Lecture Notes in Electrical Engineering 1088

Moncef Gabbouj
Shyam Sudhir Pandey
Hari Krishna Garg
Ranjay Hazra *Editors*

Emerging Electronics and Automation

Select Proceedings of E2A 2022

Springer

Lecture Notes in Electrical Engineering

Volume 1088

The book series *Lecture Notes in Electrical Engineering* (LNEE) publishes the latest developments in Electrical Engineering—quickly, informally and in high quality. While original research reported in proceedings and monographs has traditionally formed the core of LNEE, we also encourage authors to submit books devoted to supporting student education and professional training in the various fields and applications areas of electrical engineering. The series cover classical and emerging topics concerning:

- Communication Engineering, Information Theory and Networks
- Electronics Engineering and Microelectronics
- Signal, Image and Speech Processing
- Wireless and Mobile Communication
- Circuits and Systems
- Energy Systems, Power Electronics and Electrical Machines
- Electro-optical Engineering
- Instrumentation Engineering
- Avionics Engineering
- Control Systems
- Internet-of-Things and Cybersecurity
- Biomedical Devices, MEMS and NEMS

For general information about this book series, comments or suggestions, please contact leontina.dicecco@springer.com.

To submit a proposal or request further information, please contact the Publishing Editor in your country:

China

Jasmine Dou, Editor (jasmine.dou@springer.com)

India, Japan, Rest of Asia

Swati Meherishi, Editorial Director (Swati.Meherishi@springer.com)

Southeast Asia, Australia, New Zealand

Ramesh Nath Premnath, Editor (ramesh.premnath@springernature.com)

USA, Canada

Michael Luby, Senior Editor (michael.luby@springer.com)

All other Countries

Leontina Di Cecco, Senior Editor (leontina.dicecco@springer.com)

**** This series is indexed by EI Compendex and Scopus databases. ****

Moncef Gabbouj · Shyam Sudhir Pandey ·
Hari Krishna Garg · Ranjay Hazra
Editors

Emerging Electronics and Automation

Select Proceedings of E2A 2022

Springer

Editors
Moncef Gabbouj
Faculty of Information Technology
and Communication Sciences
Tampere University
Tampere, Finland

Hari Krishna Garg
Department of Electrical and Computer
Engineering
National University of Singapore
Singapore, Singapore

Shyam Sudhir Pandey
Division of Green Electronics, Graduate
School of Life Science and Systems
Engineering
Kyushu Institute of Technology
Kitakyushu, Japan

Ranjay Hazra
Department of EIE
National Institute of Technology (NIT)
Silchar
Silchar, Assam, India

ISSN 1876-1100 ISSN 1876-1119 (electronic)
Lecture Notes in Electrical Engineering
ISBN 978-981-99-6854-1 ISBN 978-981-99-6855-8 (eBook)
https://doi.org/10.1007/978-981-99-6855-8

Committee

Patron

Prof. Rajat Gupta, Director, NIT Silchar

Honorary Chair

Prof. Jagannathan Sarangapani, Missouri Institute of Science and Technology, USA

General Chairs

Prof. Moncef Gabbouj, Tampere University, Finland
Prof. Shyam Sudhir Pandey, Kyushu Institute of Technology, Japan
Dr. Hari Krishna Garg, National University of Singapore
Dr. Ranjay Hazra, NIT Silchar

Convenor

Dr. Manas Kumar Bera, NIT Silchar

Organizing Chairs

Dr. Rajdeep Dasgupta, NIT Silchar
Dr. Shivendra Kumar Pandey, NIT Silchar
Dr. Lalu Seban, NIT Silchar
Dr. Vipin Chandra Pal, NIT Silchar

Technical Program Chairs

Control and Robotics

Dr. Vipin C. Pal, NIT Silchar

Signal Processing

Dr. Shankar K., NIT Silchar

Communication System

Dr. Ranjay Hazra, NIT Silchar

Sensors and Instrumentation

Dr. Rajdeep Dasgupta, NIT Silchar

MEMS and VLSI

Dr. S. K. Pandey, NIT Silchar

Energy, Power Systems and Power Electronics

Dr. Munmun Khanra, NIT Silchar

AI and Soft Computing

Dr. Lalu Seban, NIT Silchar
Dr. Pravin P. S., NIT Silchar

Publication Chairs

Dr. Rajdeep Dasgupta, NIT Silchar
Dr. Munmun Khanra, NIT Silchar
Dr. Arun Kumar Sunaniya, NIT Silchar

