A review on Edge Artificial intelligence (Edge AI) on transportation

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1 1 Introduction

The following are the papers reviewed on edge-AI applications in transportation

Ali, E. S., Hasan, M. K., Hassan, R., Saeed, R. A., Hassan, M. B., Islam, S., Bevinakoppa, S. (2021). Machine Learning Technologies for Secure Vehicular Communication in Internet of Vehicles: Recent Advances and Applications. Security and Communication Networks, 1-23

Recently, interest in Internet of Vehicles' (IoV) technologies has significantly emerged due to the substantial development in the smart automobile industries. Internet of Vehicles' technology enables vehicles to communicate with public networks and interact with the surrounding environment. It also allows vehicles to exchange and collect information about other vehicles and roads. IoV is introduced to enhance road users' experience by reducing road congestion, improving traffic management, and ensuring the road safety. The promised applications of smart vehicles and IoV systems face many challenges, such as big data collection in IoV and distribution to attractive vehicles and humans. Another challenge is achieving fast and efficient communication between many different vehicles and smart devices called Vehicle-to-Everything (V2X).

Bibi, R., Saeed, Y., Zeb, A., Ghazal, T. M., Rahman, T., Said, R. A., . . . Khan, M. A. (2021). Edge AI-Based Automated Detection and Classification of Road Anomalies in VANET Using Deep Learning. Computational Intelligence and Neuroscience, 5, 1-15.

Road surface defects are crucial problems for safe and smooth traffic flow. Due to climate changes, low quality of construction material, large flow of traffic, and heavy vehicles, road surface anomalies are increasing rapidly. Detection and repairing of these defects are necessary for the safety of drivers, passengers, and vehicles from mechanical faults. In this modern era, autonomous vehicles

are an active research area that controls itself with the help of in-vehicle sensors without human commands, especially after the emergence of deep learning (DNN) techniques.

Broekman, A., Gräbe, P. J., Steyn, W. J. (2021). Real-time traffic quantization using a mini edge artificial intelligence platform. Transportation Engineering, 4, 1-9.

"Traffic analysis is dependent on reliable and accurate datasets that quantify the vehicle composition, speed and traffic density over a long period of time. The rapid and widespread adoption of digital twins, IoT (Internet of Things), artificial intelligence and mini edge computing technologies serve as the catalyst to rapidly develop and deploy smart systems for real-time data acquisition of traffic in and around urban and metropolitan areas. Video data acquired from an Unmanned Aerial Vehicle (UAV) is processed using a neural network architecture designed for real-time object detection tracking of vehicles".

Choudhary, A., Gupta, A., Dhuri, A., Nikam, N. (2018). Artificial Intelligence Based Smart Traffic Management System Using Video Processing. International Research Journal of Engineering and Technology, 5(3), 2271-2275.

"Due to increasing number of vehicles traffic jams are becoming a common scenario in the whole country as well as in the world. These frequent traffic jams at major junctions kill a lot of man hours. Thus it creates a need for an efficient traffic management system. So here we are going to implement a smart traffic control system which is based on the measurement of traffic density using real time video processing technique. Through this paper we tried to present a progress in the existing manual traffic control system".

Chavhan, S., Gupta, D., Gochhayat, S. P., N, C. B., Khanna, A., Shankar, K., Rodrigues, J. J. (2021). Edge Computing AI-IoT Integrated Energy Efficient Intelligent Transportation System for Smart Cities. ACM Transactions on Internet Technology, 1(2), 1-20.

Advancement of information and communication technologies (ICTs) there is high-scale utilization of IoT and adoption of AI in the transportation system to improve the utilization of energy, reduce greenhouse gas (GHG) emissions, increase quality of services and many extensive benefits to the commuters' and transportation authorities. In this paper, we propose a novel edge-based AI-IoT integrated energy efficient intelligent transport system for smart cities by using distributed multi-agent system. We have exhaustively carried out the simulation results and demonstrated the effectiveness of the proposed system.

Cowls, J., Tsamados, A., Taddeo, M., Floridi, L. (2021). The AI gambit: leveraging artificial intelligence to combat climate change

opportunities, challenges, and recommendations. AI and Society, 1-25.

In this article, we analyse the role that artificial intelligence (AI) could play, and is playing, to combat global climate change. We identify two crucial opportunities that AI offers in this domain: it can help improve and expand current understanding of climate change, and it can contribute to combatting the climate crisis effectively. However, the development of AI also raises two sets of problems when considering climate change: the possible exacerbation of social and ethical challenges already associated with AI, and the contribution to climate change of the greenhouse gases emitted by training data and computation-intensive AI systems.

Dai, Y., Xu, D., Maharjan, S., Qiao, G., Zhang, Y. (2019). Artificial Intelligence Empowered Edge Computing and Caching for Internet of Vehicles. IEEE Wireless Communications, 26(3), 12-18.

Recent advances in edge computing and caching have significant impacts on the developments of vehicular networks. Artificial Intelligence (AI) can greatly enhance the cognition and intelligence of vehicular networks and thus assist in optimally allocating resources for the problems with diverse, time-variant, and complex features. In this article, we propose a new architecture and formulate a joint edge computing and caching scheme to maximize system utility and develop a novel resource scheme by exploiting deep reinforcement learning. Numerical results demonstrate the effectiveness of the proposed scheme.

Dinh, D.-L., Nguyen, H.-N., Thai, H.-T., Le, K.-H. (2021). Towards AI-Based Traffic Counting System with Edge Computing. Journal of Advanced Transportation, 1-15.

The recent years have witnessed a considerable rise in the number of vehicles, which has placed transportation infrastructure and traffic control under tremendous pressure. Yielding timely and accurate traffic flow information is essential in the development of traffic control strategies. Despite the continual advances and the wealth of literature available in intelligent transportation system (ITS), there is a lack of practical traffic counting system, which is readily deployable on edge devices. In this study, we introduce a low-cost and effective edge-based system integrating object detection models to perform vehicle detecting, tracking, and counting.

Fernoaga, V. P., Sandu, V., Balan, T. C. (2020). Artificial Intelligence for the Prediction of Exhaust Back Pressure Effect on the Performance of Diesel Engines. Applied Sciences, 10(20), 1-33.

The actual trade-off among engine emissions and performance requires detailed investigations into exhaust system configurations. Correlations among en-

gine data acquired by sensors are susceptible to artificial intelligence (AI)-driven performance assessment. The influence of exhaust back pressure (EBP) on engine performance, mainly on effective power, was investigated on a turbocharged diesel engine tested on an instrumented dynamometric test-bench. The EBP was externally applied at steady state operation modes defined by speed and load. A complete dataset was collected to supply the statistical analysis and machine learning phases—the training and testing of all the AI solutions developed in order to predict the effective power.

Ferrández-Pastor, F. J., García-Chamizo, J. M., Gomez-Trillo, S., Valdivieso-Sarabia, R., Nieto-Hidalgo, M. (2019). Smart Management Consumption in Renewable Energy Fed Ecosystems. Sensors (Basel), 19(2967), 1-28

Advances in embedded electronic systems, the development of new communication protocols, and the application of artificial intelligence paradigms have enabled the improvement of current automation systems of energy management. Embedded devices integrate different sensors with connectivity, computing resources, and reduced cost. Communication and cloud services increase their performance; however, there are limitations in the implementation of these technologies. If the cloud is used as the main source of services and resources, overload problems will occur. There are no models that facilitate the complete integration and interoperability in the facilities already created.

Fraga-Lamas, P., Lopes, S. I., Fernández-Caramés, T. M. (2021). Green IoT and Edge AI as Key Technological Enablers for a Sustainable Digital Transition towards a Smart Circular Economy: An Industry 5.0 Use Case. Journal of Sensors, 21(17), 1-36.

Internet of Things (IoT) can help to pave the way to the circular economy and to a more sustainable world by enabling the digitalization of many operations and processes, such as water distribution, preventive maintenance, or smart manufacturing. Paradoxically, IoT technologies and paradigms such as edge computing, although they have a huge potential for the digital transition towards sustainability, they are not yet contributing to the sustainable development of the IoT sector itself. In fact, such a sector has a significant carbon footprint due to the use of scarce raw materials and its energy consumption in manufacturing, operating, and recycling processes. To tackle these issues, the Green IoT (G-IoT) paradigm has emerged as a research area to reduce such carbon footprint; however, its sustainable vision collides directly with the advent of Edge Artificial Intelligence (Edge AI), which imposes the consumption of additional energy.

Gangwani, D., Gangwani, P. (2021). Applications of Machine Learning and Artificial Intelligence in Intelligent Transportation System: A Review. Applications of Artificial Intelligence and Machine

Learning, 203-216.

Due to the tremendous population growth in the country, the use of vehicles and other transportation means has increased which has led to traffic congestion and road accidents. Hence, there is a demand for intelligent transportation systems in the country that can provide safe and reliable transportation while maintaining environmental conditions such as pollution, CO2 emission, and energy consumption. This paper focuses on providing an overview and applications of how Artificial intelligence (AI) and Machine Learning (ML) can be applied to develop an Intelligent Transportation system that can address the issues of traffic congestion and road safety to prevent accidents.

Gong, C., Lin, F., Gong, X., Lu, Y. (2020). Intelligent Cooperative Edge Computing in Internet of Things. IEEE Internet of Things Journal, 7(10), 9372 - 9382.

The fusion of edge computing and artificial intelligence (AI) technology is a key enabler for the smart Internet of Things (IoT). However, these two emerging paradigms face many issues for their integration, such as data storage structure, model generation algorithms, and cloud-edge collaboration mechanisms. Moreover, edge computing is not ready for supporting AI and can be enabled to support AI via some basic network functions related to Quality of Experience (QoE), such as passive computation offloading and content caching.

