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Borutzky Wolfgang
Khalid Chikh *Editors*

The Proceedings of the International Conference on Electrical Systems & Automation

Control of Electrical and Electronic
Systems—Volume 2

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Mohamed Bendaoud · Borutzky Wolfgang ·
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Editors

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 Springer

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Preface

This book is the second part of two volumes on “**Control of Electrical and Electronic Systems**” and is a compilation of selected contributions to the International Conference on Electrical Systems & Automation (ICESA’21) which was held on 8–9 December 2021 at the National School of Applied Sciences of Khouribga, Morocco. This conference brings together researchers in industry and academia to exchange their ideas, applications, and innovative techniques in the field of renewable energy and electrical systems.

The book provides rigorous discussions, the state of the art, and recent developments in the modelling, simulation and control of power electronics, industrial systems, and embedded systems. The book will be a valuable reference for beginners, researchers, and professionals interested in control of electrical and electronic systems.

The conference programme featured a rich set of keynote session topics and tutorials that extend beyond the papers contained in this proceedings. There were six high-profile keynotes by eminent researchers: Prof. Yazami Rachid (*KVI Pte Ltd., Singapore*), Prof. Hachimi Hanaa (*Sultan Moulay Slimane University, Morocco*), Prof. Pierluigi Siano (*University of Salerno, Italy*), Prof. Michael Schmidt (*Offenburg University, Germany*), and Prof. Yousfi Driss (*Mohammed I University, Morocco*).

The editors express their gratitude to Springer Nature authority for publishing this volume in the Springer Conference Proceedings Series.

The editors also express sincere thanks to the reviewers for their dedication in reviewing the articles. Also, thanks to the authors for submitting their articles to this volume.

It is hoped that this volume will be a good reference manual for researchers and budding engineers.

Khouribga, Morocco
Sankt Augustin, Germany
Khouribga, Morocco

Mohamed Bendaoud
Borutzky Wolfgang
Khalid Chikh

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About the Editors

Prof. Mohamed Bendaoud received the M.Sc. and Ph.D. degrees in Electrical Engineering from Cadi Ayyad University, Marrakech, Morocco, in 2012 and 2019, respectively. He is currently Assistant Professor at National School of Applied Sciences (ENSA) of Khouribga, Sultan Moulay Slimane University, Morocco.

He is Founder and General Chair of the International Conference on Electrical Systems & Automation. He has served and continues to serve on the technical programme committees and as reviewer of numerous international conferences and journals such as Journal of The Franklin Institute, Mechatronic Systems and Control. He is Editor-in-chief of the new ambitious *Journal of Electrical Systems & Automation* (JESA). He is Deputy Director of the science and technology laboratory for engineers.

His research interests include:

- Modelling and control of grid connection for photovoltaic and wind energy.
- Modelling and simulation methodologies for multidisciplinary systems, in particular bond graph-based.
- Control of power converters.

Prof. Borutzky Wolfgang is a retired professor for Modelling and Simulation of Engineering Systems at Bonn-Rhein-Sieg University of Applied Sciences, Germany. He obtained his University Diploma Degree in Mathematics in 1979 and his Doctoral Degree in Mechanical Engineering in 1985, both from the Technical University of Braunschweig, Germany.

He was Visiting Professor at universities in the Netherlands, the USA, France, and Argentina. Since 2008, he holds an honorary position as Associate Professor of Electrical Engineering and Information Technology at the University of Dubrovnik, Croatia.

His main research interests include modelling and simulation methodologies for multidisciplinary systems, in particular bond graph-based as well as object-oriented modelling; modelling, analysis, control, and fault diagnosis of mechatronic

systems and hybrid failure prognostic methods; modelling languages; and scientific computing and numerical algorithms for continuous system simulation.

He has published in the proceedings of many peer-reviewed international conferences on modelling and simulation and in refereed scientific journals. In 2019, he received the best paper award of the 12th International Conference on Integrated Modelling and Analysis in Applied Control and Automation (IMAACA 2019) in Lisbon, Portugal, which is part of the annual International Multidisciplinary Modelling & Simulation Multiconference (I3M).