Website and Online Platform Committee

Dr. Lalu Seban, NIT Silchar
Dr. Ranjay Hazra, NIT Silchar
Dr. Sudipta Chakraborty, NIT Silchar
Dr. Naresh Babu, NIT Silchar

Finance Chairs

Dr. Manas Kumar Bera, NIT Silchar
Dr. Shivendra Kumar Pandey, NIT Silchar
Dr. Dipankar Bhanja, NIT Silchar
Mr. Pulok Nath, NIT Silchar

Registration Committee

Dr. Manas Kumar Bera, NIT Silchar
Dr. Koena Mukherjee, NIT Silchar
Dr. Shankar K., NIT Silchar
Dr. Anup Kumar Sharma, NIT Silchar

Hospitality Chairs

Dr. Jupitara Hazarika, NIT Silchar
Dr. Sudarsan Sahoo, NIT Silchar
Dr. Anup Kumar Sharma, NIT Silchar
Dr. Bipul Das, NIT Silchar

Publicity Chairs

Dr. Shahedul Haque Laskar, NIT Silchar
Dr. Shankar K., NIT Silchar
Dr. Rajeeb Dey, NIT Silchar
Dr. Ripon Patgiri, NIT Silchar

Sponsorship Committee

Dr. Ranjay Hazra
Dr. Manas Kumar Bera, NIT Silchar
Dr. Bipul Das, NIT Silchar
Dr. Shivendra Kumar Pandey, NIT Silchar

Technical Program Committee

Dr. Shyam Kamal, IIT BHU
Dr. Girraj Sharma, JECRC University, Jaipur
Dr. Shyam Kamal, IIT BHU
Dr. Bhuvneswari M., SKCET Tamil Nadu
Dr. Nitin Singh, MNNIT Allahabad
Dr. Suneel Yadav, IIIT Allahabad
Dr. Bijit Choudhuri, NIT Silchar
Dr. Vijay Pratap Singh, REC Sonbhadra, Uttar Pradesh
Dr. Himanshu Maurya, IIIT Allahabad
Dr. Pankaj Pratap Singh, CIT Kokrajhar
Dr. Biswadeep Gupta Bakshi, IIEST Shibpur
Dr. S. K. Aggarwal, Thapar University
Dr. Smriti Aggarwal, MNNIT Allahabad
Dr. Arvind Yadav, Parul Institute of Engineering and Technology, Vadodora
Dr. Brinda Bhowmick, NIT Silchar