Hao, Y., Tian, Y. M., Hu, L., Hossain, M. S., Muhammad, G., Amin, S. U. (2019). Smart-Edge-CoCaCo: AI-Enabled Smart Edge with Joint Computation, Caching, and Communication in Heterogeneous IoT. IEEE Network, 1, 1-7.

The development of mobile communication technology, hardware, distributed computing, and artificial intelligence (AI) technology has promoted the application of edge computing in the field of heterogeneous IoT in order to overcome the defects of the traditional cloud computing model in the era of big data. In this article, we first propose a new AI-enabled smart edge with heterogeneous IoT architecture that combines edge computing, caching, and communication. Then we propose the Smart-Edge-CoCaCo algorithm. To minimize total delay and confirm the computation offloading decision, Smart-Edge-CoCaCo uses joint optimization of the wireless communication model, the collaborative filter caching model in edge cloud, and the computation offloading model.

Huang, H., Ogbodo, M., Wang, Z., Qiu, C., Hisada, M., Abdallah, A. B. (2021). Smart Energy Management System based on Reconfigurable AI Chip and Electrical Vehicles. 2021 IEEE International Conference on Big Data and Smart Computing (BigComp) (pp. 233-238). South Korea: IEEE.

Almost every larger city in Europe has ambitious smart city projects. This is particularly true for Hamburg, a Hanseatic city in the north of Germany. Hamburg is the smartest city in Germany according to a Federal Association for Information Technology. Although there are no megacities in the European Union (the largest city in the European Union is Berlin with 3.7 million inhabitants), the increasing urbanization is apparent and produces problems to be solved. At the same time rural depopulation creates conjugated problems.One category of these problems is mobility. Mobility can be regarded as the need to move persons and freight. In densely populated cities an increasing amount of transport users have to share a decreasing amount of space with conflicting needs.

Huh, J.-H., Seo, Y.-S. (2019). Understanding Edge Computing: Engineering Evolution with Artificial Intelligence. IEEE Access, 20, 1-18.

The key to the explosion of the Internet of Things and the ability to collect, analyze, and provide big data in the cloud is edge computing, which is a new computing paradigm in which data is processed from edges. Edge Computing has been attracting attention as one of the top 10 strategic technology trends in the past two years and has innovative potential. It provides shorter response times, lower bandwidth costs, and more robust data safety and privacy protection than cloud computing. In particular, artificial intelligence technologies are rapidly incorporating edge computing.

Khan, L. U., Yaqoob, I., Tran, N. H., Kazmi, S. M., Dang, T. N., Hong, C. S. (2020). Edge-Computing-Enabled Smart Cities: A Comprehensive. IEEE Internet of Things Journal, 7(10), 10200-10232.

Recent years have disclosed a remarkable proliferation of compute-intensive applications in smart cities. Such applications continuously generate enormous amounts of data which demand strict latency-aware computational processing capabilities. Although edge computing is an appealing technology to compensate for stringent latency-related issues, its deployment engenders new challenges. In this article, we highlight the role of edge computing in realizing the vision of smart cities. First, we analyze the evolution of edge computing paradigms. Subsequently, we critically review the state-of-the-art literature focusing on edge computing applications in smart cities. Later, we categorize and classify the literature by devising a comprehensive and meticulous taxonomy.

Leroux, S., Li, B., Simoens, P. (2022). Automated training of location-specific edge models for traffic counting. Computers and Electrical Engineering, 99(107763).

The recent years have witnessed a considerable rise in the number of vehicles, which has placed transportation infrastructure and traffic control under tremendous pressure. Yielding timely and accurate traffic flow information is essential

in the development of traffic control strategies. Despite the continual advances and the wealth of literature available in intelligent transportation system (ITS), there is a lack of practical traffic counting system, which is readily deployable on edge devices. In this study, we introduce a low-cost and effective edge-based system integrating object detection models to perform vehicle detecting, tracking, and counting.

Lin, J., Yu, W., Yang, X., Zhao, P., Zhang, H., Zhao, W. (2020). An Edge Computing Based Public Vehicle System for Smart Transportation. IEEE Transactions on Vehicular Technology, 69(11), 12635 - 12651.

As a key smart transportation service, public vehicle systems are intended to improve traffic efficiency and vehicle occupancy ratios, and to reduce the number of vehicles on roads, by inducing travelers to share rides with others. Despite the clear logic behind this service, achieving a viable model for matching multiple riders to vehicles with low latency and high satisfaction remains an open issue. In this paper, we propose an Edge Computing based Public Vehicle (ECPV) system to improve traffic efficiency and vehicle occupancy ratios by scheduling ridesharing among travelers and reduce the delay of decision making by leveraging edge computing.

Liu, A. C., Law, O. M., Liao, J., Chen, J. Y., Hsieh, A. J., Hsieh, C. H. (2021). Traffic Safety System Edge AI Computing. 2021 IEEE/ACM Symposium on Edge Computing (SEC). San Jose: IEEE.

Due to the surging of mobile data, edge AI is developed to address the cloud limitations, real-time processing, data latency, network bandwidth, and power dissipation. Kneron successfully implements the traffic safety system using the smart edge AI architecture, which applies the smart gateway to bridge the gap between cloud and edge AI, it also establishes the open platform for further integration. New architectures offer additional security and privacy protection through the blockchain approach.

Mani, G., Viswanadhapalli, J. K., Sriramalakshmi, P. (2021). AI powered IoT based Real-Time Air Pollution Monitoring and Forecasting. Journal of Physics: Conference Series, 2115, 1-13.

Air is one of the most fundamental constituents for the sustenance of life on earth. The consumption of non-renewable energy sources and industrial parameters steadily increases air pollution. These factors affect the welfare and prosperity of life on earth; therefore, the nature of Air Quality in our environment needs to be monitored continuously. This paper presents the execution and plan of Internet-of-Things (IoT) based Air Pollution Monitoring and Forecasting utilising Artificial Intelligent (AI) methods. Also, Online Dashboard was created for real-time monitoring of Air pollutants (both live and forecasted data)

through 'firebase' from the Google cloud server. The air pollutants like Carbon Mono Oxide (CO), Ammonia (NH3), and Ozone (O3) layer information are collected from IoTbased sensor nodes in Vijayawada Region.

Masood, A., Ahmad, K. (2021). A review on emerging artificial intelligence (AI) techniques for air pollution forecasting: Fundamentals, application and performance. Journal of Cleaner Production, 322, 1-23.

Accurate air quality forecasting is critical for systematic pollution control as well as public health and wellness. Most of the traditional forecasting techniques have shown inconsistent predictive accuracy due to the non-linear, dynamic and complex nature of air pollutants. In the past few years, artificial intelligence (AI)-based methods have become the most powerful and forward-looking approaches for air pollution forecasting because of their specific features such as organic learning, high precision, superior generalization, strong fault tolerance, and ease of working with high-dimensional data.

Math, S., Zhang, L., Kim, S., Ryoo, I. (2020). An Intelligent Real-Time Traffic Control Based on Mobile Edge Computing for Individual Private Environment. Security and Communication Networks, 2020, 1-11.

The existence of Mobile Edge Computing (MEC) provides a novel and great opportunity to enhance user quality of service (QoS) by enabling local communication. The 5th generation (5G) communication is consisting of massive connectivity at the Radio Access Network (RAN), where the tremendous user traffic will be generated and sent to fronthaul and backhaul gateways, respectively. Since fronthaul and backhaul gateways are commonly installed by using optical networks, the bottleneck network will occur when the incoming traffic exceeds the capacity of the gateways. To meet the requirement of real-time communication in terms of ultralow latency (ULL), these aforementioned issues have to be solved.

Mehmood, Y., Oad, A., Abrar, M., Munir, H. M., Hasan, S. F., Muqeet, H. A., Golilarz, N. A. (2021). Edge Computing for IoT-Enabled Smart Grid. Security and Communication Networks, 1-16.

Smart grid is a new vision of the conventional power grid to integrate green and renewable technologies. Smart grid (SG) has become a hot research topic with the development of new technologies, such as IoT, edge computing, artificial intelligence, big data, 5G, and so on. the efficiency of SG will be increased by smart embedded devices that have intelligent decision-making ability. Various types of sensors and data sources will collect data of high resolution. One of the vital challenges for IoT is to manage a large amount of data produced by sensors. Sending this massive amount of data directly to the cloud will create

problems of latency, security, privacy, and high bandwidth utilization.

Moubayed, A., Shami, A., Heidari, P., Larabi, A., Brunner, R. (2021). Edge-enabled V2X Service Placement for Intelligent Transportation Systems. IEEE Transactions on Mobile Computing, 20(4), 1380-1392.

Vehicle-to-everything (V2X) communication and services have been garnering significant interest from different stakeholders as part of future intelligent transportation systems (ITSs). This is due to the many benefits they offer. However, many of these services have stringent performance requirements, particularly in terms of the delay/latency. Multi-access/mobile edge computing (MEC) has been proposed as a potential solution for such services by bringing them closer to vehicles. Yet, this introduces a new set of challenges such as where to place these V2X services, especially given the limit computation resources available at edge nodes.

Moursi, A. S., El Fishawy, N., Djahel, S., Shouman, M. A. (2021). An IoT enabled system for enhanced air quality monitoring. Complex Intelligent Systems, 7, 2923–2947.

Air pollution is a major issue resulting from the excessive use of conventional energy sources in developing countries and worldwide. Particulate Matter less than 2.5 μm in diameter (PM2.5) is the most dangerous air pollutant invading the human respiratory system and causing lung and heart diseases. Therefore, innovative air pollution forecasting methods and systems are required to reduce such risk. To that end, this paper proposes an Internet of Things (IoT) enabled system for monitoring and predicting PM2.5 concentration on both edge devices and the cloud. This system was tested on a PC to evaluate cloud prediction and a Raspberry Pi to evaluate edge devices' prediction. Such a system is essential, responding quickly to air pollution in remote areas with low bandwidth or no internet connection.

