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"Artificial Intelligence in Transport"

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ABSTRACT
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, CO2 emissions, 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. Examples of AI methods that are finding their way to the transport field include Artificial Neural Networks (ANN), Genetic algorithms (GA), Simulated Annealing (SA), Artificial Immune system (AIS), Ant Colony Optimiser (ACO) and Bee Colony Optimization (BCO) and Fuzzy Logic Model (FLM) The successful application of AI requires a good understanding of the relationships between AI and data on one hand, and transportation system characteristics and variables on the other hand. Moreover, it is promising for transport authorities to determine the way to use these technologies to create a rapid improvement in relieving congestion, making travel time more reliable to their customers and improve the economics and productivity of their vital assets.

This paper provides an overview of the AI techniques applied to address transportation problems mainly in traffic management, traffic safety, public transportation, and urban mobility. The overview concludes by addressing the challenges and limitations of AI applications in transport.

Keyword: Artificial Intelligence, Public transport, Traffic management.

I. INTRODUCTION

This paper presents the process of using an Artificial intelligence, in transportation. Artificial intelligence is a broad area of computer science that makes machines function like a human brain. It is used to address issues that are difficult to clarify using traditional computational techniques. AI was first discovered in 1956 by John McCarthy but failed to achieve its objectives and the lack of technology innovations made it less promising. The Knowledge-based system (KBS) systems are computers that provide advice using pre-determined rules, according to the knowledge presented to it by humans. The Artificial Neural network systems (ANNs), on the other hand, are systems of neuron connections designed in various layers, modelled after the human brain which have been used in medicine, biology, and language translation engineering, law, manufacturing, etc. During that period of time, interest in AI diminished due to limited applications of ANNs and lack of data until the 1980a. Since the 1980s, many research was conducted to minimize the error of prediction through a method dubbed as gradient descent. This method is referred to as a Backpropagation algorithm for the training of the ANNs and it was applied to solve problems in different domains using few hidden layers. Today, the availability of data has introduced the concept of machine learning as a subcategory to AI. Machine learning implies coding the computers to behave like a human brain instead of teaching them everything. It provides the computers with access to big data and extract important features from them to solve complicated problems. ANN is the most distinguished AI method used in different applications. One of the first and most common types of ANNs is the Feedforward Neural Network in which the data moves in one direction from the input layer to the hidden layer to the output layer. Other types of ANNs are Convolutional Neural Network (CNN) and Recurrent Neural Network. The CNN performs better for image processing tasks while RNN Processes a sequence for the

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input data to become well-suited for many applications such as; language, writing and text recognition. They are often referred to as Deep Learning Techniques due to the multiple hidden layers structured in their architectures. There are many uncertainties and gaps within the data that cannot be solved using traditional techniques. Therefore, AI uses those uncertainties and model a relationship between the cause and effect of different real-life scenarios by combining the available data with assumptions and probabilities for a better analysis.

Transportation problems become a challenge when the system and users' behaviour is too difficult to model and predict the travel patterns. Therefore, AI is deemed to be a good fit for transportation systems to overcome the challenges of an increasing travel demand, CO2 emissions, safety concerns, and environmental degradation. These challenges arise from the steady growth of rural and urban traffic due to the increasing number of populations, especially in the developing countries. Many researchers in the 21st-century attempt to accomplish a more reliable transport system with less effect on people and the environment using cost-effective and more reliable by AI techniques. It has a potential application for the road infrastructure, drivers, road users, and vehicles.

The AI applications in transport have been developing and implemented in a variety of ways. Among those, this research paper aims to address three main examples.

(i) The use of AI in corporate decision making, planning, and managing. This is important to overcome the issue of a continuously rising demand with limited road supply. This includes better utilization of accurate prediction and detection models aiming to better forecast traffic volume, traffic conditions, and incidents.
(ii) Applications of AI aiming to improve public transport is also discussed. It is due to the fact that public transportation is regarded as a sustainable mode of mobility.
(iii) The next promising AI application in transport is connected and autonomous vehicles, which aims to enhance productivity by reducing the number of accidents on highways. The self-driven cars and small-scale autonomous bus trials that have been initiated, most prominently in Finland, Singapore, and China are overviewed in this paper.

The remainder of this paper is divided as follows: Part 2 discusses the application of AI in transport. This section is subdivided into the application of AI for planning, designing and decision making, public transportation, intelligent self-driving cars. It also illustrates real-time incident detection and future traffic state prediction. Part 3 shows that the future of AI is focused on Deep Learning. Section 4 explains the future research work by the authors while Part 5 provides a conclusion of this paper review.