Dr. Vijay Pratap Singh, Thapar University
Dr. Pravin Prajapati, AD Patel Institute of Technology, Gujarat
Dr. Gaurav Singh Baghel, NIT Silchar
Dr. Chandrajit Choudhury, NIT Silchar
Dr. S. Prakash, Thapar University
Dr. Shashi Singh, MNNIT Allahabad
Dr. Sahaj Saxena, Thapar University, Patiala
Dr. Dhruba Bora, NEHU Shillong
Dr. Amrita Sinha, Thapar University
Dr. Manoj Badoni, Thapar University, Patiala
Dr. Swati Sondhi, Thapar University, Patiala
Dr. Dinesh Bhardwaj, Thapar University
Dr. Shakti Singh, Thapar University
Dr. Sunanda Sinha, MNIT Jaipur
Dr. Richa Negi, MNNIT Allahabad
Dr. Achu Chandran, CSIR—NIIST Kerela
Dr. Amit Kumar, Thapar University
Dr. Nikhil Deep Gupta, VNIT Nagpur
Prof. B. K. Roy, NIT Silchar
Dr. Raja Ram Kumar, GCKIET Malda
Dr. Pawan Kumar, Thapar University
Dr. Ravi Kumar Maddila, MNIT Jaipur
Dr. Lal Priya P. S., College of Engineering, Trivandrum
Dr. Anurag Dwivedi, SRMCEM Lucknow
Dr. Rajan Kumar, NIT Hamirpur
Dr. Brajesh Rawat, IIT Ropar
Dr. Quanxin Zhu, Hunan Normal University, China
Dr. Asha Rani M. A., NIT Silchar
Dr. Janardan Kundu, Government College of Engineering and Technology, Bikaner
Dr. Tejendra Dixit, IIIT Kancheepuram
Dr. R. Periyasamy, NIT Trichy
Dr. Ranjay Hazra, NIT Silchar
Dr. Anish Ahmad, Tezpur University
Dr. Prabina Pattanayak, NIT Silchar
Dr. Sandeep Kumar, NIT Delhi
Ganesh Chiilakalapudi, NIT Silchar
Dr. Prasenjit Basak, Thapar University
Dr. Saurabh Kumar Pandey, IIT Patna
Dr. Deep Gupta, VNIT Nagpur
Dr. Hari Shankar Singh, Thapar University
Dr. Sulabh Sachan, M. J. P. Rohilkhand University Bareilly
Dr. Amitesh Kumar, NIT Patna
Dr. Shitala Prasad, A STAR, Singapore
Dr. Himanshu Katiyar, REC Sonbhadra
Khadim Khadim Siddiqui, SRMU Lucknow

Dr. Menka, MNIT Jaipur
Dr. S. Mohamed Yacin, Majmaah University, Saudi Arabia
Indrojeet Chakraborty, NIT Silchar
Dr. Shashi Bhushan, NIT Kurukshetra
Dr. Shivam Verma, IIT BHU
Dr. Ribhu, IIT Guwahati
Jayabrata Maity, NIT Silchar
Dr. Pradeep Kumar, NIT Kurukshetra
Dr. Pankaj Pal, NIT Uttarakhand
Dr. Devendra Singh Gurjar, NIT Silchar
Jayati Vaish, AMITY University, Lucknow
Dr. Bhanu Pratap, NIT Kurukshetra
Dr. Chiranjib Koley, NIT Durgapur
Dr. Omhari Gupta, NIT Jamshedpur
Dr. Jayendra Kumar, NIT Jamshedpur
Dr. Altaf Q. H. Badar, NIT Warangal
Dr. Arjun Singh Yadav, NIT Rourkela
Dr. Ekant Sharma, IIT Roorkee
Dr. Jiwanjot Singh, NIT Silchar
Dr. Anulekha Saha, NIT Sikkim
Dr. Shalendra K. Saxena, Weizmann Institute of Science, Israel
Dr. Anuradha Ravi, SMU Singapore
Dr. Kamlesh Kumar Singh, AIMTY University, Lucknow
Dr. Bunil Kumar Balabantaray, NIT Meghalaya
Dr. Arvind Kumar, Indira Gandhi National Tribal University (IGNTU), Amarkantak
Dr. Amrit Mukherjee, Anhui University, China
Dr. Kavicharan Mummaneni, NIT Silchar
Dr. Rahul Antony, SAINTGITS College of Engineering
Dr. Pooran Singh, Mahindra University, Hyderabad
Dr. Sukwinder Singh, NIT Jalandhar
Dr. Koena Mukherjee, NIT Silchar
Dr. Arunangshu Ghosh, NIT Patna
Dr. Pratap Khuntia, CV Raman Global University, Odisha
Dr. Sarthak Singhal, MNIT Jaipur
Dr. Komal Agrawal, GBU Noida
Dr. Abhishek Midya, Memorial Sloan Kettering Cancer Center
Dr. Prateek Dolas, NIT Raipur
Dr. Jitendra Kumar, NIT Jamshedpur
Krishanu Nath, NIT Silchar
Dr. Jayasree Chakraborty, Memorial Sloan Kettering Cancer Center
Dr. Swati M. V., NIT Silchar
Dr. Pradyumna Kumar Behera, VSSUT Odisha
Dr. Lalu Seban, NIT Silchar
Dr. Anjan Kumar Ray, NIT Sikkim
Mr. Subhra S. Sarmah, NIT Silchar