Munir, S., Abedin, S. F., Kim, K., Hong, C. S. (2019). Towards Edge Intelligence: Real-Time Driver Safety in Smart Transportation System. Korea Computer Congress 2019, (pp. 1336-1338). Korea.

In this research, we introduce an edge intelligence model for real-time driver safety in the smart transportation system to enhance the fifth-generation (5G) networks to the beyond 5G. In order to do this, first, we design an intelligent model for road side unit (RSU) that facilitates driver activity recognition in the edge of the networks, where we adopt the concept of capsule network. Second, utilizing this model, we propose a real-time safety notification algorithm for RSU, where this algorithm is capable of sending real-time safety notification to the vehicle driver as well as to centrally controlled road safety agent. So, the risk of road accident due to distracted driving is minimized.

Nammouchi, A., Aupke, P., Kassler, A., Theocharis, A., Raffa, V., Felice, M. D. (2021). Integration of AI, IoT and Edge-Computing for Smart Microgrid Energy Management. 2021 IEEE International Conference on Environment and Electrical Engineering and 2021 IEEE Industrial and Commercial Power Systems Europe (EEEIC / ICPS Europe). Italy: IEEE.

Towards zero CO2 emissions society, large shares of renewable energy sources and storage systems are integrated into microgrids as part of the electrical grids for energy exchange aiming to effectively reduce the stress from the transmission grid. However, energy management within and across microgrids is complicated due to many uncertainties such as imprecise knowledge on energy production and demand, which makes energy optimization challenging. In this paper, we present an open architecture that uses machine learning algorithms at the edge to predict energy consumption and production for energy management in smart microgrids.

Nikodem, M., Słabicki, M., Surmacz, T., ega, C. D. (2020). Multi-Camera Vehicle Tracking Using Edge Computing and Low-Power Communication. Sensors (Basel)., 20(11), 1-16.

Typical approaches to visual vehicle tracking across large area require several cameras and complex algorithms to detect, identify and track the vehicle route. Due to memory requirements, computational complexity and hardware constrains, the video images are transmitted to a dedicated workstation equipped with powerful graphic processing units. However, this requires large volumes of data to be transmitted and may raise privacy issues. This paper presents a dedicated deep learning detection and tracking algorithms that can be run directly on the camera's embedded system. This method significantly reduces the stream of data from the cameras, reduces the required communication bandwidth and expands the range of communication technologies to use. Consequently, it allows to use short-range radio communication to transmit vehicle-related information directly between the cameras, and implement the multi-camera tracking directly in the cameras.

Peyman, M., Copado, P. J., Tordecilla, R. D., Martins, L. d., Xhafa, F., Juan, A. A. (2021). Edge Computing and IoT Analytics for Agile Optimization in Intelligent Transportation Systems. Journal of Energies, 14(6309), 1-26. *With the emergence of fog and edge computing, new possibilities arise regarding the data-driven management of citizens' mobility in smart cities. Internet of Things (IoT) analytics refers to the use of these technologies, data, and analytical models to describe the current status of the city traffic, to predict its evolution over the coming hours, and to make decisions that increase the efficiency of the transportation system. In this paper, we review the state of the art of IoT in intelligent transportation systems*

(ITS), identify challenges posed by cloud, fog, and edge computing in ITS, and develop a methodology based on agile optimization algorithms for solving a dynamic ride-sharing problem (DRSP) in the context of edge/fog computing.

Pu, T., Wang, X., Cao, Y., Liu, Z., Qiu, C., Qiao, J., Zhang, S. (2021). Power flow adjustment for smart microgrid based on edge computing and multi-agent deep reinforcement learning. Journal of Cloud Computing, 10(48), 1-13.
In current power grids, a massive amount of power equipment raises various emerging requirements, e.g., data perception, information transmission, and real-time control. The existing cloud computing paradigm is stubborn to address issues and challenges such as rapid response and local autonomy. Microgrids contain diverse and adjustable power components, making the power system complex and difficult to optimize. The existing traditional adjusting methods are manual and centralized, which requires many human resources with expert experience.

Rigas, E. S., Ramchurn, S. D., Bassiliades, N. (2015). Managing Electric Vehicles in the Smart Grid Using Artificial Intelligence: A Survey. IEEE Transactions on Intelligent Transportation Systems, 1(4), 1-17.
Along with the development of smart grids, the wide adoption of electric vehicles (EVs) is seen as a catalyst to the reduction of CO 2 emissions and more intelligent transportation systems. In particular, EVs augment the grid with the ability to store energy at some points in the network and give it back at others and, therefore, help optimize the use of energy from intermittent renewable energy sources and let users refill their cars in a variety of locations. However, a number of challenges need to be addressed if such benefits are to be achieved. On the one hand, given their limited range and costs involved in charging EV batteries, it is important to design algorithms that will minimize costs and, at the same time, avoid users being stranded.

Sánchez, J. M., Jörgensen, N., Törngren, M., Inam, R. (2021). Edge computing for cyber-physical systems: A systematic mapping study emphasizing trustworthiness. ACM Transactions on Cyber-Physical Systems, 1(1), 1-29.
Edge computing is projected to have profound implications in the coming decades, proposed to provide solutions for applications such as augmented reality, predictive functionalities, and collaborative Cyber-Physical Systems (CPS). For such applications, edge computing addresses the new computational needs, as well as privacy, availability, and real-time constraints, by providing local high-performance computing capabilities to deal with the limitations and constraints of cloud and embedded systems. Our interests lie in the applications of edge computing as part of CPS, where several properties (or attributes) of trustworthiness, including safety, security, and predictability/availability are of particular concern, each facing challenges for the introduction of edge-based CPS.

Saouli, A., Margae, S. E., Aroussi, M. E., Fakhri, Y. (2021). Real-Time Traffic Sign Recognition based AI Edge computing. International Journal of Computer Science and Information Security, 19(7), 64-69.

Convolutional Neural Network (CNN) is a model used in many disciplines to classify objects in video streaming, clustering, pattern recognition, and prediction. With many systems that deal with the classification problem, mobility is often necessary. In this article, an implementation of Tiny-YOLOv3 (You Only Look Once) with CNN in Internet of Things (IoT) devices is proposed to address the traffic sign classification problem on the EDGE AI Sipeed MAIX platform. The main feature of this module is the availability of the first RISC-V 64 AI module with K210-KPU inside, allowing high performance with low power consumption.

Shah, S. K., Tariq, Z., Lee, J., Lee, Y. (2021). Event-Driven Deep Learning for Edge Intelligence (EDL-EI). Sensors, 21(6023), 1-30.

Edge intelligence (EI) has received a lot of interest because it can reduce latency, increase efficiency, and preserve privacy. More significantly, as the Internet of Things (IoT) has proliferated, billions of portable and embedded devices have been interconnected, producing zillions of gigabytes on edge networks. Thus, there is an immediate need to push AI (artificial intelligence) breakthroughs within edge networks to achieve the full promise of edge data analytics. EI solutions have supported digital technology workloads and applications from the infrastructure level to edge networks; however, there are still many challenges with the heterogeneity of computational capabilities and the spread of information sources.

Shen, X., Wu, Y., Chen, S., Luo, X. (2021). An Intelligent Garbage Sorting System Based on Edge Computing and Visual Understanding of Social Internet of Vehicles. Mobile Information Systems, 1-12.

In order to enable Social Internet of Vehicles devices to achieve the purpose of intelligent and autonomous garbage classification in a public environment, while avoiding network congestion caused by a large amount of data accessing the cloud at the same time, it is therefore considered to combine mobile edge computing with Social Internet of Vehicles to give full play to mobile edge computing features of high bandwidth and low latency. At the same time, based on cutting-edge technologies such as deep learning, knowledge graph, and 5G transmission, the paper builds an intelligent garbage sorting system based on edge computing and visual understanding of Social Internet of Vehicles.

Sittón-Candanedo, I., Alonso, R. S., García, Ó., Muñoz, L., Rodríguez-González, S. (2019). Edge Computing, IoT and Social Computing in

Smart Energy Scenarios. Journal of Sensors, 19(3353), 1-20.

The Internet of Things (IoT) has become one of the most widely research paradigms, having received much attention from the research community in the last few years. IoT is the paradigm that creates an internet-connected world, where all the everyday objects capture data from our environment and adapt it to our needs. However, the implementation of IoT is a challenging task and all the implementation scenarios require the use of different technologies and the emergence of new ones, such as Edge Computing (EC). EC allows for more secure and efficient data processing in real time, achieving better performance and results. Energy efficiency is one of the most interesting IoT scenarios.

Slama, S. (2022). Prosumer in smart grids based on intelligent edge computing: A review on Artificial Intelligence Scheduling Techniques. Ain Shams Engineering Journal, 13(1), 1-22.

Smart Grid technology has been considered an attractive research issue due to its efficiency in solving energy demand, storage, and power transmission. The integration of IoT technology in the Smart Grids is a critical way to accelerate the digitization of the power grid and is useful for the efficient performance of the energy grid infrastructure. For efficient real-time data analysis and decision-making, the Internet of Things will incorporate various communication systems seamlessly. To achieve efficient communication between all Internet of Things, devices are expected to use multiple means, including smart sensors, cable and wireless communication.

Sun, D., Ou, Q., Yao, X., Gao, S., Wang, Z., Ma, W., Li, W. (2020). Integrated human-machine intelligence for EV charging prediction in 5G smart grid. EURASIP Journal on Wireless Communications and Networking, 2020(139), 1-15.

