Proceedings in Adaptation, Learning and Optimization 13

Manjaree Pandit
Laxmi Srivastava
Ravipudi Venkata Rao
Jagdish Chand Bansal *Editors*

Intelligent Computing Applications for Sustainable Real-World Systems

Intelligent Computing Techniques and their Applications

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Volume 13

The role of adaptation, learning and optimization are becoming increasingly essential and intertwined. The capability of a system to adapt either through modification of its physiological structure or via some revalidation process of internal mechanisms that directly dictate the response or behavior is crucial in many real world applications. Optimization lies at the heart of most machine learning approaches while learning and optimization are two primary means to effect adaptation in various forms. They usually involve computational processes incorporated within the system that trigger parametric updating and knowledge or model enhancement, giving rise to progressive improvement. This book series serves as a channel to consolidate work related to topics linked to adaptation, learning and optimization in systems and structures. Topics covered under this series include:

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Editors
Manjaree Pandit
Department of Electrical Engineering
Madhav Institute of Technology and Science
Gwalior, India

Laxmi Srivastava
Department of Electrical Engineering
Madhav Institute of Technology and Science
Gwalior, India

Ravipudi Venkata Rao
Mechanical Engineering Dept, A-2 Quarter
S.V. National Institute of Technology
Surat, Gujarat, India

Jagdish Chand Bansal
Department of Mathematics
South Asian University
New Delhi, Delhi, India

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Preface

The concept of sustainability is central to all developments. The term becomes more relevant by each passing day as the very existence of life on this planet is endangered due to the continuous and mindless exploitation of nature and natural resources due to population explosion, economic growth, infrastructure development, lifestyle changes and many other such factors. Nature, defined by its abundance, is a miraculous entity; it nurtures and blesses our lives in a million ways; nature keeps rejuvenating, replenishing, recycling and renewing itself constantly, at a steady pace. However, alarm bells are ringing now in every corner of the globe as the latest figures reveal a very grim picture, showing a huge gap between the rate of resource depletion and rate of recycling.

The professionals of engineering, management, science and technology fraternity need to redefine their role at this crucial point in the history of humanity, where the saying, "the last straw breaks the camel's back" seems to fit so well. The signs are already visible everywhere, be it heavy smog in winter, frequent floods and cyclones, erratic climate pattern, unmanageable burgeoning piles of waste, polluted air, water, earth; even the stars are losing their sheen. Nature is crying out for help! We urgently need to answer that call to help ourselves and to the future generations.

However, sustainability is a rather controversial issue; some would argue that development comes at the cost of sacrificing resources or else the human race will regress to the dark ages. I would say that striking a balance between development and sustainability is perhaps the biggest challenge before mankind. Accepting this challenge is our only hope, else we are doomed for sure; the only question is when and how.

The idea behind the conference is to bring together engineers, scientists, researchers, academicians, sociologists, planners and all those who can make a difference by introducing new policies, models, techniques and ideas that may help in creating a better tomorrow.

This interdisciplinary International Conference on "Sustainable and Innovative Solutions for Current Challenges in Engineering & Technology", ICSISCET 2019, was planned about two years ago, but it got a final form after receiving the sanction from the All India Council of Technical Education, New Delhi (AICTE). The idea

was to encompass and link all domains of engineering and technology with sustainable development. Overall, there were ten tracks; broadly based on exploring sustainability in infrastructure, manufacturing practices and design, power and energy systems, and computing and information technology. Tracks were also planned on the latest developments in computational intelligence and machine learning, embedded systems and VLSI design and advances in electronics and communication technology; two tracks on societal implications of technology and multidisciplinary research and practices.

The conference received 148 papers through the "easy chair conference management system". The papers were checked for plagiarism using the standard Turnitin software before sending the papers for review. After a rigorous review (each paper was reviewed by minimum two reviewers), 88 papers were accepted and presented in 16 separate sessions. There was one Skype session. Five sessions were run in parallel on 2nd November afternoon, 3rd November morning and afternoon. Each session was chaired by one internal and one external expert. Also, spread over these two days, ten expert lectures were arranged which were delivered before the paper presentations in each session. Overall, 24 experts from diverse fields of engineering, technology and science had participated in the conference.

The session chairs and supporting teams had been provided with the review comments and soft copies of all camera-ready papers assigned to their respective sessions, in advance.