He is author of a 2010 Springer monograph on bond graph methodology and of a 2015 Springer book on bond graph model-based fault diagnosis in hybrid systems. He is also Editor and Co-author of a 2011 Springer compilation text on Bond Graph Modelling of Engineering Systems and of a 2016 compilation text entitled Bond Graphs for Modelling, Control and Fault Diagnosis with contributions from experts in various fields from all over the world. His latest book published with Springer is titled Bond Graph Modelling for Control, Fault Diagnosis and Failure Prognosis. Furthermore, he was Guest Editor of two special journal issues on bond graph modelling.

Since 1990, he has served in many international scientific conferences on modelling and simulation in various capacities. In 2005, he was Assistant General Chair of the European Conference on Modelling and Simulation (EMCS) in Riga, Latvia, in 2006 he was General Chair of the ECMS 2006 in Sankt Augustin, Germany, and in 2013 he was Conference Chair of the IASTED Conference on Modelling, Identification, and Control (MIC 2013) in Innsbruck, Austria. From 2005 to 2007, he served on the Board of the European Council for Modelling and Simulation.

In 2009, he was an invited tutorial speaker of the IASTED Conference on Modelling, Simulation and Identification (MSI 2009) in Beijing, China, and in 2010, he was one of the invited keynote speakers to the Conference on Power Control and Optimisation (PCO 2010) in Kuching, Malaysia.

In 2012, he was one of the invited keynote speakers of a workshop on bond graph modelling in Pune, India, and one of the invited keynote speakers of the SCS Summer Simulation Multiconference in Genoa, Italy.

In 2013, he was an invited tutorial speaker of the IASTED Conference on Control and Applications (CA 2103) in Honolulu, USA, and one of the invited keynote speakers of the International Conference on Smart Technologies for Mechanical Engineering at Delhi Technological University (DTU), Delhi, India.

In 2018, he was one of the invited keynote speakers of the 1st International Conference on New Frontiers in Engineering, Science & Technology (NFEST 2018), New Delhi, India, and of the 1st International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS'18), Kenitra, Morocco.

He has also served as an invited external examiner and as Member of Ph.D. defense committees in France, in India, in the UK, and in Norway. Moreover, he has given invited lectures and short courses in industry on bond graph modelling.

During the 2004–2006 biennium, he served on the SCS Board of Directors. He was also active as Member of the Editorial Board of some major modelling and

simulation-related journals. Since 2009, he is again Associate Editor of the journal *Simulation: Transactions of the Society for Modeling and Simulation International*.

Prof. Khalid Chikh obtained Post-Doctoral Degree (HDR) in electrical engineering for renewable energy from the Sultan Moulay Slimane University, Beni Mellal, Morocco; Ph.D. degree in electrical engineering from the National School of Electricity and Mechanics (ENSEM), Hassan II University, Casablanca, Morocco; and Diploma of Advanced Higher Studies (DESA) in electrical engineering from the Faculty of Science Semlalia, Cadi Ayyad University, Marrakesh, Morocco.

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Recent Advances in Machine Learning and Deep Learning in Vehicular Ad-hoc Networks: A Comparative Study



Taib Chaymae, Haimoudi Elkhatir, and Abdoun Otman

Abstract The expanding population necessitates the development of solutions to make human life easier. Smart transportation plays an important role in society by improving road security, lowering mishap rates, and making the travel experience more valuable for passengers. As a result, the vehicular ad hoc network (VANET) provides communication between vehicles for exchanging information in order to improve traffic flow and ensure driving safety. However, the Vanet network has faced several challenges that have compromised the driver's privacy; thus, Machine learning and Deep learning contribute to enhance. We offer a detailed assessment of Artificial intelligence approaches being investigated by diverse research initiatives in the field of VANETs. We examine the benefits and drawbacks of these suggested AI-based methods for the VANET environment, in addition, we make a comparative analysis of some ML and AI algorithms based on four essential criteria. Finally, we highlight future VANET research areas that may fully use AI's capability.

Keywords Deep learning · Machine learning · Vanet network · Ad-hoc · Smart transportation · Smart city · Security · Artificial intelligence

1 Introduction

The growth of the population number which's according to the united nation we had reached 7.9 billion, China in the leads, with 1.4 billion population exceeded, this problem urges us to search for a way to improve security and reliability and comfort of traditional cities by developing smart cities. Thus, urban transportation is considered a big part of the enhancement of smart cities [1].