With the rapid development of the power infrastructures and the increase in the number of electric vehicles (EVs), vehicle-to-grid (V2G) technologies have attracted great interest in both academia and industry as an energy management technology in 5G smart grid. Considering the inherently high mobility and low reliability of EVs, it is a great challenge for the smart grid to provide on-demand services for EVs. Therefore, we propose a novel smart grid architecture based on network slicing and edge computing technologies for the 5G smart grid. Under this architecture, the bidirectional traffic information between smart grids and EVs is collected to improve the EV charging experience and decrease the cost of energy service providers.

Sun, J. (2022). The Legal Regulation of Artificial Intelligence and Edge Computing Automation Decision-Making Risk in Wireless Network Communication. Wireless Communications and Mobile Computing, 2022(1303252), 1-13.

This article is aimed at studying the legal regulation of artificial intelligence and edge computing automated decision-making risks in wireless network communications. The data under artificial intelligence is full of flexibility and vitality, which has changed the way of data existence in the whole society. Its core is various algorithm programs, which determine the existence of artificial intelligence. In this environment, society develops rapidly with unstoppable momentum. However, from a legal perspective, artificial intelligence has algorithmic discrimination, such as gender discrimination, clothing discrimination, and racial discrimination. It does not possess openness, objectivity, and accountability.

Torre, R. d., Corlu, C. G., Faulin, J., Onggo, B. S., Juan, A. A. (2021). Simulation, Optimization, and Machine Learning in Sustainable Transportation Systems: Models and Applications. Sustainability, 13(1551), 1-21.

The need for effective freight and human transportation systems has consistently increased during the last decades, mainly due to factors such as globalization, e-commerce activities, and mobility requirements. Traditionally, transportation systems have been designed with the main goal of reducing their monetary cost while offering a specified quality of service. During the last decade, however, sustainability concepts are also being considered as a critical component of transportation systems.

Vacheva, G., Hinov, N., Kanchev, H., Stanev, R., Cornea, O. (2019). Energy Flows Management of Multiple Electric Vehicles in Smart Grid. Elektronika ir Elektrotechnika, 25(1), 14-17.

This paper presents energy flows management of multiple electric vehicles charging and its impact on a microgrid. The studied low voltage grid comprises also two photovoltaic generators and non-dispatchable loads. Three concepts using electric vehicles batteries as a distributed storage and bidirectional energy transfer in the Smart Grid are considered: Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid. The potential for implementation of flexible microgrid energy flow management strategy for reduction of peaks in power consumption, absorption or production of reactive power (when required) and improving the power quality in the studied microgrid are estimated.

Vermesan, O., John, R., Pype, P., Daalderop, G., Kriegel, K., Mitic, G., . . . Waldhör, S. (2021). Automotive Intelligence Embedded in Electric Connected Autonomous and Shared Vehicles Technology for Sustainable Green Mobility. Frontiers in Future Transportation, 2(688482), 1-35.

The automotive sector digitalization accelerates the technology convergence

of perception, computing processing, connectivity, propulsion, and data fusion for electric connected autonomous and shared (ECAS) vehicles. This brings cutting-edge computing paradigms with embedded cognitive capabilities into vehicle domains and data infrastructure to provide holistic intrinsic and extrinsic intelligence for new mobility applications. Digital technologies are a significant enabler in achieving the sustainability goals of the green transformation of the mobility and transportation sectors.

Wang, A., Xu, J., Tu, R., Saleh, M., Hatzopoulou, M. (2020). Potential of machine learning for prediction of traffic related air pollution. Transportation Research Part D Transport and Environment, 88, 1-14.

Land use regression (LUR) has been extensively used to capture the spatial distribution of air pollution. However, regional background and non-linear relationships can be challenging to capture using linear approaches. Machine learning approaches have recently been used in air quality prediction. Using data from a mobile campaign of fine particulate matter and black carbon in Toronto, Canada, this study investigates the boundaries of LUR approaches and the potential of two different machine learning models: Artificial Neural Networks (ANN) and gradient boost. In addition, a moving camera was used to collect real-time traffic.

Wang, X., Zheng, X., Chen, W., Wang, F.-Y. (2020). Visual Human-Computer Interactions for Intelligent Vehicles and Intelligent Transportation Systems: The State of the Art and Future Directions. IEEE Systems, Man, and Cybernetics Society, 14(8), 1-13.

Research on intelligent vehicles has been popular in the past decade. To fill the gap between automatic approaches and man-machine control systems, it is indispensable to integrate visual human-computer interactions (VHCIs) into intelligent vehicles systems. In this article, we review existing studies on VHCI in intelligent vehicles from three aspects: 1) visual intelligence; 2) decision making; and 3) macro deployment. We discuss how VHCI evolves in intelligent vehicles and how it enhances the capability of intelligent vehicles.

Wang, Z., Ogbodo, M., Huang, H., Qiu, C., Hisada, M., Abdallah, A. B. (2020). AEBIS: AI-Enabled Blockchain-Based Electric Vehicle Integration System for Power Management in Smart Grid Platform. IEEE Access, 8, 226409-226421.

A Virtual Power Plant (VPP) is a network of distributed power generating units, flexible power consumers, and storage systems. A VPP balances the load on the grid by allocating the power generated by different linked units during periods of peak load. Demand-side energy equipment, such as Electric Vehicles (EVs) and mobile robots, can also balance the energy supply-demand when ef-

fectively deployed. However, fluctuation of the power generated by the various power units makes the supply power balance a challenging goal.

Wu, X., Yang, D., Wu, R., Gu, J., Wen, Y., Zhang, S., . . . Hao, J. (2022). High-resolution mapping of regional traffic emissions. Atmospheric Chemistry and Physics, 22, 1939-1950.

On-road vehicle emissions are a major contributor to significant atmospheric pollution in populous metropolitan areas. We developed an hourly link-level emissions inventory of vehicular pollutants using two land-use machine learning methods based on road traffic monitoring datasets in the Beijing–Tianjin–Hebei (BTH) region. NOx , fine particulate matter (PM2.5), and black carbon (BC) emissions from heavy-duty trucks (HDTs) generally have a higher emission intensity on the highways connecting to regional ports.

Xiao, D., Fang, F., Zheng, J., Pain, C., Navond, I. (2019). Machine learning-based rapid response tools for regional air pollution modelling. Atmospheric Environment, 199(15), 463-473.

A parameterised non-intrusive reduced order model (P-NIROM) based on proper orthogonal decomposition (POD) and machine learning methods has been firstly developed for model reduction of pollutant transport equations. Our motivation is to provide rapid response urban air pollution predictions and controls. The varying parameters in the P-NIROM are pollutant sources. The training data sets are obtained from the high-fidelity modelling solutions (called snapshots) for selected parameters (pollutant sources, here) over the parameter space.

Yan, G., Qin, Q. (2020). The Application of Edge Computing Technology in the Collaborative Optimization of Intelligent Transportation System Based on Information Physical Fusion. IEEE Access, 8, 153264-153272.

Edge computing technology is an important computer operating system in China. It plays a key role in multi-system fusion and intelligent manufacturing, and can play a key role in training and testing of deep neural networks. The purpose of this paper is to study the application of edge computing technology in the collaborative optimization of intelligent transportation systems based on information and physical fusion. This article sets up monitoring points at different traffic intersections, and applies long-term and short-term memory networks to collect data at each traffic intersection.

Zhang, J., Letaief, K. B. (2020). Mobile Edge Intelligence and Computing for the Internet of Vehicles. Proceedings of the IEEE. 108, pp. 246 - 261. IEEE.

The Internet of Vehicles (IoV) is an emerging paradigm that is driven by

recent advancements in vehicular communications and networking. Meanwhile, the capability and intelligence of vehicles are being rapidly enhanced, and this will have the potential of supporting a plethora of new exciting applications that will integrate fully autonomous vehicles, the Internet of Things (IoT), and the environment. These trends will bring about an era of intelligent IoV, which will heavily depend on communications, computing, and data analytics technologies. To store and process the massive amount of data generated by intelligent IoV, onboard processing and cloud computing will not be sufficient due to resource/power constraints and communication overhead/latency, respectively.

Liu, Z., Song, H., Tan, H., Hao, H., Zhao, F. (2022). Evaluation of the Cost of Intelligent Upgrades of Transportation Infrastructure for Intelligent Connected Vehicles. Journal of Advanced Transportation, 1-15.

Intelligent connected vehicles (ICVs) have become the focus and development direction of the automobile industry. As a flexible intelligent terminal, ICVs will become a necessary part of the intelligent transportation system. The routes of developing ICVs based on "vehicle to X" (V2X) can effectively alleviate the demands of vehicles for intelligent functions and cut related research costs, accelerating commercialization of ICVs and leading to many social benefits. At present, China has made it clear to develop ICVs based on V2X, which requires simultaneous intelligent upgrades of vehicles and transportation infrastructure. Therefore, intelligent upgrades of transportation infrastructure must match the functional requirements of ICVs.

Xie, B., Zhang, K., Zhao, Y., Zhang, Y., Cai, Y., Wang, T. (2021). Self-adaptive trajectory prediction for improving traffic safety in cloud-edge based transportation systems. Journal of Cloud Computing: Advances, Systems and Applications, 10(10), 1-13.

Intelligent transportation brings huge benefits to humans' life and Industrial production in terms of vehicle control and traffic management. Now, the development of edge-cloud computing has once again promoted intelligent transportation into a new era. However, the development of intelligent transportation inevitably produces a large amount of data, which brings new challenges to data privacy protection and security. In this paper, we propose to develop an improved trajectory prediction framework based on the self-adaptive trajectory prediction model (SATP), which could significantly enhance traffic safety in transportation systems. The proposed framework is capable of guaranteeing the accurate trajectory prediction of moving target under different application scenarios. In particular, to reduce the size of original trajectory point data collected by sensors, the angle change and minimum description length (MDL) principle are first combined to remove the redundant points in raw trajectories".

