

SURVEY

A Survey on Machine Learning Techniques in Smart Grids Based on Wireless Sensor Networks

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The work in this paper was supported, in part, by the open access program and project FRO24-C-066 from the American University of Sharjah.

ABSTRACT Smart grids (SGs) are crucial to the efficiency and sustainability of modern energy systems. As the world's population continues to increase, so does the need for energy, and traditional energy systems are struggling to keep up. In this context, this study reviews the possibilities of deploying machine learning (ML) on wireless sensor networks (WSNs) in smart grid systems. In several ways, SGs may gain from combining WSNs with ML, including enhance system reliability, sustainability, improve fault detection, and increase energy efficiency. This paper offers an extensive review of pertinent research emphasizing the use of supervised, unsupervised, and reinforcement learning approaches. The evaluation contains 234 peer reviewed articles from highly regarded academic journals and conferences covering the years 2017 through 2024 which depict the effectiveness of supervised techniques on WSNs in the field of SGs. In addition the paper presents set of the most usable datasets in the field of WSNs and SGs, and introduces a comparison between our paper and relevant surveys. The study also analyses the opportunities and challenges related to the application of WSNs and ML in SGs and offers possible research directions. Overall, the study makes it clear that combining WSNs with ML may significantly contribute to the creation of smart grid systems that are more effective, dependable, and sustainable.

INDEX TERMS Wireless sensor networks, smart grids, machine learning, supervised ML, smart sensors.

I. INTRODUCTION

Electric Power System (EPS) is one of the most common types of energy that affects humanity's life, economy, and governmental issues. It is generated in the basic foundation known as the power network or grid. A power network consists of many parts linked and distributed in numerous places [2]. EPS consists of three main stages, firstly, generating stations usually called (power plants). Then a Transmission stage transports Power efficiently from power plants to consumers via transmission lines. The final stage is electricity distribution to consumers. The three stages are depicted in Figure 1.

The associate editor coordinating the review of this manuscript and approving it for publication was Salvatore Panavazza.

The consumer's demand level may be increased over the distributed level or decreased. There is a need to control and manage the power system, load balancing, and automation system. The demand and supply of electrical energy must be balanced, the system operator uses data provided by a higher-level control and data acquisition framework called Supervisory Control and Data Acquisition (SCADA) to observe, manage, and control the generation and transmission system within the Energy Management System (EMS). References [1], [3], [4], [5], and [6] presented other system control approaches for smart automated systems depending on (SG).

An SG is an energy network that continuously monitors the energy flow and adapts to any change in power supply or energy demands. SG uses the smart metering system to

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Machine Learning and Deep Learning Techniques in Wireless and Mobile Networking Systems K. Suganthi,R. Karthik,G. Rajesh,Peter Ho Chiung Ching,2021-09-13 This book offers the latest advances and results in the fields of Machine Learning and Deep Learning for Wireless Communication and provides positive and critical discussions on the challenges and prospects It provides a broad spectrum in understanding the improvements in Machine Learning and Deep Learning that are motivating by the specific constraints posed by wireless networking systems The book offers an extensive overview on intelligent Wireless Communication systems and its underlying technologies research challenges solutions and case studies It provides information on intelligent wireless communication systems and its models algorithms and applications The book is written as a reference that offers the latest technologies and research results to various industry problems

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Research Anthology on Machine Learning Techniques, Methods, and Applications Management Association, Information Resources,2022-05-13 Machine learning continues to have myriad applications across industries and fields To ensure this technology is utilized appropriately and to its full potential organizations must better understand exactly how and where it can be adapted Further study on the applications of machine learning is required to discover its best practices challenges and strategies The Research Anthology on Machine Learning Techniques Methods and Applications provides a thorough consideration of the innovative and emerging research within the area of machine learning The book discusses how the technology has been used in the past as well as potential ways it can be used in the future to ensure industries continue to develop and grow Covering a range of topics such as artificial intelligence deep learning cybersecurity and robotics this major reference work is ideal for computer scientists managers researchers scholars practitioners academicians instructors and students