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The increasing number of accidents in the cities leads to several human lost pushes to improve the quality of transportation and that by strengthening the security and communication between the vehicles for better driving and more safety [2].

A VANET network, or vehicular ad hoc network, is a self-organized network that allows smart cars to communicate with one another in order to improve traffic flow and assure driving safety [3]. Despite the benefits of this solution, it still faces a number of issues in terms of security and privacy; the information exchanged in the cloud might lead to a number of assaults, compromising the driver's security [4]. Machine learning algorithms are strong tools that may assist in dealing with assaults as well as predicting a safe route with fewer collisions [5].

The main contributions of this paper include:

- We explored various AI approaches and highlighted their effectiveness as well as limits in solving various VANET difficulties and requirements.
- We conducted a comparison study of machine learning and deep learning algorithms based on four important criteria.

In this study, we present a survey about Vanet Ad-hoc network, we examined numerous AI approaches and evaluated their applicability as well as limits in solving various VANET difficulties and needs, we also highlight future research areas that need to be investigated further in order to fully integrate AI with VANET.

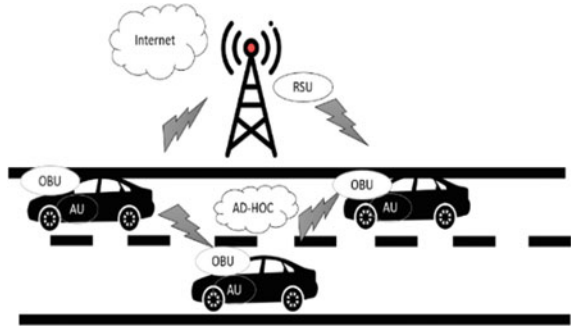
The rest of this paper is organized as follows. Section 2 an overview of Vanet and the types of communication. In Sect. 3, background on machine learning and deep learning. Section 4 presents the issue of the challenge of Vanet. Section 5 the application of each algorithm in Vanet area with their limitation. Section 6 presents a comparative study. Section 7 conclusions and future works.

2 Vehicular Ad-hoc Network

A vehicular ad hoc network (VANET) was created based on the principle of a Mobile Ad Hoc network (MANET) that gives the possibility to communicate between vehicle and its environment (nearby vehicles, road devices) for an exchange of information about traffic state for improving road safety and avoid the congestion in addition to entertainment systems. As shown in Fig. 1. The network provides three main communication nodes: On-board Units and On-road Side and Application Unit [6]:

- On Board Unit (OBU): An On-Board Unit (OBU) is OBU is a device that was mounted in every vehicle for receiving and transmission of information with other OBUs or RSUs.
- Application Unit (AU): An AU is a device installed inside the vehicle for the ability to transmit and receive information with OBU and it can be linked via a wireless medium or wired, in addition, AU could operate via normal devices.
- Road Side Unit (RSU): RSU is a wave device being placed all along the roadside or in an intersection or parking. It can help to prevent accidents and that with the

Fig. 1 The three communication nodes



fact the device connected to the internet will provide to the users the information in addition to their security.

2.1 Type of Communication System

The Vanet network allows vehicles to communicate with each other for safer and more comfortable driving. As a result of the exchange of information regarding road conditions, the Vanet has seven forms of communication, which we will unveil in the following paragraph:

- **Vehicle to vehicle (V2V):** it's a communication between vehicles to transmit and receive information about the road, for example, if there is an accident or jam or an ambulance.
- **Vehicle to Infrastructure (V2I):** The vehicle connected to RSU to be able to communicate with the infrastructure network like the internet.
- **Vehicle to broadband cloud (V2B):** technology of Vanet can't handle a large amount of data with different types (audios, videos, text), therefore Vanet uses Edge Cloud Computing for beneficial communication that can interconnect through 4G or 5G (wireless broadband mechanisms).
- **Vehicle to everything (V2X):** vehicle to everything is communication that enables to transmit and receive information between a vehicle with other vehicles, pedestrians, road infrastructure, and the Internet, to get a safer exchange, more coordinated, and smarter use of transportation networks.
- **Intra-Infrastructure communication (I2I):** Is a communication, gathering V2V and V2I. A vehicle may either exchange information with the roadside infrastructure in two ways: a single hop or multi-hop fashion.
- **Vehicle-to-Sensor communication (V2S):** vehicle to sensor connection provides communication between vehicles and miscellaneous sensors which are installed inside or out vehicles.