Zhang, Y. (2019). The application of artificial intelligence in logis-

tics and express delivery. Journal of Physics: Conference Series, 1325 (012085), 1-6. https://doi.org/10.1088/1742-6596/1325/1/012085

"With the rapid development of e-commerce, the volume of express goods in China has been increasing explosively. In 2018, China's express delivery business will reach 50.5 billion units. With the increasing popularity of artificial intelligence technology, many modern logistics enterprises try to use artificial intelligence technology to optimize the logistics link and improve the logistics efficiency. This paper will discuss the application status and prospect of artificial intelligence in logistics and express industry".

Munim, Z. H., Dushenko, M., Jimenez, V. J., Shakilb, M. H., Imseta, M. (2020). Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions. Journal of international shipping and port research, 47(5), 577-588. https://doi.org/10.1080/03088839.2020.1788731

"This study provides a bibliometric review of 279 studies on the applications of big data and artificial intelligence (AI) in the maritime industry, published in 214 academic outlets, authored by 842 scholars. We extracted bibliographical data from the Web of Science database and analysed it using the Bibliometrix tool in R software"

Abduljabbar, R., Dia, H., Liyanage, S., Bagloee, S. A. (2019). Applications of Artificial Intelligence in Transport: An Overview. Sustainability, 11(189), 1-22. https://doi.org/10.3390/su11010189

"The rapid pace of developments in Artificial Intelligence (AI) is providing unprecedented opportunities to enhance the performance of different industries and businesses, including the transport sector. The innovations introduced by AI include highly advanced computational methods that mimic the way the human brain works. The application of AI in the transport field is aimed at overcoming the challenges of an increasing travel demand, CO2emissions, safety concerns, and environmental degradation. In light of the availability of a huge amount of quantitative and qualitative data and AI in this digital age, addressing these concerns in a more efficient and effective fashion has become more plausible".

Younis, H., Sundarakani, B., Alsharairi, M. (2021). Applications of artificial intelligence and machine learning within supply chains:systematic review and future research directions. Journal of Modelling in Management, 1-10. https://doi.org/doi.org/10.1108/JM2-12-2020-0322

"AI and ML applications are still at the infant stage and the opportunity for them to elevate supply chain performance is very promising. Some researchers developed AI and ML-related models which were tested and proved to be effective

in optimizing SC, and therefore, the application of AI and ML in supply chain networks creates competitive advantages for firms. Other researchers claim that AI and ML are both currently adding value while many other researchers believe that they are still not fully exploited and their tools and techniques can leverage the supply chain's total value. The research found that adoption of AI and ML have the ability to reduce the bullwhip effect, and therefore, further supports the performance of supply chain efficiency and responsiveness".

Alahmadi, R. N. (2020). Applications of Artificial Intelligence in Transportation. International Journal of Advanced Research in Engineering and Technology , 11(6), 1074-1083. https://doi.org/10.34218/IJARET.11.6.2020.097

"Artificial Intelligence (AI) has developed at a rapid pace and this provides a good chance to enhance the execution of different fields like business, industries, and the transportation sector. In the transportation field, the AI had applied to overcome the challenges of pollution, environmental deterioration, increasing travel demand, and safety concerns. The good understanding of the relationship between the AI and input data on one hand and characteristics of the transportation system leads to a perfect and successful application of AI".

Manoharan, S. (2019). An Improved Safety Algorithm for Artificial Intelligence Enabled Processors in Self Driving Cars. Journal of Artificial Intelligence and Capsule Networks , 1(2), 95-104. https://doi.org/doi.org/10.36548/jaicn.2019.2.005

"The innovation in the automobiles have undergone a most noteworthy leap from the operation of the vehicles that was human cantered to vehicles with the self –driving ability. The self-driving cars being a major level of attraction today, needs to concentrate also on the privacy, energy, traffic flow, environmental issues and the road safety. The perfect road safety is a goal that can be never achieved, due to the growing number of vehicles and the human population all over the world. Measures to improve the probability of the safety is put forward in the paper for the cars with the capability of the self-driving built with the artificial intelligence enabled processors. The performance evaluation of the proposed algorithm for using real time data ensures the competence of the safety algorithm in the self-driving cars".

Sarker, I. H. (2021). Machine Learning: Algorithms, Real-World Applications and Research Directions. SN Computer Science, 2(160), 160-180. https://doi.org/doi.org/10.1007/s42979-021-00592-x

"In the current age of the Fourth Industrial Revolution (4IR or Industry 4.0), the digital world has a wealth of data, such as Internet of Things (IoT) data, cybersecurity data, mobile data, business data, social media data, health data, etc. To intelligently analyze these data and develop the corresponding smart and

automated applications, the knowledge of artifcial intelligence (AI), particularly, machine learning (ML) is the key. Various types of machine learning algorithms such as supervised, unsupervised, semi-supervised, and reinforcement learning exist in the area. Besides, the deep learning, which is part of a broader family of machine learning methods, can intelligently analyze the data on a large scale".

Carlan, V., Vanelslander, T. (202). Economic Aspects of Introducing Artificial Intelligence Solutions in Logistics and Port Sectors: The Data Entry Case. Front. Future Transp, 2(710330), 1-10. https://doi.org/10.3389/ffutr.2021.710330

"The development and implementation of digital solutions are new in contemporary businesses in logistics. As a next step, the potential of advanced solutions that make use of an AI or ML algorithm and which leverage on data is highly promoted. Yet, the implementation on a large scale of these types of solutions is happening at a slow pace. Recent studies show that a considerable amount of data in the maritime supply chain (MarSC) is still transferred through traditional communication channels (e.g., via e-mails or attached xls, pdf, csv, xml, etc. documents). Human intervention is thus needed to fetch this information and type it over in internal ERP systems. This type of practice opens the scene for extra labour, misinterpretation, or faults".

Ahmed, H. E. (2018). AI Advantages disadvantages. International Journal of Scientific Engineering and Applied Science, 4(4), 22-26.

"Artificial intelligence (AI) is kind of technology that makes the devices smart as human beings to develop the human's life by using these devices in all of the life's aspects such service robots, healthcare, education, including electronics, software, medicine, entertainment (games), engineering, communications and manufacturing.AI is a science and technology based on disciplines such as Computer Science, Biology, Psychology, Linguistics, Mathematics, and Engineering".

Geetha, Gomathy, C. K., Harshitha, T., Varma, V. N. (2021). A Traffic Prediction for Intelligent Transportation System using Machine Learning. International Journal of Engineering and Advanced Technology, 10(4), 166-169. https://doi.org/10.35940/ijeat.D2426.0410421

"Traffic control has been an issue for a long time from the past. The modern world demands Technology. Now a days cars are one of the main methods of improvement in technology. Intelligent Traffic System is also known as Intelligent Transportation System apply communication and information technology to find the solution for the Traffic control issues. Intelligent Transportation System represents the main problem in transportation. ITS is a program .it is used to

improve the efficiency of transportation through advanced technologies by using sensors and communication".

Zhu, L., Yu, F. R. (2018). Big Data Analytics in Intelligent Transportation Systems: A Survey. IEEE Transactions of Intelligence Transportation Systems, 20(1), 383 - 398. https://doi.org/10.1109/TITS.2018.2815678

"Big data is becoming a research focus in intelligent transportation systems (ITS), which can be seen in many projects around the world. Intelligent transportation systems will produce a large amount of data. The produced big data will have profound impacts on the design and application of intelligent transportation systems, which makes ITS safer, more efficient, and profitable. Studying big data analytics in ITS is a flourishing field. This paper first reviews the history and characteristics of big data and intelligent transportation systems".

Tak, S., Lee, J.-D., Song, J., Kim, S. (2021). Development of AI-Based Vehicle Detection and Tracking System for C-ITS Application. Journal of Advanced Transportation, 2021, 1-15. https://doi.org/10.1155/2021/4438861

"There are various means of monitoring traffic situations on roads. Due to the rise of artificial intelligence (AI) based image processing technology, there is a growing interest in developing traffic monitoring systems using camera vision data. This study provides a method for deriving traffic information using a camera installed at an intersection to improve the monitoring system for roads. The method uses a deep-learning-based approach (YOLOv4) for image processing for vehicle detection and vehicle type classification".

Rigano, C. (2019). Using Artificial Intelligence to Address Criminal Justice Needs. NIJ Journal(280), 1-10.

"AI applications can be found in many aspects of our lives, from agriculture to industry, communications, education, finance, government, service, manufacturing, medicine, and transportation. Even public safety and criminal justice are benefiting from AI. For example, traffic safety systems identify violations and enforce the rules of the road, and crime forecasts allow for more efficient allocation of policing resources. AI is also helping to identify the potential for an individual under criminal justice supervision to reoffend".

Tizghadam, A., Khazaei, H., Moghaddam, M. H., Hassan, Y. (2019). Machine Learning in Transportation. Journal of Advanced Transportation, 2019, 1-4. https://doi.org/10.1155/2019/4359785

"Nation's economy, safety, and quality of life are influenced by a well-behaved transportation system. Yet, demands in transportation are ever increasing due

to trends in population growth, emerging technologies, and the increased globalization of the economy which has kept pushing the system to its limits. The rate of increasing the number of vehicles is at points even more than the overall population increase rate, which leads to more congested and dangerous roadways. This problem is not going to be addressed by just adding to the number of roads anymore. The construction cost is very high and the time to return the result is too lengthy to catch up with the vehicle increase rate".

