Lecture Notes in Electrical Engineering 1029

Subhas Chandra Mukhopadhyay
S. M. Namal Arosha Senanayake
P. W. Chandana Withana *Editors*

Innovative Technologies in Intelligent Systems and Industrial Applications

CITISIA 2022

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Volume 1029

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Preface

Systems mimicking the human brain have a long history. The recent advancements brought about by the Industry Revolution 4.0 and Smart Society 5.0, however, have led to unprecedented volumes of *Innovative Technologies in Intelligent Systems and Industrial Applications*. These mostly depend on the design of new algorithms applied to existing historical patterns and decision-making solutions such as building critical (time VS space) systems using artificial intelligence (AI) and machine learning (ML). Over the past decade, this has produced innovative technologies for smart manufacturing to better satisfy global needs and demands. However, despite these recent advancements, there is still an urgent need to find optimal solutions for real-world applications, in particular mission-critical systems in terms of reliability, precision, and repeatability. Furthermore cross-disciplinary research engagement is vital to solving cross-domain problems encountered during daily life for which embedded hybrid intelligence (AI and human intelligence) is vital if we are to develop hybrid intelligent systems to build a truly smart society.

Thus, complex processes and data-driven models are paramount for innovative technologies that minimize human intervention to minimize or even eliminate human error during manufacturing and general daily processes. Production of mission-critical systems is still facing challenges due to the latency inherent in communication technologies (i.e., the latency in 5G mobile communication is around 1 ms). Minimizing such latency and thus optimizing processes are generally addressed using mixed reality from the active engagement of humans in critical processes and data signals from the environment. However, challenges remain in terms of achieving real-time processes due to the nature of occurrences and events in highly complex situations such as those taking place in nuclear plants, cockpits of flights, and space vehicles, for drones. Not only automatic re-configuration and re-installation of processes are required, it is mandatory to embed programmable systems on board in order to adjust and to re-configure critical parameters that change the nature of the execution of processes in real time. Thus, innovation under catastrophic conditions in real time is still a serious challenge in smart manufacturing.

Furthermore, business processes involved in the production of smart products and services are seriously impacted by unpredictable environmental conditions in

the form of sudden atmospheric changes such as changes in weather patterns and pandemics. Yet, state-of-the-art AI and ML are capable of positively impacting mission-critical processes and thus resolve a significant range of cross-discipline processes in different domains. Designing and building such multidimensional processes equates to the development of novel hybrid models embedding information fusion, smart decision-making models, and information visualization processes using smart devices. Innovative technologies in intelligent systems and industrial applications provide this vital research through adaptation and development for the benefit of humanity through improvements in lifestyle. Thus, future industrial revolutions and societal evolutions heavily depend on the innovation and invention of smart processes and information fusion for the development of mission-critical systems.

This book focuses on cross-disciplinary research impacting industry and smart society—ultimately leading to smart manufacturing, management of critical processes, and information fusion. It contains chapters from authors presented during the International Conference on Innovative Technologies in Intelligent Systems and Industrial Applications (CITISIA) 2022 which was held in Sydney, Australia, on November 14–16, 2022. This book familiarizes the reader with new dimension of innovation designed for future generations to be inspired by and to learn from and to retain as a valuable library. In the current context, the book addresses Industry Revolution 4.0 and Smart Society 5.0 impacting technological evolution and transformations in the years to come. Chapters are categorized by main topics so that readers are guided to their areas of interest:

Topic 1 addresses the contributions that impact on society through novel neural network architectures and machine learning algorithms.
Topic 2 explores novel mixed reality approaches for real-world applications.
Topic 3 introduces hybrid data security models for a smart society.
Topic 4 analyzes synergy of signal processing, AI, and ML for systems.
Topic 5 discusses advanced system modeling for industry revolution.
Topic 6 explores IoT and cybersecurity for smart devices.
Topic 7 describes recent advances in AI for digital innovations.
Topic 8 introduces AI and IoT for industry applications.
Topic 9 explores knowledge-based IoT and intelligent systems.

Sydney, Australia
Selangor, Malaysia
Bathurst, Australia

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S. M. Namal Arosha Senanayake
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Contents

About the Editors

Dr. Subhas Chandra Mukhopadhyay (M'97, SM'02, F'11) graduated from the Department of Electrical Engineering, Jadavpur University, Calcutta, India, with a gold medal and received the Master of Electrical Engineering degree from Indian Institute of Science, Bengaluru, India. He has Ph.D. (Eng.) degree from Jadavpur University, India, and Doctor of Engineering degree from Kanazawa University, Japan.

Currently, he is working as Professor of Mechanical/Electronics Engineering and Discipline Leader of the Mechatronics Degree Program of the School of Engineering, Macquarie University, Sydney, Australia. He has over 30 years of teaching and research experiences.

His fields of interest include smart sensors and sensing technology, wireless sensor networks, Internet of Things, electromagnetics, control engineering, magnetic bearing, fault current limiter, electrical machines, numerical field calculation, etc.

