare Technologies, and also Associate Editor of International Journal of End-User Computing and Development, Journal of Science & Engineering, IET-The Journal of Engineering, Int. Journal of Strategic Engineering, and has conducted a session of SoCTA-19, ICICC – 2019, Springer CIS 2020, SoCTA-20, SoCPaR 2020, and also a reviewer for international journals including IEEE Access, IEEE Sensors, IEEE Internet of Things, IEEE TII, IEEE JBHI, IEEE Sensors, Elsevier, Springer, Taylor & Francis, IGI, IET, TELKOMNIKA Telecommunication Computing Electronics and Control, and Wiley. Dr. Chakraborty is co-editing several books on Smart IoMT, Healthcare Technology, and Sensor Data Analytics with Elsevier, CRC Press, IET, Pan Stanford, and Springer. He has served as a Publicity Chair member at renowned international conferences including IEEE Healthcom, IEEE SP-DLT. Dr. Chakraborty is a member of Internet Society, Institute for Engineering Research and Publication and IEEE. He received a Best Session Runner-up Award, Young Research Excellence Award, Global Peer Review Award, Young Faculty Award, Outstanding Researcher Award, Outstanding Paper in the 2022 Emerald Literati Awards**,** and also selected as one of the top 2% of scientists in the world in the field of "Artificial Intelligence and Image Processing," Stanford University, USA.

Mohammad R. Khosravi, (MACM) is currently a researcher in the fields of communications, networking, computing, and multimedia systems. He is now an international research fellow at Shandong Provincial University Laboratory for Protected Horticulture, Weifang University of Science and Technology, China, and a non-resident research associate for multimedia and networking at the Department of Computer Engineering, Persian Gulf University, Iran. Iran National Elites Foundation (INEF) has selected Mohammad as elite for benefiting from several services since 2019. He is also a professional member of Association for Computing Machinery (ACM) since 2020 where he has been included in some volunteer editorial roles. He has served as a publication/TPC co-chair for EAI-CloudComp 2020 & 2021. In addition, he is currently serving as an editor/editorial board member for International Journal of Intelligent Systems (Wiley), International Journal of Crowd Science (IEEE-TUP) and IEEE Technology Policy and Ethics (IEEE), and has served as a topic editor for The Journal of Supercomputing and SN Applied Sciences (both at Springer). Mohammad is an active reviewer of many top journals of IEEE and ACM, and received the title of outstanding reviewer of Bentham Science journals in 2019. His main interests include statistical signal and image processing, medical and health informatics, radar imaging and satellite remote sensing, computer communications, internet of things (IoT), wireless sensor networks, cyber-physical systems, multimedia networks, UAV networks, and information science (scientometrics). Mohammad has received

his Ph.D. in electrical engineering with expertise in communications and signal processing.

Lalit Garg, (SMIEEE) is a Senior Lecturer in Computer Information Systems at the University of Malta, Malta, and an honorary lecturer at the University of Liverpool, UK. He has been a researcher at the Nanyang Technological University, Singapore, and Ulster University, UK. He has supervised 200+ Masters' dissertations, 2 DBA and 2 PhD theses and published 150+ high-impact publications in refereed journals/conferences/books, five edited books and 22 patents. He has delivered numerous keynote speeches, organised/chaired international conferences, and consulted numerous public and private organisations for information systems implementation and management. His research interests are business intelligence, machine learning, data science, deep learning, cloud computing, mobile computing, the Internet of Things (IoT), information systems, management science and their applications, mainly in healthcare and medical domains. He participates in many EU, and local funded projects, including a one million euro Erasmus+ Capacity-Building project in Higher Education (CBHE) titled Training for Medical education via innovative eTechnology (MediTec), and Malta Council of science and technology's Space Research Funds. The University of Malta has awarded him the 2021-22 Research Excellence Award for exploring Novel Intelligent Computing Methods for healthcare requirements forecasting, allocation and management (NICE-Healthcare).

M Shamim Kaiser is currently working as a Professor at the Institute of Information Technology of Jahangirnagar University, Savar, Dhaka-1342, Bangladesh. He received his Bachelor's and Master's degrees in Applied Physics Electronics and Communication Engineering from the University of Dhaka, Bangladesh in 2002 and 2004 respectively, and the Ph. D. degree in Telecommunication Engineering from the Asian Institute of Technology (AIT) Pathumthani, Thailand, in 2010. He worked as a postdoc fellow in the Big data and Cyber Security Lab of Anglia Ruskin University, UK from 2017-2018. He also worked as a Special Research Student at the Wireless Signal Processing and Networking Lab (Adachi Lab) of Tohoku University, Japan in 2008. His current research interests include Data Analytics, Machine Learning, Wireless Network & Signal processing, Cognitive Radio networks, Big IoT data, Healthcare, Neuroinformatics, and Cyber Security. He has authored more than 150 papers in different peer-reviewed journals and conferences. He is an Academic Editor of Plos One Journal; Associate Editor of the IEEE Access and Cognitive Computation Journal, Guest Editor of Brain Informatics Journal, IJACI (IGI Global), Electronics MDPI, Frontiers in Neuroinformatics, and Cognitive Computation Journal. Dr. Kaiser is a Life Member of Bangladesh Electronic Society; Bangladesh Physical Society and NOAMI. He is also a senior member of IEEE, USA, and IEICE, Japan, and an active volunteer of the IEEE Bangladesh Section. He is the founding Chapter Chair of the IEEE Bangladesh Section Computer Society Chapter.