Diez, F. P., Sinca, J. C., Vallès, D. R., Cacheda, J. M. (2021). Evaluation of Transport Events with the use of Big Data, Artificial Intelligence and Augmented Reality techniques . Transportation Research Procedia, 58(2021), 173–180. https://doi.org/10.1016/j.trpro.2021.11.024

"The phenomenon of "smart cities" generalizes the use of Information and Communication Technologies. The generation and use of data to manage mobility is a challenge that many cities are betting on and investing in. Through the Internet of all things (IoT) and the use of sensors and mechanisms for capturing information, the number of data analysis tools such as Big Data, Artificial Intelligence (AI), and Augmented Reality (AR) has increased. With the constant use of assisted process learning (Machine Learning), it's possible to improve event interpretation through the customization of learning protocols".

Manoharan, S. (2019). An Improved Safety Algorithm for Artificial Intelligence Enabled Processors in Self Driving Cars. Journal of Artificial Intelligence and Capsule Networks , 1(2), 95-104. https://doi.org/doi.org/10.36548/jaicn.2019.2.005

"The innovation in the automobiles have undergone a most noteworthy leap from the operation of the vehicles that was human centered to vehicles with the self –driving ability. The self-driving cars being a major level of attraction today, needs to concentrate also on the privacy, energy, traffic flow, environmental issues and the road safety. The perfect road safety is a goal that can be never achieved, due to the growing number of vehicles and the human population all over the world. Measures to improve the probability of the safety is put forward in the paper for the cars with the capability of the self-driving built with the artificial intelligence enabled processors".

Shadrin, S. S., Varlamov, O. O., Ivanov, A. M. (2017). Experimental Autonomous Road Vehicle with Logical Artificial Intelligence. Journal of Advanced Transportation, 2017, 1-10. https://doi.org/10.1155/2017/2492765

"A universal approach to performing the reverse engineering of electric power steering (EPS) for the purpose of external control is also presented. The primary objective of the related study was to solve the problem associated with the

precise prediction of the dynamic trajectory of an autonomous vehicle. This was accomplished by deriving a new equation for determining the lateral tire forces and adjusting some of the vehicle parameters under road test conductions. A Mivar expert system was also integrated into the control system of the experimental autonomous vehicle. The expert system was made more flexible and effective for the present application by the introduction of hybrid artificial intelligence with logical reasoning".

Krol, A. (2016). The application of the artificial intelligence methods for planning of the development of the transportation network. Transportation Research Procedia , 14(2016), 4532 – 4541. https://doi.org/10.1016/j.trpro.2016.05.376

"A transportation network is a layout of connections, in a region, between communities of people developed in the course of interaction of economic and social, as well as natural environment factors. The current form of transportation network is the result of long-term development, which started with the first settlements in the region. When in the course of history, a modernization or an expansion was done, it was to fulfil the new transport requirements, and the work was based on the current structure of the transportation network. These temporary requirements mostly arouse due to random factors which as time went by ceased to prevail".

Soltani, Z. K. (2021). The Applications of Artificial Intelligence in Logistics and Supply Chain. Turkish Journal of Computer and Mathematics Education, 12(13), 4488-4499.

"The range of potential market shows high growth, which can be achieved by the market in next years. It is expected that strategic allocation and asset positioning can help competitive goals. Estimation of certain regulations introduced by the governments of several countries increases the market revenues. It has been predicted that the availability of appropriate means to make powerful distribution channels can specify the expansion of the market's future in the predicted period. The stability of economic government can mostly help favourable development of global market power. It is also predicted that advances in research and development equipment can affect market growth in the prediction period. Need to provide conditions for emergencies such as natural disasters, pandemics, and international commercial wars can enable the market to fight the challenges".

Real, J. L., Toril, J. U., Torres, J. A., Pablo, J. D. (2021). Artificial Intelligence in Business and Economics Research: Trends and Future . Journal of Business Economics and Management, 22(1), 98–117. https://doi.org/10.3846/jbem.2020.13641

"Artificial Intelligence is a disruptive technology developed during the 20th century, which has undergone an accelerated evolution, underpinning solutions

to complex problems in the business world. Neural Networks, Machine Learning, or Deep Learning are concepts currently associated with terms such as digital marketing, decision making, industry 4.0 and business digital transformation. Interest in this technology will increase as the competitive advantages of the use of Artificial Intelligence by economic entities is realised. The aim of this research is to analyse the state-of-the-art research of Artificial Intelligence in business. To this end, a bibliometric analysis has been implement using the Web of Science and Scopus online databases".

Li, X., Jiang, H. (2017). Artificial Intelligence Technology and Engineering Applications. ACES Journal , 32(5), 381-389.

"There has been sixty-year development of the artificial intelligence (AI) and the maturation of AI techniques is now leading to extensive applications and industrialization. In this paper, authors review the connotation and evolution of AI techniques and engineering applications. A four-layer framework of the AI technology system is summarized in this paper to help readers understand AI family. Engineering applications of AI techniques have made remarkable progress in the recent years, for instance, applications in fault diagnosis, medical engineering, petroleum industry and aerospace industry".

Machin, M., Sanguesa, J. A., Garrido, P., Martinez, F. J. (2018). On the use of Artificial Intelligence techniques in Intelligent Transportation Systems. IEEE Wireless Communications and Networking Conference Workshops , 1-8.

"Due to the progressive increase in the population and the complexity of their mobility needs, the evolution of transportation systems to solve advanced mobility problems has been necessary. Additionally, there are many situations where the application of traditional solutions is not entirely effective, e.g., when the processing of large amounts of data collected from in-vehicle sensors and network devices is required. To overcome these issues, several Artificial Intelligence-based techniques have been applied to different areas related to the transportation environment".

Ittamalla, R., Mohammed, S. (2021). Artificial Intelligence and its Applications in Service Industry - A Review . International Jouranal of Technology, Management Knowledge Processing , 1(1), 18-28.

"Artificial intelligence has been recognized as the innovative technology throughout the world. Today, the relevance of AI is acknowledged in most of the sectors like health care, manufacturing, education, travel, etc. Despite of this, there is limited literature available on role and application of AI in service industry. This study aims to a show a comprehensive analysis of AI in service industry using a systematic literature review".

Sun, N. (2021). Intelligent Transportation System Planning in the Age of Artificial. E3S Web of Conferences, 253, 1-5. https://doi.org/10.1051/e3sconf/202125301036

"This paper mainly studies the planning of intelligent transportation system in the era of artificial intelligence. The research content mainly includes: intelligent transportation system implementation mechanism, system application and empirical research. The research conclusion is as follows: First of all, the implementation mechanism and system application of China's intelligent transportation system are constantly improving in both technology and process. Second, Yunnan is the province with the highest public satisfaction of intelligent transportation system".

Alshriem, M. (2020). The Use of Artificial Intelligence in Traffic Violation Data Analysis. International Journal of Engineering Research and Technology, 13(4), 644-652.

"Artificial Intelligence, or AI, is profoundly impacting the ways in which people across the globe interact. Being a powerful set of technologies, people have been helped in solving almost every everyday problem, which makes AIs applicable in numerous fields. One of which is transportation that has already been disrupted the ways in which the people and goods are moved. In addition, AI has also been playing an important role in transportation section from scanning of the traffic patterns to the reduction of the road accidents, and from the optimisation of the routes to the minimisation of the emission".

Zear, A., Singh, P. K., Singh, Y. (2016). Intelligent Transport System: A Progressive Review. Indian Journal of Science and Technology, 9(32), 1-7. https://doi.org/10.17485/ijst/2016/v9i32/100713

"Increase in traffic density in the world results in more and more congestion, air pollution and accidents. Hence Intelligent Transport System (ITS) has been emerged as a solution to various transport related issues. The aim of this research paper is to conduct systematic analysis on ITS. Methods/Statistical Analysis: ITS is defined as the set of applications which are advance and aim to apply intelligent information and communication technologies in order to provide services for transport and traffic management. ITS have combined various technologies such as Data collection, Communication, Data Mining, Machine Learning, Artificial Intelligence and Database Management. By combining these information technologies, ITS have provided various applications such as Traffic control, Fault detection systems, In-vehicle information and navigation systems and driver assistance systems".

Besinovi, N., Donato, L. D., Flammini, F., Goverde, R. M., Lin, Z., Liu, R., . . . Vittorini, V. (2021). Artificial Intelligence in Railway Transport: Taxonomy, Regulations and Applications. IEEE

Transactions on Intelligent Transportation Systems, 1-15. https://doi.org/10.1109/TITS.2021.3131637

"Artificial Intelligence (AI) is becoming pervasive in most engineering domains, and railway transport is no exception. However, due to the plethora of different new terms and meanings associated with them, there is a risk that railway practitioners, as several other categories, will get lost in those ambiguities and fuzzy boundaries, and hence fail to catch the real opportunities and potential of machine learning, artificial vision, and big data analytics, just to name a few of the most promising approaches connected to AI. The scope of this paper is to introduce the basic concepts and possible applications of AI to railway academics and practitioners. To that aim, this paper presents a structured taxonomy to guide researchers and practitioners to understand AI techniques, research fields, disciplines, and applications, both in general terms and in close connection with railway applications such as autonomous driving, maintenance, and traffic management".

Yin, M., Li, K., Cheng, X. (2020). A review on artificial intelligence in high-speed rail. Transportation Safety and Environment, 2(4), 247–259. https://doi.org/10.1093/tse/tdaa022

"High-speed rail (HSR) has brought a number of social and economic benefits, such as shorter trip times for journeys of between one and five hours; safety, security, comfort and on-time commuting for passengers; energy saving and environmental protection; job creation; and encouraging sustainable use of renewable energy and land. The recent development in HSR has seen the pervasive applications of artificial intelligence (AI). This paper first briefly reviews the related disciplines in HSR where AI may play an important role, such as civil engineering, mechanical engineering, electrical engineering and signalling and control".

Poola, I. (2017). How Artificial Intelligence in Impacting Real Life Every day. International Journal of Advance Research and Development, 2(10), 96-100.