II. LITERATURE REVIEW METHODOLOGY

To give a comprehensive overview on the state-of-the-art of AI-based applications in rail systems, we initially followed the methodology. However, since Artificial Intelligence and Rail are two wide domains, creating an all-encompassing and well-structured search query was not straightforward. Specifically, to obtain the papers in this systematic literature review, we went through the following steps. First, we initially searched for macro-areas considering the terms and an AI e.g., "Maintenance and Inspection" & "Machine Learning". This was done on the title, abstract and keywords. Second, we additionally included relevant (e.g., with a high number of citations) papers that were published before 2010, and some papers we previously analyzed in but were not covered by the first step. Third, we manually filtered and removed the non-relevant. Fourth, we further explored the literature databases using the additional specific (subdivided).

Problem Definition

AI has the potential to make traffic more efficient, ease traffic congestion, free driver's time, make parking easier, and encourage car- and ridesharing. As AI helps to keep road traffic flowing, it can also reduce fuel consumption caused by vehicles idling when stationary and improve air quality and urban planning.

Objective

The objective of this paper is to create vehicle accident prevention by method of any problem detection in an order to reduce accidents that are caused due to driving under influence of alcohol that also reduces the traffic.

The objective of planning is to identify the community needs and decide on the best approach to meet this demand while utilizing the impact of social, environmental and economic in transportation.

People driving while intoxicated still causing lakhs of deaths a year around the world.

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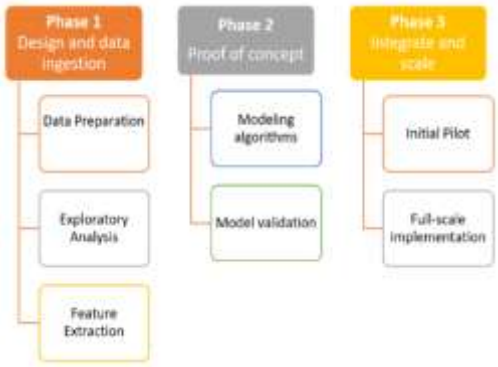
Research Methodology

In phase 1, all data sources must be evaluated and used for incorporating the advanced model into the industry. This phase is important for the initial assessment of the asset performance. Relatively, in the proof-of-concept phase, many models can be chosen for a more critical assessment of the performance by identifying failures modes and the time required for the overall life-cycle of the project. Moreover, the last phase of the diagram represents the real-time prediction information on asset performance as the model in this phase should be constantly updated and scaled to give the best results. In [80] the authors use demographic and Geographic data to predict future mobility demand in Switzerland. This demand estimation is important to make a decision on planning and future techniques that are most needed to manage a more effective transportation system. They, first cluster the population data based on their daily route choices. Then, a decision tree is used to classify these data and support vector machine to improve to extract more important features from the data. They are both supervised NNs. A decision tree uses large numbers of de-correlated decision trees to create a forest. Higher accuracy is achieved by the increasing number of trees. It works by classifying each tree (x) based on its attributes. The tree votes for (x) and the classification with most votes is chosen by the forest. While SVM classifies the inputs based on maximizing the margins between the data. Then, they use machine learning algorithms with respect to daily distance travelled by a vehicle for the estimation of the future demand. In another study [65], the authors investigate the methods applicable for real-time short-term prediction of public transport users waiting at bus stops and also on-board passengers. This information will help operators to control transit trips more effectively. It also helps travellers to decide on the best route during congested hours. The communication of information requires integration between public transport systems and ITS which in turn will enhance the forecasting tools for advanced traveller information systems and operation controls. Similarly, recent ridesharing services such as Uber increased the possibility of collecting massive amounts of data. AI can benefit from these data to predict passenger demand effectively to avoid empty vehicles which in return will reduce congestion and energy consumption. The authors collected large scale ridesharing demand requested data from Uber. They combined Local CNN that captures local regions in relations to their surrounding area and Long Short-Term Memory network (LSTM) to model temporal features. The results demonstrated a superior performance of this recommended model The results showed that the historical demand data of 4 h with 50 neurons in the hidden layers provided better prediction accuracy. Similarly, another study determined the performance of taxis by selecting the most important feature from a taxi pattern

System Flow Chart



Car Sensor

This sensor can detect the presence of car up to a range of 2 meters thereby making the detection process much accurate. Also, the sensitivity can be adjusted according to needs, making the sensor more versatile.