Xingwang Li (SMIEEE) is an Associate Professor at the School of Physics and Electronic Information Engineering, Henan Polytechnic University, Jiaozuo, China, from Jul. 2015. He was also a Visiting Researcher with Pro. Ping Zhang and Dr. Michail at State Key Laboratory of Networking and Switching Technology, Beijing University of Posts and Telecommunications, Beijing China, and the Institute of Electronics, Communications and Information Technology (ECIT), Queen's University Belfast, Belfast, UK. He received his Master degree and PhD degree in communication and information systems, respectively, from University of Electronic Science and Technology of China, Chengdu, China, and Beijing University of Posts and Telecommunications in Jul. 2010 and Jul. 2015, respectively. Before this, he worked at Comba as an engineer from Jul. 2010 to Aug. 2012. Dr. Li is the Senior Member of IEEE. Dr. Li is on the Editor Board of IEEE Transactions on Intelligent Transportation Systems, IEEE Transactions on Vehicular Technology, IEEE Systems Journal, Physical Communication action. He has serviced as Editor of IEEE Access, Computer Communications, Wireless Communications and Mobile Computing, IET Networks, IET Quantum Communication, KSII Transactions on Internet and Information Systems. He is the Guest Editor for the special issue on Computational Intelligence and Advanced Learning for Next-Generation Industrial IoT of IEEE Transactions on Network Science and Engineering, "Recent Advances in Physical Layer Technologies for 5G-Enabled Internet of Things" of the Wirless Communications and Mobile Computing. He has served as many TPC members, such as IEEE/CIC, GLOBECOM, WCNC, etc. He is also the Co-Chair of IEEE/IET CSNDSP 2020 of the Green Communications and Networks track. . He has published 70 papers in prestigious journals and international conferences. His research interests span wireless communication, intelligent transport system, Artificial intelligence for wireless communication and Internet of Things.

Houbing Herbert Song (SMIEEE) received the Ph.D. degree in electrical engineering from the University of Virginia, Charlottesville, VA, in August 2012. He is currently a Tenured Associate Professor of AI and the Director of the Security and Optimization for Networked Globe Laboratory (SONG Lab, www.SONGLab.us), University of Maryland, Baltimore County, Baltimore, MD. He was a Tenured Associate Professor of Electrical Engineering and Computer Science at Embry-Riddle Aeronautical University, Daytona Beach, FL. SONG Lab graduates work in a variety of companies and universities. Those seeking academic positions have been hired as tenure-track assistant professors at US universities like Auburn University, Bowling Green State University, and University of Tennessee. He has served as an Associate Technical Editor for IEEE Communications Magazine (2017-present), an Associate Editor for IEEE Internet of Things Journal (2020-present), IEEE Transactions on Intelligent Transportation Systems (2021-present), and IEEE Journal on Miniaturization for Air and Space Systems (J-MASS) (2020-present), and a Guest Editor for IEEE Journal on Selected Areas in Communications (J-SAC), IEEE Internet of Things Journal, IEEE Network, IEEE Transactions on Industrial Informatics, IEEE Sensors Journal, IEEE Transactions on Intelligent Transportation Systems, and IEEE Journal of Biomedical and Health Informatics. He is the editor of eight books, including Aviation Cybersecurity: Foundations, principles, and applications, Scitech Publishing, 2022, Smart Transportation: AI Enabled Mobility and Autonomous Driving, CRC Press, 2021, Big Data Analytics for Cyber-Physical Systems: Machine Learning for the Internet of Things, Elsevier, 2019, Smart Cities: Foundations, Principles and Applications, Hoboken, NJ: Wiley, 2017, Security and Privacy in Cyber-Physical Systems: Foundations, Principles and Applications, Chichester, UK: Wiley-IEEE Press, 2017, Cyber-Physical Systems: Foundations, Principles and Applications, Boston, MA: Academic Press, 2016, and Industrial Internet of Things: Cybermanufacturing Systems, Cham, Switzerland: Springer, 2016. He is the author of more than 100 articles and the inventor of 2 patents (US & WO). His research interests include cyber-physical systems/internet of things, cybersecurity and privacy, AI/machine learning/big data analytics, edge computing, unmanned aircraft systems, connected vehicle, smart and connected health, and wireless communications and networking. His research has been sponsored by federal agencies (including National Science Foundation, US Department of Transportation, Federal Aviation Administration, Air Force Office of Scientific Research, US Department of Defense, and Air Force Research Laboratory) and industry. Dr. Song is a Highly Cited Researcher identified by Clarivate™ (2021) and a Top 1000 Computer Scientist identified by Research.com.