Dr. Pratik Gowsami, Poornima University, Jaipur
Dr. Malaya Dutta Borah, NIT Silchar
Dr. Arun P., SJCET, Palai
Dr. Radhika Gour, IIIT Allahabad
Dr. Pravin P. S., NIT Silchar
Dr. Manas Bera, NIT Silchar
Dr. Badal Soni, NIT Silchar
Dr. Neha Singh, Thapar University, Patiala
Dr. Amrit Mukherjee, Anhui University, China
Dr. Mani Kant Kumar, CV Raman Global University, Odisha
Dr. R. Murugan, NIT Silchar
Dr. Piyush Kant, Berkeley University
Dr. Rahul Upadhyay, Thapar University
Dr. Manoranjan Rai Bharti, NIT Hamipur
Dr. Rinku Rabidas, Assam University
Dr. Achu Chandran, CSIR-NIIST, Thiruvananthapuram
Dr. Rajdeep Dasgupta, NIT Silchar
Mohamed Yacin Sikkandar, MAJMAAH University, Saudi Arabia
Dr. Avadh Pati, NIT Silchar
Dr. Robin Khosla, NIT Silchar
Dr. Ram Karsh, NIT Silchar
Mohd Faisal, NIT Silchar
Dr. Aditi Srivastava, MNIT Allahabad
Dr. Pooja Deori, Tezpur University
Dr. Ramanujam E., NIT Silchar
Dr. Monalisa Pattnaik, NIT Rourkela
Dr. Ahmad Faiz Minai, Integral University
Dr. Ramudu Ganji, NIT Silchar
Rupesh Mahamune, NIT Silchar
Dr. Munmun Khanra, NIT Silchar
Alok Kumar Dubey, NIT Silchar
Dr. Ritabrata Bhattacharya, CADENCE Delhi
Dr. Sachin Kumar, AMITY University, Lucknow
Dr. Nabanita Adhikary, NIT Silchar
Dr. Ankur Bhattacharjee, BITS Pilani
Dr. Santan Kumar, NIT Silchar
Dr. Shankar K., NIT Silchar
Dr. Naiwrita Dey, RCCIIT Kolkata
Dr. Anshul Agarwal, NIT Delhi
Dr. Shahedul Laskar, NIT Silchar
Dr. Shivendra Kumar Pandey, NIT Silchar
Dr. Naresh Babu Muppalaneni, NIT Silchar
Dr. Anup Kumar Sharma, NIT Silchar
Dr. Soumesh Chatterjee, NIRMA University Ahmedabad
Sovit Pradhan, NIT Silchar

Dr. Nikita Jaggi, IIT Kanpur
Dr. Arun Kumar Sunaniya, NIT Silchar
Dr. Sreejith S., NIT Silchar
Dr. Sreekanth N., NIT Silchar
Dr. Suchandan Das, CSIR, NML
Dr. Ashish Paramane, NIT Silchar
Dr. Sudarsan Sahoo, NIT Silchar
Dr. Sudipta Chakraborty, NIT Silchar
Dr. Swagatadeb Sahoo, NIT Jamshedpur
Dr. Swati M. V., NIT Silchar
Dr. Tarikul Islam, Jamia Milia University, New Delhi
Dr. Tripti Goel, NIT Silchar
Dr. Tushar Kanti Das, NIT Silchar
Dr. Umakant Majhi, NIT Silchar
Dr. Varun Bajaj, IIITDM Jabalpur
Dr. Vipin Pal, NIT Silchar
Dr. Zhe Wu, NUS Singapore

About the Conference

Emerging Electronics and Automation (E2A) 2022 is the 2nd annual International Conference organized by the Department of Electronics and Instrumentation Engineering at NIT Silchar, Assam. E2A 2022 is scheduled to be in hybrid mode between 16 and 18 December 2022.

We are happy to share that the first edition of E2A was successfully organized from 17 to 19 December 2021, and the accepted papers were published in Springer LNEE and indexed by EI Compendex and Scopus databases.