"Artificial intelligence in today's world is progressing rapidly with new advanced innovations day in day out. Today's computer systems are designed to perform small tasks, for instance, facial recognition, car driving, and performance of other minor duties. However, the primary goal of artificial intelligence is to develop advanced and more complex systems that would outperform humans at whatever way. This includes the performance of more complicated tasks like playing chess and solving equations. Therefore, the future goal of AI is to perfect all human activities and provide better solutions to problems than the human can do".

Sen, S. (2018). Artificial Intelligence in Automobiles: An Overview.

International Journal of Innovative Research in Science, Engineering and Technology, 7(5), 6306-6313.
https://doi.org/10.15680/IJIRSET.2018.0705224

"The objective of this paper is to introduce the concept of artificial intelligence in the world of automobiles. The development of artificial intelligence has taken a significance step in recent years and since then, the development has taken place in every domain of the modern world. This paper enlightens the need of a strong artificial intelligence in the world of automobiles and recent development that has taken place till now in the field of automotive".

Singh, A. (2016). Artificial Intelligence in Various Domains of Life - A Review . International Journal of Computer Science and Information Technologies, 7(5), 2353- 2357.

"Artificial Intelligence is the activity of making machines intelligent since intelligent means to work with foresight in the given environment. It is the science of making intelligent computer programs and related to tasks of using computers to understand human thoughts and decisions. Artificial Intelligence is involved in various domains of lifelike education, entertainment, transportation, employment etc. No doubt, Artificial Intelligence has transformed lives but it has to be adopted under suitable and relevant policies. AI applications will be common and useful in near future but some challenges like gaining public trust, overcoming fears, should be addressed and handled".

George, G., Thomas, M. R. (2019). Integration of Artificial Intelligence in Human Resource. International Journal of Innovative Technology and Exploring Engineering , 9(2), 5069- 5073.
https://doi.org/10.35940/ijitee.L3364.129219

"Technological innovations are unending and have impacted almost all, in every aspect of life over the past few decades. One such technological innovation which is capable of revolutionising the world, the most spoken, discussed and implemented in many fields is artificial intelligence. Artificial intelligence (AI) is software which can think intelligently, similar to how an intelligent human think. Based on few studies AI is organized into four categories such as, it's a system that thinks like a human, think rationally act like a human and act rationally".

2 Paper Selection

2.1 Sources of Information

The selection of papers is from different journals and conference proceedings as described below.

- Transportation Engineering
- International Research Journal of Engineering and Technology
- IEEE Wireless Communications
- Computational Intelligence and Neuroscience
- IEEE Transactions on Mobile Computing
- Security and Communication Networks
- ACM Transactions on Internet Technology
- Journal of Advanced Transportation
- Applied Sciences
- Sensors
- IEEE Access
- IEEE International Conference on Big Data and Smart Computing (BigComp)
- IEEE Internet of Things Journal
- Computers and Electrical Engineering
- IEEE Transactions on Vehicular Technology
- IEEE/ACM Symposium on Edge Computing
- Journal of Physics: Conference Series
- Journal of Cleaner Production
- Security and Communication Networks
- Complex Intelligent Systems
- Journal of Energies
- Journal of Cloud Computing
- IEEE Transactions on Intelligent Transportation Systems
- Mobile Information Systems

- EURASIP Journal on Wireless Communications and Networking
- Wireless Communications and Mobile Computing
- ACM Transactions on Cyber-Physical Systems
- Atmospheric Chemistry and Physics
- Atmospheric Environment

2.2 Search Websites

The main websites used for searching the peer reviewed articles include Google scholar, IEEE, Microsoft academic, university database, Google Books, and Research Gate.

2.3 Search Terms

The following are the search key terms used for finding the research papers over internet.

- Edge-AI in transportation
- AI and edge computing in smart energy management
- AI and edge computing in pollution control in vehicles
- AI based intelligent transportation systems
- Edge-AI in Vehicle internet of things
- Edge AI in traffic controlling
- Traffic management using AI and edge computing
- Machine learning for pollution control in transportation

3 Literature Review

Ref., Year, citations	Application	Simulator	Data type	AI/ML Model	AI/ML model Inputs	AI/ML model out-puts	Data sets	Evaluation metrics

(Ali, et al., 2021)	Securing communication in internet of vehicles	NA	Videos in different pixel levels	Deep learning and Markov decision process	Traffic history and sensor data	Next vehicle location	VeReMi datasets	Quality of service or quality of experience
(Bibi, et al., 2021)	Detecting and classifying anomalies in VANET	Google Colab	2D images with 224×224 size	CNN, Naïve bayes, RESNet	images of pothole, bump, no and crack	Defects detected	Images contained in ImageNet	Accuracy, precision, recall
(Broekman, et al., 2021)	Real-time traffic quantization	Open Data Cam	Video with resolution of 2160 p	Region Based Convolutional Neural Network	MS COCO dataset	No. of vehicle per liner	The videos of vehicles through UAV	Performance and capacity utilization
(Chavhan, et al., 2021)	Intelligent transportation system	COPERT	Unstructured data	Radial Basis Function Neural Network	Vehicle density, clearance time, and vehicle speed	No. of future freight vehicle	Next Generation Simulation datasets in Atlanta region	Queue length and total waiting time in high traffic situations
(Choudhary, et al., 2018)	Smart Traffic Management System	Matlab	Video footage of road	Gaussian mixture model	Video of vehicle	Count of vehicles on road	Original and foreground images	Traffic signals

(Cowls, et al, 2021)	Controlling GHG emissions in vehicles	Machine Learning Emissions Calculator	Numerical data	Reinforcement learning and Natural language processing	CO2 emissions and changes in climate	Carbon footprint	MS COCO and CIFAR-10 and data from Oxford AIxSDG database	Accuracy and efficiency
(Dai, et al, 2019)	Internet of Vehicles	DDPG	Speed of vehicles	DDPG and q-learning	State of vehicular environment	Action adapted by smart vehicles	State, action, and reward of vehicle	Learning rates
(Dinh, et al, 2021)	Traffic counting system	Google Coral Dev Board and Nvidia Jetson Nano	Live video stream of 1280 p with length of 28 min	Deep learning and CNN	Videos of vehicles on road	Graphs and charts including vehicle counting	VDD dataset including traffic conditions in Vietnam	FPS, accuracy, memory used, model size, and compatibility.
(Fernoaga, et al., 2020)	Embedded intelligence for determining the back exhaust pressures on diesel engines of vehicles	Ricardo wave software	Engine characteristics of 1035-L6-DT series vehicles	ANN and edge AI	Engine load, EBP and speed	Effective power	246 datasets taken from database	Precision and variance score

(Ferrández-Pastor, et al., 2019)	Smart management of renewable energy consumption	NA	Unstructured sensor data	AI and ML	Estimated power generation	Transmission in smart grids	Datasets of energy consumption in households	Efficiency
(Fraga-Lamas, etl al., 2021)	Promoting green energy consumption	MLPerf	Emissions and energy consumption	ML and DL	Energy consumption	Carbon footprint	NA	Accuracy and energy efficiency
(Iyer, 2021)	Developing intelligent transportation system	NA	Data from sensors and drivers	Autonomous vehicle	Traffic on road and infrastructure	Route determination	NA	Efficiency of vehicles
(Liu, et al., 2022)	Estimating cost for intelligent connected vehicle	NA	NA	Cost evaluation model	Road length, number of lanes, road density, and traffic flow	Cost per unit and coverage radius	Upgrade plans, suggestions for improving infrastructure, and cost of upgrade	Cost performance index
(Hao, et al., 2019)	Optimization of communication in transportation	Smart-Edge-CoCaCo software	Dataset of images	ML, DL, and filter caching model	Facial expression images	Average delay	NA	Growth rate

(Huang, et al., 2021)	Smart energy management system for	Xilinx Zed-Board	Neural networks	Feature of grids and vehicles	Energy require for power grid, remaining power, energy consumption, and EV state	Neutral, charge, and discharg	indispensable features	Accuracy and neuron number
(Huh, et., 2019)	Edge computing and AI in engineering	Amazon Echo	ML	Data from IOT	Videos and images	Detected obstacles	Datasets from analytics platform	Performance
(Khan, et al., 2020)	Smart transport development	IoTIFY	Images with good resolution	Convolutional Neural Network	NA	NA	NA	NA
(Leroux, et., 2022)	Traffic counting systems	Coral Dev Board	Videos and images	R-CNN, Fast R-CNN, Faster R-CNN, and Mask R-CNN)	Videos of vehicles	No. of vehicles	VDD dataset	Average precision

(Lin, et al., 2020)	Public vehicle system to support smart transportation	Matlab	NA	ML	Local public vehicles	Route segment	NA	Travel satisfaction, travel distance, and travel time.
(Xie, et al., 2021)	Prediction of traffic safety in cloud based transportation systems	NA		SATP Model	Raw data of 1 to 2 billions	No. of hidden states	Dataset based on hidden Markov model	Accuracy
(Mani, et al., 2021)	Air Pollution Monitoring and Forecasting	AQI monitor analysis and Raspberry Pi-3	Information related to pollution	Auto-Regression Integrating Moving Average Model	CO levels, ozone information, and Ammonia	Pollution levels	Data from firebase database	MAE and MAE
(Masood	Ahmad, 2021)	Forecasting pollution	ANFIS	Feature of environment ANN and DNN	Qir quality	Ozone concentration	Datasets of meteorological parameters and air pollution	RMSE and MAE.
(Math, et.al., 2020)	Intelligent system for real time traffic control	network simulation version 3	Videos and images	ML	Live video streaming of vehicles	No. of vehicle		Waiting time and round trip time.