In keeping with the conference theme of "sustainability", the organizing chairs had tried to avoid the use of paper as far as possible; all communications, review process, data management, registration, most of the session documentation, etc. had been done electronically, to the extent that we had given e-certificates to all participants, session chairs and experts, as a best practice and also as a small initiative towards the commitment of the institute to sustainability.

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The **conference patron Prof. K. K. Aggarwal, Chairman NBA**, was the guiding force behind the conference, and he also kindly accepted to deliver the keynote address, for which the organizers are eternally indebted.

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The organizers are grateful for the constant inputs and support from our conference chairs **Prof. R. V. Rao of NIT, Surat**, **Dr. J. C. Bansal of South Asian University, New Delhi**, and **Dr. Mukhtiar Singh of DTU, Delhi**. Without their support the conference could not have been conducted at this scale.

Dr. M. H. Lim of **Nanyang Technological University, Singapore**, deserves special thanks for helping the organizers in publishing the proceedings.

The organizing team is grateful to **Shri Prashant Mehta**, **Former Director General of the Academy of Administration**, Bhopal, for sparing time to inaugurate the conference.

Sincere thanks to Alumnus and Secretary of **The Scindia Engineering College Society, Gwalior**, **Er. Ramesh Agrawal**, who has been a constant source of support. The conference could not have been possible without the support of the Director, MITS, Dr. R.K. Pandit.

Thanks are also due to all the **esteemed reviewers** for their time and significant contribution in maintaining the quality of the papers.

The contribution of **internal and external experts as session** chairs and the **session support teams** during the two days was most important for the effective conduction of the conference. They accepted the invitation and played a key role in conference conduction by giving valuable comments for improving the quality of the paper, post-conference, before publication. The organizers are grateful for their support and efforts in conference conduction.

We thank the experts who have taken time from their busy schedules for delivering expert sessions during the conference.

The hard work and efforts of the Conference Core Team are sincerely acknowledged. The members have worked relentlessly and have left no stone unturned to make the conference a reality.

Thanks are also due to media persons, guests, authors and all those who have directly or indirectly contributed in organizing and conducting this conference.

Contents

Smart Grid Communication: A Survey of State-of-the-Art

Vimal Tiwari(✉), Salil Madhav Dubey, Hari Mohan Dubey, and Manjaree Pandit

Madhav Institute of Technology and Science, Gwalior, India
vimaltiwari01@gmail.com, salil.dubey3107@gmail.com, harimohandubeymits@gmail.com, manjaree_p@hotmail.com

Abstract. The existing power grid has undergone drastic changes within a decade, in order to deal with the increase in energy demand. With the integration of different distributed energy resources (DERs) for a group of interconnected loads within a defined electrical boundary, microgrid came into existence. However, with the increased use of effective communication, automation and monitoring skills the microgrids are technologically advanced with fast response and are referred to as 'Smart Grids'. In smart grid, efficient and reliable communication is incorporated to improve the efficiency, sustainability, and stability of the whole system. This paper presents a review on the different types of available communication methods and protocols which are used for data communication within and outside a smart grid based power supply system.

Keywords: Smart grid · Communication methods · Communication protocols · Microgrid

1 Introduction

A Microgrid (MG) can be defined as a small-scale, self-sustaining electric network which consists of distributed energy resources (DERs), such as wind, solar, and fuel cells, with storage devices and controllable loads. MG is designed to provide uninterrupted power supply to a balanced load demand for various diverse and changing customer demands. In MG, energy is supplied by one or more DERs of same or different types. It can reduce feeder loss, improve the reliability of the local power distribution system and increase energy efficiency. Depending on the coupling of different elements, MG can be divided into AC MG, DC MG, and hybrid MG structures which include AC and DC both elements. MGs can be connected to the main network or operated separately. Depending on these operations, MGs are operated in two modes namely Island mode and Grid-connected mode. In island mode MG can operate standalone i.e. the DERs can supply power to load only. In grid-connected mode, MG can exchange power with the power grid i.e. it can feed extra power to the power grid or consume the power of grid when needed.

MG can be disconnected from the power grid at the time of occurence of fault or when the grid has no power. Also, it can be reconnected to the power grid when the fault is cleared provided that this transition does not cause any negative effects on the

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