This conference focuses on trending research and product outcomes in the domain of control and robotics, signal processing, communication systems, sensors and instrumentation, MEMS and VLSI, AI, and soft computing. E2A 2022 will provide a common platform for the academicians, researchers, industrial players, and budding scholars to discuss their results, innovations, and challenges encountered during research and concerns with peers and update their knowledge by interacting with leading researchers of respective domains. It offers a great opportunity for them to network together, present research progress, and address new challenges. This conference promises to provide knowledge-enriching keynote lectures to the participants by world-renowned researchers in the relevant thematic areas.

The peer-reviewed and selected papers of this E2A 2022 conference will be published as proceedings with Springer in their prestigious "Lecture Notes in Electrical Engineering" series (*https://www.springer.com/series/7818*). This series is indexed by EI Compendex and Scopus databases.

Message from the Patron

It gives me immense pleasure to welcome you all to the 2nd International Conference on Emerging Electronics and Automation (E2A 2022) to be held from 16 to 18 December 2022. NIT Silchar has been offering engineering, science, and management programs that instill leadership qualities and teamwork, and that carry a global appeal in the corporate and academic fields. The institute aims to produce skilled and trained industry-ready professionals by imparting quality technical education and strives to act as the center of excellence for engineering education and scientific research. With rapidly advancing technological development, the field of instrumentation finds application in all areas of engineering and science. Responding to the global challenges for research and industrial development, the 2nd E2A 2022 conference will focus on the interdisciplinary fields of instrumentation, signals, systems, and computing. My best wishes are with the Department of Electronics and Instrumentation Engineering for hosting this international conference, and I look forward for a successful three days of ideating, intellectually enriching experiences, and academic collaborations for NIT Silchar and our esteemed participants and guests.

I wish you all a successful conference.

Prof. Rajat Gupta
Director
NIT Silchar

Message from the Honorary Chair

As Honorary Chair, it gives me extraordinary pleasure to welcome all the conference delegates to the 2nd International Conference of Emerging Electronics and Automation (E2A 2022) to be held at NIT Silchar from 16–18 December 2022. The planning and organization of such a major event are no small a challenge, and through diligent effort, the members of the organization committee have successfully been able to organize such a vibrant conference.

I was honored to be included as part of this conference event, and I hope that the delegates enjoy the conference.

With best wishes.

Prof. Jagannathan Sarangapani
Missouri Institute of Science and Technology, USA

Message from the General Chair

It is my great pleasure and honor to welcome you all to the 2nd International Conference on Emerging Electronics and Automation scheduled on 16–18 December 2022 at the National Institute of Technology Silchar, India. Serving as Conference General Chair has been a real privilege to me. The conference aims to create a highly interactive forum to bring together researchers from various academic and research institutions, industry and public organizations to present, exchange, and promote knowledge. We have received 110 numbers of high-quality papers from India and other countries. We are also pleased to have several keynote lectures by well-known leading experts from various disciplines. We hope the lectures and presentations at the conference will inspire future studies and advancement in the fields promoted by the conference. I wish to express my sincere appreciation to the organizing committee for their dedication and hard work, the plenary speakers for sharing their top-quality work, the authors for submitting and presenting their valuable work, and all the attendees. I hope that you will find the program interesting and a source of inspiration for future research.

Prof. Moncef Gabbouj
General Chair of E2A 2022
Tampere University, Finland

Message from the General Chair

It is our great pleasure to cordially invite you to participate in the 2nd International Conference on Emerging Electronics and Automation (E2A 2022), which is scheduled to be held at the National Institute of Technology, Silchar, Assam, India from 16–18 December 2022 in hybrid mode. This E2A 2022 will provide an excellent opportunity for researchers from academia as well as industries in the fast-growing field of electronics and automation encompassing robotics, signal processing and communication engineering to sensors, MEMS, and energy and power electronics.

The conference will bring together scientists and engineers from academia and industry to have scintillating discussions on cutting-edge issues and the most recent developments in the areas of electronics and automation. We are also happy to announce that selected high-quality papers from this international conference will be published with Springer in the "Lecture Notes in Electrical Engineering" after the peer-reviewed process.