- Vehicle-to-Personal Device communication (V2PD): this connection allows the passenger to exchange information such as music and video between vehicle and portable devices

3 VANET and ML and DL: Background

3.1 Machine Learning Algorithms

Machine learning is the combination of statistics and algorithms models that teaches the machine how to benefit from data to produce a prediction or a decision. In this section we will present some of machine learning algorithms:

- Support vector machine learning: support vector machine is a supervised algorithm, SVM is a distinct of linear classifiers built on the principle of margin maximization that provides an improvement in the case of complexity, therefore, reach a better performance. The main task of SVM is to find the finer hyperplane that splits the data into two classes.
- Decision Tree: is a supervised machine learning, the goal of this method is to create a model that extracts features from data and makes a prediction for the value of a target variable of learning simple decision rules, DT is used in both classification and regression problems.
- Random forest: the random forest is based on a collection of plenty decision trees in the training and for the classification phase by the majority vote, the RF is simple to implement and fast and has proven its success in many fields.
- Principal component analysis: PCA is utilized in exploratory data analysis and predictive model development. It's the process of calculating the primary components and using them to change the basis of the data, sometimes simply using the first few and ignoring the rest. It's usually used to reduce dimensionality.
- K-Nearest Neighbor: KNN is a simple supervised learning technique that can be used in both classification and regression issues. It's also straightforward to comprehend and use, requiring no additional assumptions or tuning of multiple parameters. However, it becomes extremely slow when dealing with huge datasets. If the problem is a classification or regression, it works by calculating the distance between a query and all the data and selecting the one that is closest to the query, and then voting for the most frequent or averages label dependent.
- Reinforcement Learning (RL) is a type of machine learning issue in which the aim is to learn what to do based on previous experiences in order to discover the optimal answer. Reinforcement learning differs fundamentally from supervised and unsupervised learning in terms of the interactive and iterative aspects: the algorithm attempts many solutions (exploration), observes the reaction of the environment, and changes its behavior (the variables) to discover the optimal approach.

3.2 *Deep Learning Algorithms*

Deep Learning is a branch of machine learning, this subfield is inspired by the structure and function of the human brain in order to generate predictions using neural networks. In this section we will present some of the deep learning algorithms:

- **Artificial Neural Networks:** ANN Are multi-layer, fully connected neural nets that consist of an input layer, multiple hidden layers, and an output layer. Every node in one layer is linked to every other node in the next layer. We reinforce the network by increasing the number of hidden layers.
- **Convolutional Neural Network:** CNN is a type of feed-forward neural network in AI, it is commonly used in image recognition and feature extraction. CNN consists of five layers: the input layer, pooling layer, full-connection layers, and output layer.
- **Recurrent Neural Network:** RNN Is a sort of neural network containing loops that allow data to be stored inside the network. Recurrent Neural Networks employ reasoning from prior experiences to predict future events. Recurrent models are useful because they can chain vectors which enable the API to execute more complex tasks.
- **Long Short-Term Memory:** The control flow of an LSTM is much like that of a recurrent neural network. It processes data and forwards information as it propagates. The processes within the cells of the LSTM vary. The cell state and its numerous gates are at the heart of LSTMs. The cell state serves as a conduit for relative information to be sent all the way down the sequence chain.
- **Deep Belief Network:** Were developed as a solution to the issues faced when utilizing standard neural networks for deeply layered network training, such as sluggish learning, becoming trapped in local minima owing to poor parameter selection, and requiring a large number of training data sets.

4 **Vehicular Ad-hoc Network Challenges**

4.1 *Security*

The most serious issue for VANET is safety. Security capabilities include access protection, data management, traceability, and security, as well as revocability, availability, trustworthiness, transparency, repudiation, privacy, and confidentiality. The study [7] describes a methodology that raises vehicle driver's awareness of sidewalks near to crossings.

The suggested system connects roadside units (RSUs) to vehicles in order to transfer information concerning pedestrian presence through traffic. To avoid the transmission of misleading information, before sending out alert messages, RSUs sign them, and all cars may validate the signature. This imposes stringent safety requirements, such as not replicating warnings and the rigorous requirement for