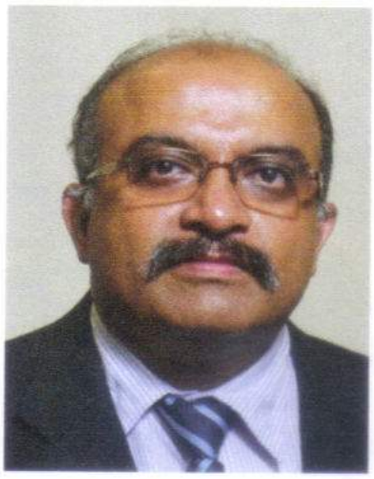
He has authored/co-authored over 500 papers in different international journals, conferences, and chapters. He has edited eighteen conference proceedings. He has also edited twenty-five special issues of international journals as Lead Guest Editor and thirty-five books with Springer-Verlag.

He was awarded numerous awards throughout his career and attracted over AUD 6.2 M on different research projects.

He has delivered 359 seminars including keynote, tutorial, invited, and special seminars.

He is Fellow of IEEE (USA), Fellow of IET (UK), and Fellow of IETE (India). He is Topical Editor of *IEEE*

Sensors Journal and Associate Editor *IEEE Transactions on Instrumentation*. He has organized many international conferences either as General Chair or Technical Program Chair. He is Founding Chair of the IEEE Sensors Council New South Wales Chapter.



Dr. S. M. Namal Arosha Senanayake, Senior Member of IEEE, is Founder and Leader of IntelliHealth Solutions (Technology Licensing), and he gained well-balanced portfolio on research, education (teaching), and service (administration). Currently, he, jointly with University of Malaya Connected Health (UMCH) Technology Pvt. Ltd., is establishing a joint venture within Asia-Pacific region (ASEAN, Japan, South Korea, Singapore, and Vietnam). He is also working as Adjunct Professor, School of Engineering, at Taylor's University.

He started his career as Pioneer Assistant Lecturer in computer science at the University of Peradeniya, Sri Lanka. After he obtained his Ph.D. in artificial intelligence, he has been promoted to Senior Lecturer at the University of Peradeniya, Sri Lanka.

He joined Monash University Sunway Campus as Senior Lecturer in 2002 where he was considered as Active Researcher. He succeeded in getting the largest eScience fund from Ministry of Science Technology and Innovation under the title Bio-Inspired Robotic Devices for Sportsman Screening Services (BIRDSSS). Based on research outcomes, he was awarded Pro-Vice Chancellor's award for excellence in research within three consecutive years; 2008, 2009, and 2010. In 2011, he joined as Associate Professor in artificial intelligence at the University of Brunei Darussalam. He was Recipient of the UK-South East Asia Knowledge Partnership—Collaborative Development Award, 2013. In 2021, he jointly with team members comprised of Japan, Malaysia, and Vietnam was Recipient of research excellence award by the National Institute of Information and Communications Technology (NICT), Japan, for the best project among six leading projects sponsored by the NICT during 2017–2020. He has been appointed as Liaison Officer and Visiting Professor under the Advanced Global Program (AGP) at Gifu University, Japan, since 2018.

As Senior Member of IEEE, he actively engaged with IEEE during the last two decades. He served as

Chairman of IEEE Robotics and Automation Society Chapter, Director of IEEE Asia-Pacific Robotics and Automation Council, and Student Branch Counselor. He also serves as Associate Editor of four international journals, Reviewer of 13 different IEEE Transactions, ELSEVIER, Springer, Taylor & Francis, Acta press, etc. He authored a book with the title *Bio-Interfacing Devices*. He was Editor for ten proceedings. He was External Examiner for Ph.D. and Master's by research candidates at well-known universities in the Asia-Pacific region.

Dr. P. W. Chandana Withana is Associate Professor with the School of Computing and Mathematics at Charles Sturt University, Australia. Before this, he was Lecturer at the United Arab Emirates University in UAE, Multimedia University in Malaysia, and also the Informatics Institute of Technology (IIT), Sri Lanka. He gained his undergraduate and postgraduate degrees from St. Petersburg State Electrotechnical University in the early 90s and completed his Ph.D. studies at the Multimedia University in Malaysia. He is Active Researcher in "computer architecture, digital systems, and modeling and simulation". He has published more than 230 research articles in computing and engineering journals and conference proceedings. He has co-authored two books entitled *Digital Systems Fundamentals* and *Computer Systems Organization and Architecture* published by Prentice Hall. He is Senior Member of the IEEE Computer Society.

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This book presents the proceedings of the 7th International Conference on Innovative Technologies in Intelligent Systems and Industrial Application (CITISIA), held in virtual mode in Kuala Lumpur, Malaysia, and Sydney, Australia on November 16–18, 2022. It showcases advances and innovations in Industry 4.0, smart society 5.0, mobile technologies, smart manufacturing, smart data fusion, hybrid intelligence, cloud computing, and digital society.

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