I look forward to welcoming all of you at E2A 2022.

Prof. Shyam Sudhir Pandey
Kyushu Institute of Technology, Japan

Message from the General Chair

I am honored to be General Co-chair of the 2nd International Conference on Emerging Electronics and Automation E2A 2022. It is my privilege to welcome you all at this conference being organized and hosted by the Department of Electronics and Instrumentation Engineering, National Institute of Technology Silchar, Silchar, India, from 16 to 18 December 2022. Mr. P. K. Goswami, GM (ES) IOCL has kindly agreed to be our Chief Guest and inaugurate the event. We express our most sincere gratitude to him.

As one of the General Chairs of E2A 2022, I am happy to share that the conference is a celebration of technological advances within a broad spectrum of areas in electrical, computer, and related engineering disciplines. The Technical Program Committee (TPC) folks have been hard at work. I strongly believe that their hard work will truly be reflected in the quality and caliber of the papers presented at the conference. Keeping with the times, we are facilitating both face-to-face as well as online mode for the presentations and the conversations that may be spawned. The organizing committee members have generously given their time to make this conference happen. I am grateful to them and all the other committee members as well as the reviewers. Student volunteers are our unsung heroes. Thanks guys!

Collectively, our sincere appreciation to Springer LNEE for accepting the proposal to publish the accepted papers as book chapter proceedings. A heartfelt thanks to our sponsors too!

Silchar is a most wonderful place to visit and experience. You will find the air cool and crisp, the environment green, and the people-friendly. Of course, you are invited to indulge and enjoy the local delicacies of Assam to your heart's content.

We graciously welcome you to Silchar, a unique place with a distinct charm. Enjoy!

Best Wishes.

Dr. Hari Krishna Garg
National University of Singapore

Message from the General Chair

I feel privileged to be the General Chair of 2nd International Conference on Emerging Electronics and Automation E2A 2022, and it gives me great pleasure to welcome you all at this conference to be held at the Department of Electronics and Instrumentation Engineering, National Institute of Technology Silchar, Silchar, India, from 16 to 18 December 2022. Mr. P. K. Goswami, GM (ES) IOCL has agreed to be the chief guest and inaugurate the event for which we are highly obliged.

As one of the General Chairs of E2A 2022, I am glad to say that the conference call included research areas ranging from signal and image processing to MEMS and VLSI, control and robotics, AI and soft computing, energy, power systems and power electronics, communication systems and sensors and instrumentation. Of the 110 papers received, only 54 papers were accepted. I congratulate all the authors/ presenters for becoming the part of this conference. The highlight of the conference includes nine keynote talks and 13 technical tracks. The conference will be held in hybrid mode with 16 papers being presented in physical mode while the rest in online mode.

I am extremely thankful to the Technical Program Committee (TPC) for completing the reviews on time and accepting them for presentation. The organizing committee deserves a special applause in meticulously planning the event. I am also thankful to all the other committee members, reviewers, and student volunteers for their untiring efforts in organizing this event.

My sincere thanks to Springer LNEE for accepting the proposal of publishing the accepted papers as book chapter proceedings. The sponsors have added a charm to the conference to whom I am extremely thankful. Last but not least, I warmly welcome you to Silchar and enjoy the conference.

Best Wishes.

Dr. Ranjay Hazra
General Chair, E2A 2022
NIT Silchar

Message from Head of the Department

As the head of the department, I am pleased to welcome you all to the 2nd International Conference on Emerging Electronics and Automation (E2A 2022). It is our annual international conference being organized by the department of EIE, NIT Silchar. By the age, may be this conference is young but the standard of the research articles received, the papers are selected for publication, and the coverage of the thrust areas can meet international standards.

To keep up with the growth of technological revolution in the field of electronics, instrumentation, control, and automation, the department of EIE brings before you E2A 2022. This conference is a unique forum for exchange of innovative ideas and technical expertise for technological advancements in these fields. It includes keynote addresses from world-renowned academicians and paper presentations by the researchers from different parts of the country. It is a matter of joy for us to welcome the participants to this conference.