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transformative potential of AI in addressing complex real world challenges The conference received an overwhelming response attracting more than 120 research paper submissions from various regions of India and abroad After a rigorous review process 55 high quality papers were accepted out of which over 44 papers were registered for presentation at the summit By fostering interdisciplinary collaboration and showcasing impactful innovations NEIAIS 2025 aims to inspire sustained research technological growth and broader societal benefits

Underwater Vehicle Control and Communication Systems Based on Machine Learning Techniques Tien Anh Tran, Kolla Bhanu Prakash, Subrata Chowdhury, Ivan CK Tam, 2023-12-04 The development of intelligent transportation systems especially autonomous underwater vehicles has become significant in marine engineering with an aim to enhance energy efficiency management and communication systems This book covers different aspects of optimization of autonomous underwater vehicles and their propulsion systems via machine learning techniques It further analyses hydrodynamic characteristics including the study of experimental investigation combined with hydrodynamic characteristics backed by MATLAB codes and simulation study results Features Covers utilization of machine learning techniques with a focus on marine science and ocean engineering Details effect of the intelligent transportation system ITS into the sustainable environment and ecology system Evaluates performance of particle swarm intelligence based optimization techniques Reviews propulsion performance of the remote controlled vehicles based on machine learning techniques Includes MATLAB examples and simulation study results This book is aimed at graduate students and researchers in marine engineering and technology computer science and control system engineering

Applied Mathematical Modeling for Biomedical Robotics and Wearable Devices S. Sountharajan, M. Karthiga, Balamurugan Balasamy, Ali Kashif Bashir, 2025-08-29 Applied Mathematical Modelling for Biomedical Robotics and Wearable Devices delves into the innovative convergence of mathematical frameworks and biomedical engineering The book begins by exploring how advanced mathematical modelling underpins the development and optimization of robotic systems and wearable technologies tailored for medical applications With a strong emphasis on practical implementation it serves as a bridge between theoretical concepts and real world engineering challenges in the healthcare sector Readers will gain insights into the transformative role of mathematical techniques that drive precision functionality and human centric design in cutting edge medical technologies The book also covers interdisciplinary applications integrating domains like biomechanics sensor technology and data analytics By highlighting case studies and real world scenarios it showcases practical advancements in wearable devices that monitor health metrics and robotic systems that assist in surgical procedures Examines the role of applied mathematical modeling in the design analysis and optimization of biomedical robots and wearable devices Provides an insightful exploration of cutting edge developments in robotics and wearable devices Bridges the gap between the areas of mathematics engineering and healthcare

Deep Learning Strategies for Security Enhancement in Wireless Sensor Networks Sagayam, K. Martin, Bhushan, Bharat, Andrushia, A. Diana, Albuquerque,

Victor Hugo C. de,2020-06-12 Wireless sensor networks have gained significant attention industrially and academically due to their wide range of uses in various fields Because of their vast amount of applications wireless sensor networks are vulnerable to a variety of security attacks The protection of wireless sensor networks remains a challenge due to their resource constrained nature which is why researchers have begun applying several branches of artificial intelligence to advance the security of these networks Research is needed on the development of security practices in wireless sensor networks by using smart technologies Deep Learning Strategies for Security Enhancement in Wireless Sensor Networks provides emerging research exploring the theoretical and practical advancements of security protocols in wireless sensor networks using artificial intelligence based techniques Featuring coverage on a broad range of topics such as clustering protocols intrusion detection and energy harvesting this book is ideally designed for researchers developers IT professionals educators policymakers practitioners scientists theorists engineers academicians and students seeking current research on integrating intelligent techniques into sensor networks for more reliable security practices **Journal of Machine Learning Research**,2007 An international forum covering all areas of machine learning Sensors, Measurement and Intelligent Materials Yun Hae Kim,Prasad Yarlagadda,2013-02-13 Selected papers from the 2012 International Conference on Sensors Measurement and Intelligent Materials ICSMIM 2012 December 26 27 2012 Guilin China **Intelligent Sensor Networks** Fei Hu,Qi Hao,2012-12-15 In the last decade wireless or wired sensor networks have attracted much attention However most designs target general sensor network issues including protocol stack routing MAC etc and security issues This book focuses on the close integration of sensing networking and smart signal processing via machine learning Based on their world class research the authors present the fundamentals of intelligent sensor networks They cover sensing and sampling distributed signal processing and intelligent signal learning In addition they present cutting edge research results from leading experts **Smart Sensor Networks** Umang Singh,Ajith Abraham,Arturas Kaklauskas,Tzung-Pei Hong,2021-09-01 This book provides IT professionals educators researchers and students a compendium of knowledge on smart sensors and devices types of sensors data analysis and monitoring with the help of smart sensors decision making impact of machine learning algorithms and artificial intelligence related methodologies for data analysis and understanding of smart applications in networks Smart sensor networks play an important role in the establishment of network devices which can easily interact with physical world through plethora of variety of sensors for collecting and monitoring the surrounding context and allowing environment information Apart from military applications smart sensor networks are used in many civilian applications nowadays and there is a need to manage high volume of demands in related applications This book comprises of 9 chapters and presents a valuable insight on the original research and review articles on the latest achievements that contributes to the field of smart sensor networks and their usage in real life applications like smart city smart home e healthcare smart social sensing networks etc Chapters illustrate technological advances and trends examine