III. ANALYSIS & FINDINGS

Artificial intelligence can be used in designing an optimal transit network for a given community, developing an optimal work plan for maintaining and rehabilitating a pavement network, and developing an optimal timing plan for a group of traffic signals, Artificial intelligence can be used for identifying specific classes of drivers based on

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driver behavior, It is used for decision support systems for transportation planning.

Artificial intelligence is used in law enforcement capacities, This can be a challenge to human officers due to the speeds at which vehicles and passengers can come into and out of view, with artificial intelligence, this is no longer such an issue, By using advanced analytics and data processing capabilities, AI could help to detect & identify when a driver is drinking or texting behind the wheel and alert any officers within the local area to intercept them.

Artificial intelligence can manage the transmission & processing of received data as well as optimize connectivity to ensure the best connection, Artificial intelligence can be used in nonlinear prediction of the behavior of systems in which inputs & outputs, Traffic demand modeling, or in modeling the transportation infrastructure health as a function of traffic, construction and weathering.

AI can be used in signal control of traffic at road intersections, ramp metering on freeways, dynamic route guidance, positive train control on railroads, AI can be used in automatic incident detection, It is used in image processing for traffic data collection & identifying cracks in pavements or bridge structures and transportation equipment diagnosis.

According to the research, there are several challenges that are persistent throughout the transportation industry and that have plagued this sector ever since its inception, among them safety, reliability, efficiently and pollution.

IV. LIMITATION

AI methods have initiated different criticism since they were introduced to the field of transportation. One of the major limitations to AI is considering ANNs as a "black box". This means that the relationship between the input and the output is developed without any knowledge to the internal computations of the system. Also, it was suspected of the ability of ANNs to generalize in cases where some information is missing in the data sets. However, research overcome this limitation by combining neural network with other traditional technique and other AI tools as a hybrid solution to fix this problem.

Development of an AI-based for an efficient transportation system is very complicated, due to the creation of a mechanical intelligence along with the proper understanding the human-based information. Until today, AI applications in transportation are limited to specific ITS applications such as data analysis and predictions of future mobility. It would be more efficient if AI applications are capable of handling the full range of the process. Accordingly, realizing the full potential of AI to develop applications that are capable of operating as standalone systems is needed. Therefore, it is important to introduce AI knowledge in traffic analysis, data collection and storage, decision making and optimization modelling in future researches. When AI techniques are based on data, which is collected from classical methods using loop detectors, sensors, and actuators etc. the accuracy and on-time predictions are not reliable. Therefore, departing from classical data collection methods to new AI-based technologies is important as that may provide data mining tools that are novel and easily deployable.

In transportation, the capability to forecast short and long-term traffic flow is essential. The challenge is to forecast under unexpected events and adverse weather conditions. Unfortunately, the existing AI techniques are not capable of addressing such events and conditions. Therefore, the development of weather and incident responsive algorithms and prediction schemes is important to obtain high accuracy. The AI in developing these algorithms would enhance the efficiency in online computations and improve the standardizing the requirements with regard to spatial and temporal data coverage.

Future Research Work It has been noted that ANN is a robust model because it can cover multiple AI tasks and it doesn't need a deep understanding of the process for a certain targeted task. Its advantages also include relating inputs to outputs using pattern recognition. It also can manage a huge amount of data with well adjustment and performance when surrounded by noisy data. It saves time since it is a fast computation tool with good performance. It is successfully implemented when tested around different structures and different tasks. However, very few research has been conducted for a long-term traffic state prediction using deep learning architecture. Also, previous research focuses on only one or two traffic parameters to develop the model. Therefore, future research will be directed towards enhancing predictive operations using more than two features and more than one hidden layer for the structure of the mode

V. CONCLUSION

Conclusions

This paper presents an overview of the applications of AI to a variety of transport-related problems.

The range of applications is expected to increase as our cities and transport systems become more instrumented providing much-needed data for AI application development. The review focused on a number of application areas which are expected to have more autonomous vehicles, public transport, disruptive urban mobility, automated incident detection, future traffic status prediction, and traffic management and control. It shows that AI can be used to solve the challenge of increasing travel demand, CO_2emissions, safety concerns, and wasted fuels. Scope for further studies

Due to the conceptual nature of the present study, it may lack generalizability of application in different scenarios. An impact studies based on primary data collected from the stakeholders involved in the transport industry can be taken up in future.

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