I thank Springer, which agreed to publish the peer-reviewed and selected papers of this E2A 2022 conference as proceedings within their prestigious "Lecture Notes in Electrical Engineering" which is indexed by EI Compendex and Scopus databases.

In a nutshell, the conference promises to transcend to a new and unprecedented level of excellence.

Thank you.

Dr. Manas Kumar Bera
Convener, E2A 2022

Message from the Organizing Chairs

On behalf of the E2A 2022 organizing committee, we are honored and delighted to welcome you to the 2nd International Conference on Emerging Electronics and Automation (E2A) 2022 to be held virtually from 16 to 18 December 2022 at the Department of Electronics and Instrumentation Engineering, NIT Silchar, Assam, India. The conference focuses on trending research and product outcomes in the domain of control and robotics, signal processing, communication systems, sensors and instrumentation, MEMS and VLSI, energy and power systems, and AI and soft computing. The conference is technically co-sponsored by Springer, DST SERB, Government of India, North Eastern Council, Government of India, alongside other sponsors, namely Allied Telesis, Realsoft, Poddar and Systems, Edutech, BMG Informatics, and Converge Systems and Services. The technical program consists of nine keynote speeches and 54 technical papers. The peer-reviewed and selected papers will be published as proceedings with Springer in prestigious Lecture Notes Electrical Engineering series.

The conference is a result of the hard work, support, dedication, and effort from all the stakeholders. In particular, we are thankful to the Director of the Institute and Patron of the Conference Prof. Rajat Gupta for his guidance and vision in organizing the conference. Our sincere thanks to the Honorary Chair Prof. Jagannathan Sarangapani, Missouri Institute of Science and Technology, USA, for his valuable suggestion. The immense help and support received from the general chairs, namely Prof. Moncef Gabbouj, Tampere University, Finland, Prof. Shyam Sudhir Pandey, Kyushu Institute of Technology, Japan, Dr. Hari Krishna Garg, National University of Singapore, and Dr. Ranjay Hazra, NIT Silchar have been instrumental in improving the quality of the conference. Our sincere gratitude to Convener, Dr. M. K. Bera, Assistant Professor, Department of Electronics and Instrumentation Engineering, NIT Silchar, for sharing his knowledge and wisdom. We are thankful to the various committees, namely technical program chairs, publication chairs, publicity chairs, hospitality chairs, session chairs, and finance chairs. We are extremely thankful to the technical program committee for their thorough and timely reviewing of the papers and our sponsors who have helped us to organize E2A 2022 in a better way. The

recognition should go to the local organizing committee members, namely registration committee, sponsorship committee, website, and online platform committee who have all worked extremely hard for the minute details of the conference programs. Last but not least, we are thankful to all the participants without whose presence the program would not have been a success. Thank you for your presence at the conference.

Regards
Organizing Chairs

Dr. Rajdeep Dasgupta

Dr. Shivendra K. Pandey

Dr. Lalu Seban

Dr. Vipin C. Pal

Keynote Speakers

Name: **Prof. Jagannathan Sarangapani**

Affiliation: Missouri Institute of Science and Technology, USA

Biography: Dr. Jagannathan Sarangapani (or S. Jagannathan) is at the Missouri University of Science and Technology (former University of Missouri-Rolla) where he is at present Professor and Rutledge-Emerson Endowed Chair. He is also serving as Interim Director of Intelligent Systems Center and served as Site Director for the graduated NSF Industry/University Cooperative Research Center on Intelligent Maintenance Systems for over 13 years. He has a joint appointment with the Department of Computer Science and the Department of Engineering Management and Systems Engineering. Prior to joining the Missouri S&T, he was employed at the University of Texas at San Antonio and Caterpillar Inc. His research interests include learning and adaptation, deep learning-based adaptive and neural network control, networked control systems/cyber-physical systems, sensor networks, prognostics, and autonomous systems/robotics.