research opportunities highlight best practices and standards and discuss applications and adoption Some chapters also provide holistic and multiple perspectives while examining the impact of smart sensor networks and the role of data analytics data sharing and its control along with future prospects **HPSR 2004** Ariz) Workshop on High Performance Switching and Routing (2004 PH,2004 IEEE Catalog Number 04TH8735 T p verso *Proceedings of the 2003 ACM Workshop on*

Wireless Security ,2003 *Machine Learning, Deep Learning and Computational Intelligence for Wireless Communication*

E. S. Gopi,2021-05-28 This book is a collection of best selected research papers presented at the Conference on Machine Learning Deep Learning and Computational Intelligence for Wireless Communication MDCWC 2020 held during October 22nd to 24th 2020 at the Department of Electronics and Communication Engineering National Institute of Technology Tiruchirappalli India The presented papers are grouped under the following topics a Machine Learning Deep learning and Computational intelligence algorithms b Wireless communication systems and c Mobile data applications and are included in the book The topics include the latest research and results in the areas of network prediction traffic classification call detail record mining mobile health care mobile pattern recognition natural language processing automatic speech processing mobility analysis indoor localization wireless sensor networks WSN energy minimization routing scheduling resource allocation multiple access power control malware detection cyber security flooding attacks detection mobile apps sniffing MIMO detection signal detection in MIMO OFDM modulation recognition channel estimation MIMO nonlinear equalization super resolution channel and direction of arrival estimation The book is a rich reference material for academia and industry

Proceedings of the ... ACM Workshop on Wireless Security ,2003 *Proceedings of the Twenty-second AAAI Conference on Artificial Intelligence* ,2007 **Smart Sensor Networks Using AI for Industry 4.0** Soumya Ranjan

Nayak,Biswa Mohan Sahoo,Muthukumaran Malarvel,Jibitesh Mishra,2021-10-10 Smart Sensor Networks WSNs using AI have left a mark on the lives of all by aiding in various sectors such as manufacturing education healthcare and monitoring of the environment and industries This book covers recent AI applications and explores aspects of modern sensor technologies and the systems needed to operate them The book reviews the fundamental concepts of gathering processing and analyzing different AI based models and methods It covers recent WSN techniques for the purpose of effective network management on par with the standards laid out by international organizations in related fields and focuses on both core concepts along with major applicational areas The book will be used by technical developers academicians data sciences industrial professionals researchers and students interested in the latest innovations on problem oriented processing techniques in sensor networks using IoT and evolutionary computer applications for Industry 4 0 **KDD ...** ,2003 *Advanced Computer Science Applications*

Karan Singh,Latha Banda,Manisha Manjul,2023-09-15 This new book brings together the most recent trends related to AI machine learning and network security The chapters cover diverse topics on machine learning algorithms and security analytics AI and machine learning and network security applications The volume presents a survey of speculative

parallelism techniques performance reviews and efficient power consumption The book also covers the concepts of IoT security early detection for COVID 19 multimetric geographical routing in VANETs V2X communication in VANET and optimization of congestion control scheme for VANETs This book is a comprehensive take on recent applications and advancement in the field of computer science and will be of value to scientists researchers faculty and students involved in research in the area of AI machine learning and network security **Proceedings** American Association for Artificial Intelligence,2006

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