(Mehmood, et al., 2021)	Edge computing based smart grid	MEC framework	High resolution videos	AI and ML	Images and videos of vehicles	Changes in conditions	NA	NA
(Moubayed, et al., 2021)	Intelligent transportation system	Matlab based G-VSPA algorithm	NA	Optimized v2x service placement	Lane length, core nodes, number of vehicles	Aggregated delay	NA	Computational resource utilization, latency, and delay probability function.
(Moursi, et al., 2021)	Monitoring air quality using IoT enabled system	Raspberry Pi 4	Data from sources	AI prediction algorithm	Exogenous input	Green, red, and Yellow alarm level	Dataset related to air and meteorological pollution from 2010-2014	MAE, RMSE, and NMSE
(Munir, et al., 2019)	Monitoring real time driver safety in smart transportation	Python platform	Images with high resolution	edge intelligence model and CNN	Images from camera sensors	Warning or safe driver guidelines	Distracted driver detection dataset	Accuracy.
(Nammouchi, et al., 2021)	Smart microgrid energy management	Renewable energy-based MG	MQTT model	Telemetry data	Consumer and production information	ESS discharge or charge	Datasets from Feroamp website	Accuracy

(Nikodem, et, al., 2020)	Tracking vehicle using edge computing	Vehicle tracking algorithm software	Videos and images from 10 intersections and 40 cameras	AL models	Monochrome images with size of 524x384 pixels.	Heatmap, detected class, and bounding boxes	City scale traffic camera	Accuracy.
(Peyman, et al., 2021)	Optimization of intelligent transportation system	Traffic simulator named GESTRAF	Unstructured data	ARIMA, KNN algorithm, random walking, and deep learning	Passenger demand, number of customers, list of vehicles, and seats capacity	Optimized results	Datasets from dispatch center	Accuracy
(Pu, et al., 2021)	Microgrid based reinforcement learning	Python 3.7	Structured data	DRL model	Voltage magnitude and load rate	enerator output	Transformer related data	Training speed and accuracy
(Rigas, et al,, 2015)	Management of electric vehicles related to smart grid	MATSim Map data	Predictive control method	NA	NA	Dataset from Altitude map and OpenStreet reet map	Map Maximization of battery efficiency and accurate prediction of future.	

(Saouli, Margae, Aroussi,	Fakhri, 2021)	Traffic sign recognition using real time data	EDGE AI Sipeed MAIX platform	Images in 5x5 grid	TinyYOLOv3 Road images	Traffic signs	BTSD Dataset	Power consumption, recognition time, and FPS.
(Shah, et al . , 2021)	Application of deep learning into edge intelligence	NVIDIA Jetson Nano	Column data in two records	2D-CNN model	Data recording time	Start time and end time	Air quality, sensor data, and ROCOF data	Recall, FI score, and precision.
(Shen et al., , 2021)	Garbage sorting system and social internet of vehicles	Ubuntu system Videos and images, structured data and text	R–CNN and DNN	Recyclable garbage pictures, hazardous garbage, kitchen waste, and others	Sorted garbage	Dataset belonged to 15000 garbage pictures	Precision and accuracy	
(Sittón et al.,, 2019)	Application of IOT and edge computing in smart energy management	Raspberry Pi 3 Model	Structured data	Distributed generation model	Traffic from the sensors in uplink and downlink	Real time locating vehicle	Datasets from Google Cloud SQL	Energy efficiency.
(Slama, 2022)	Application of AI in intelligent smart grid	SGBD analytics	Images	Clustering and reinforcement learning	Energy distribution	Energy consumption	Resilient Distributed Dataset	Efficiency

(Sun, et al., 2020)	Prediction of electric vehicle charging in 5G smart grid	EV-CBA analysis	Numerical data	KNN and RNN	EV user data	Performance of EV	Dataset related to EV charging behavior	Charging efficiency.
(Sun J. , 2022)	Reducing the risk of automated decision-making	Bayesian algorithm	Text data of legal professionals	BP Neural	Network Model and deep learning model	No. of people legal things	Attitude of researcher NA	Improvement in clustering effect.
(Sánchez, et al.,, 2021)	Implementing edge computing for augmented reality and cyber physical systems	CPS systems	Textual information related to CPS	Artificial intelligence and machine learning	Cost and bandwidth	Safety, predictability, security, and energy efficiency	Datasets are taken from IEEE Xplore Digital Library and ACM Digital Library	Accuracy
(Vacheva, Hinov, Kanchev, Stanev,	Cornea, 2019)	Managing energy flow in electric vehicles	Maximum power point tracking	NA	NA	Charging mode	Power Information from centralized system	NA.

(Vermesan, et al., 2021)	Embedding automotive intelligence in shared and autonomous vehicles	CASCaS tool	Images	neural network and deep learning	Logs of three months data	Traffic lights and route management	Datasets taken from database	Accuracy.
(Wang, et al.,u, 2020)	Application of machine learning to study land use regression to find the amount of air pollution due to traffic	Monte Carlo simulation with XGBoost approach	GPS data and traffic videos	Gradient boost and NN	Videos with 30 frames/second	Vehicle counting and classification	Open maps and municipal databases	Evaluating classification results.
(Wang, et al., 2020)	Developing virtual power plant management in vehicles with smart grid management	Ubuntu 18.04.3	Feature of vehicle and weather in numerical format	CNN for learning with FL based scheme	Start time, weekday, temperature, humidity, latitude, age, gender, and rainfall	Power consumption	Data sets taken from EV nodes	Accuracy, timeliness, and reliability.

(Wu, et al., 2022)	Mapping high resolution traffic emissions in regional areas	EMBEV model	Numerical data with different traffic pattern	land-use random forest learning models	Daily emissions, speed, and intensity of emotions	Traffic activity characteristics	Traffic data from The Chinese Ministry of Transport	RMSE, Pearson coefficient, and MAPE.
(Xiao, et al.,, 2019)	Modeling regional air pollution using machine learning techniques	P-NIROM	Pollution data in numerical format	LSTM deep learning method	Pollutant sources and emission intensity	proper orthogonal decomposition	Datasets related to Regional Emission inventory in Asia	Computationa efficiency.
(Yan	Qin, 2020)	Optimizing the intelligent transportation system using edge computing	Matllab 2014 Audio and image data on traffic flow	DBN-SVR with deep learning	Traffic flow in current time	Rate of missing report and false rate of alarm	Data sets related to traffic flow	Accuracy.
(Zhang et. al., 2020)	Applying mobile computing and edge intelligence for internet of vehicles	NVIDIA DRIVE Hyperion 7.1 and OpenVDAP	Unstructured vehicle data	DNNs and CNNs	Vehicle related data	Visualization of data	Local data set	Delay, reliability, and accuracy.

(Zhang, 2019) Improving the efficiency of logistics transportation.	ptimization of the transportation path and improve the delivery efficiency	NA	Big data analysis and machine learning	NA	NA	NA	Historic data	Big data
(Munim et al., 2020)	Transformation of maritime transport	KNN	SVM	NA Predictive analysis	Temperature, flow rates and pressure data	Performance of vessel	Big data	Accuracy.
(Younis et al., 2021)	AI within supply chain	NA	Secondary data	NA	NA	NA	Google scholar	Ability to reduce the bullwhip effect and increase supply chain performance.
(Alahmadi, 2020)	Address transportation challenges like poor safety record, CO2 emissions, wasted energy, capacity problems and unreliability.	NA	ANN	NA	NA	NA	AA	Applications of AI in transportation.

(Manoharan, 2019)	Perfect road safety is a goa	NA	Linear –quadratic Gaussian propagation	ANO LQP Algorithms	Sensor data	Road obstacle	Primary data	Avoid obstacles and improve safety.
(Sarker, 2021)	Traffic congestion, higher fuel prices, increased CO22 pollution, accidents, emergencies	NA	Structured and unstructured data	Naïve bayes, KNN and SVM	NA	NA	Historic data	Traffic prediction and transportation.
(Carlan et. al, 2021)	Finding optimal schedule plans for public transport authorities, enhancing timing plans for traffic signals, and optimizing routes for individual drivers,	NA	Structured data unstructured data	NA	NA	NA	Sensor data	Replacing human resources with AI technologies.
(Ahmed, 2018)	Increase the accuracy and productivity of the electronic devices	NA	NA	NA	NA	NA	NA	Smart car manufacturing.

(Geetha et al., 2021)	Controlling overspeed issue in transportation	NA	Images and videos	Deep neural network	Vehicle registration ID and images	Vehicle detection	Primary data	Implement traffic rules effectively.

4 Challenges and Open Problems

Based on the information available from all the chosen articles, it is identified that use of edge AI is creating several challenges for the transportation industry. Use of internet of vehicles and smart vehicles to few challenges to the humans. The challenges include collection of data from sensors and facilitating communication in speed, fast, and efficient manner. Use of AI technology is also associated with set of ethical and social challenges in determining the amount of pollution emitted into air and making right decisions when an obstacle presented on the roadside. It needs to consider the contribution of GHG emissions into air using trained data on AI systems. When IoT technologies are integrated, it is hard to gather huge volume of data from the sensors that further leading to increased privacy and security challenges along with bandwidth utilization and latency challenges. Integration of AI and edge computing is a challenging thing in optimization of energy generation and developing right knowledge on estimating demand and supply for energy production.

5 Acronyms and their full forms

AI: Artificial Intelligence
EIS: Edge Information System
ML: Machine Learning
CNN: Convolutional Neural Network
FPS: frames per second
ARIMA: Auto-Regression Integrating Moving Average Model
MAE: Mean Absolute Error
RMSE: Root Mean Square Error
ANFIS: Adaptive Neuro-Fuzzy Inference System
MQTT: Message Queuing Telemetry Transport
KNN: k-nearest neighbors
CASCaS: Cognitive Architecture for Safety-Critical Task Simulation
LURF: land-use random forest
DBN-SVR: deep belief network support vector regression

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