He has coauthored 189 peer-reviewed journal articles, 292 refereed IEEE conference articles, several book chapters, and six books. He holds 21 patents with several pending. He has far supervised the completion of 32 doctoral students and 31 M.S. students. He is Fellow of IEEE, US National Academy of Inventors, IET (UK), and Institute of Measurement and Control, UK. He received NSF Career Award in 2000, Caterpillar Research Excellence Award in 2001, Presidential Award for Research Excellence at the University of Texas in 2001, Boeing Pride Achievement Award in 2007, 2021 University of Missouri Presidential Award of Excellence: Sustained Career and several Faculty Excellence and Teaching Excellence Awards at Missouri S&T, and many others.

Title: **Lifelong Online Learning in Feedback Control of Robotics/Autonomous Systems**

Abstract: Machine learning (ML)/artificial intelligence (AI) is making advances faster that the society is able to absorb, understand, and assimilate them in areas such as image recognition, natural language processing, and data analytics; at the same time feedback control that employ AI and ML are becoming more pervasive and critical. Today, application of learning controllers can be found in areas as diverse as process control, energy or smart grid, civil infrastructure, healthcare, manufacturing, automotive, transportation, entertainment, and consumer appliances. Moreover, controllers designed in discrete time have the important advantage that they can be directly implemented in digital form using modern-day embedded hardware. However, optimal control of uncertain linear or nonlinear dynamic systems is a major challenge. By incorporating learning features, optimal adaptive control of such uncertain dynamical systems can be designed.

In this talk, an overview of first and second-generation feedback controllers with learning component will be discussed. Subsequently, the lifelong learning-based optimal adaptive control of uncertain nonlinear dynamic systems will be presented in a systematic manner using a forward in time approach based on reinforcement learning (RL)/approximate dynamic programming (ADP). Challenges in developing the three generations of learning controllers will be addressed using practical examples such as automotive engine emission control, robotics and others. The talk will conclude with a short discussion of open research problems in the area of deep learning-based control.

Name: **Dr. Hari Krishna Garg**

Affiliation: National University of Singapore

Biography: Dr. Hari Krishna Garg is currently working as Associate Professor in the Department of Electrical and Computer Engineering, NUS Singapore. He obtained his B.Tech. degree in electrical engineering from IIT Delhi, India, in 1981, and M.E. and Ph.D. degrees in electrical engineering from Concordia University, Canada, in 1983 and 1985, respectively. He also obtained his M.B.A. degree from Syracuse University, USA, in 1995. Dr. Hari has been affiliated with Syracuse University, USA, National University of Singapore, Singapore, and Philips Consumer Communications, USA, in various academic and industrial positions. He has extensive experience in academic work, leadership, and research supervision. He held a senior position in a product development team during his industrial affiliation. His areas of interests are wireless/mobile telecoms (research and enterprise), signal and image processing, technology entrepreneurship, and enterprise and start-ups. Dr. Hari has extensive research experience in his areas of expertise. He has published over 150 journal and conference papers, 4 books, and over 10 patents granted in the USA, India, Singapore, and Australia. In addition, Dr. Hari has worked as consultant to companies providing expert guidance on patent and other technology-related matters. He is also an entrepreneur and has founded multiple technology companies, namely YuViTime Pte Ltd., Manovega Communications Pte Ltd., Fatte Telecom Pte Ltd., and Purple ACE Pte Ltd.

Title: **Blockchain: Building Trust in Untrusted Environments, Past, Present, and Future**

Abstract: Blockchain, an outgrowth of "trusted computing," has created a perfect storm thereby knocking, and at times upending, established institutions. It is a marvel of human ingenuity, going way beyond being a cool technology with marginal utility. Money, as a well-entrenched concept, with currency as its tangible realization, is getting refined and re-defined at the speed of Internet. All of this is happening presumably with dire consequences for political and economic institutions.

In this talk, we compare and contrast blockchain with another invention from a century ago—the light bulb. We do this to understand blockchain better for its future prospects. We further explore the use of blockchain/bitcoin as a "trusted party in-the-middle" for facilitating transactions between two non-trusting parties. We also reason that blockchain must present a value proposition in a forever-evolving marketplace for it to stay relevant. A certain "Animal Farm" effect finds a suitable place in our conversation.