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Intelligent Transportation System (ITS) Using Neural Networks

[1] Dr.R.P. Sonar, [2]Mohammad Arsalan, [3]Furqan Ahmad [4]Ubaid Ur Rehman [5] Syed Umair

[1]Assistant professor, [2,3,4,5] Student
Department of Computer science and Engineering
Prof.Ram Meghe College of Engineering and Management, Badnera- Amravati.

Abstract: This paper delves into the integration of neural network technologies as the cornerstone of an intelligent transportation system aimed at transforming urban traffic management in smart cities. Focusing on the convergence of machine learning and transportation infrastructure, this study examines the role of neural networks in real-time traffic prediction, adaptive signal control, and optimized routing strategies. by analyzing vast amounts of historical and real-time traffic data, neural networks empower traffic management authorities with predictive capabilities, allowing proactive interventions to mitigate congestion hotspots and optimize traffic flow. The paper explores the efficacy of neural network models in understanding complex traffic patterns, enabling traffic engineers to dynamically adjust signal timings and optimize traffic routes. Furthermore, the discussion encompasses the potential societal and environmental impacts of implementing such intelligent systems. By leveraging neural networks, cities can envision reduced travel times, minimized fuel consumption, and lower emissions, thereby fostering a sustainable and efficient urban transportation ecosystem.

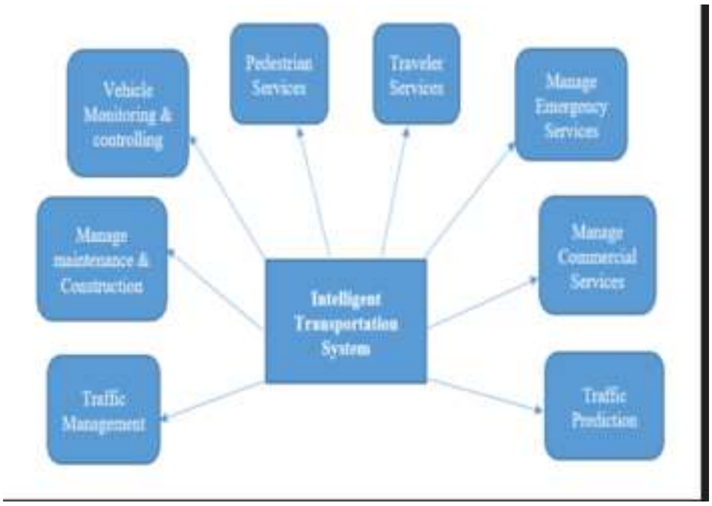
***Index Terms* - Traffic Environment, Deep Learning, Machine Learning, Genetic Algorithms, Soft Computing, Image Processing**

I. Introduction

In the persistent march of urbanization, the complexities of transportation systems have evolved into multifaceted challenges, demanding innovative solutions. The exponential growth in urban centres has engendered a parallel surge in vehicular density, giving rise to perennial issues of traffic congestion, operational inefficiencies, and, most critically, safety hazards. In response to these challenges, this research paper unfolds a transformative journey toward the development and implementation of an Intelligent Transportation System (ITS). This ITS capitalizes on the prowess of advanced neural networks, envisaging a paradigm shift in the intelligence, safety, and efficiency of contemporary transportation networks.

ITS is an integrated traffic management system composed of advanced data communication, information processing and traffic management technologies. In recent years, the success of deep learning in computer vision, speed recognition, and natural language processing makes it natural to apply it to ITS. We divide the applications in ITS into visual recognition tasks, TFP, traffic speed prediction (TSP), travel time prediction (TTP) and other tasks.

The term "ITS" refers to the use of systems for communication, information, transportation, and urban transportation. Two of ITS primary Objectives are efficiency and traffic safety. Reduced intersection stalls and delays, improved traffic times, improved speed control, capacity management, and incident management are all benefits of an ITS. Figure given below depicts numerous tasks that are covered by ITS



Traffic is influenced by many factors that we need to consider for accurate predictions. So, there are several main groups of data that we'll have to obtain.

- **Mapping data:**

First of all, we need to have a detailed map of road networks with related attributes. Connecting to such global mapping data providers as Google Maps, Mappls is a great way to obtain complete and up-to-date information.

- **Traffic information**:

Then, we need to collect both historical and current traffic-related information such as the number of vehicles passing at a certain point, their speed, and type (trucks, light vehicles, etc.). Devices used to collect this data are loop detectors, cameras, weigh in motion sensors, and radars, or other sensor technologies.
Fortunately, we don't have to install these devices all over the place on our own. It's easier to get this information from the aforementioned providers that gather data from a system of sensors, diverse third-party sources, or make use of GPS probe data. Other platforms such as Otonomo use an innovative Vehicle to Everything (V2X) technology to collect so-called connected car data from embedded modems.
We can also get other important information on incidents (road closures or roadworks), places of interest, etc., from data providers.

- **Weather information**:

Weather data (historical, current, and forecasted) is also necessary as meteorological conditions impact the road situation and driving speed. There are lots of weather data providers such as OpenWeather or Tomorrow.io

- **Additional data on road conditions:**

There are external data sources that can provide important information that impacts traffic such as social media posts, local news, or even police scanners.

In short, to anticipate TFP, we consider a multi-parameters prediction approach that takes into account traffic patterns in a variety of ways.
a) Flow:
The amount of traffic that passes through a particular spot on the road in a given amount of time is referred to as the flow of traffic.
b) Speed:
The distance travelled per unit of time determines a vehicle's speed. In most cases, the speed of any vehicle on the road will differ from others around it due to factors such as the driver's position and the traffic conditions.
c) Day:
The day can be Sunday to Saturday.
d) Day of type:
The day of type is mainly described as public holiday, weekend, and working.
e) Clock time:
The clock time can be divided into hours, a total of 24 hours (1- 24 hour).
f) **Weather condition**:
Weather data such as sunny & rain can be taken to training and perdition purposes.

The below figure depicts the growth of ITS in recent years.

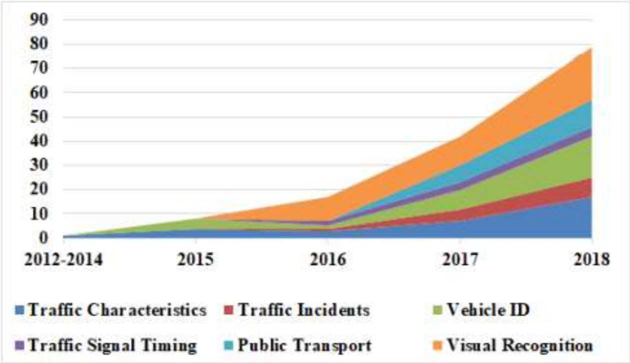


Figure 1: Year-wise publication growth in ITS domains

II .BACKGROUND

A meticulous exploration of the existing literature lays the groundwork for understanding the landscape of intelligent transportation systems and the pivotal role of neural networks. Studies in this domain reveal a burgeoning interest in leveraging advanced technologies to tackle traffic-related challenges. The deployment of Long Short-Term Memory (LSTM) layers for time-series data analysis has been explored, demonstrating their efficacy in capturing nuanced traffic patterns and trends over time. Moreover, research on Graph Neural Network (GNN) layers showcases their significance in comprehending the intricate network of roads and intersections, fostering intelligent route planning. The integration of Convolutional Neural Network (CNN) layers emerges as a promising avenue for hazard detection through computer vision, addressing safety concerns and fortifying the resilience of transportation systems. The literature survey underscores the pivotal role of real-time data processing in optimizing traffic flow. Dynamic traffic signal adjustments have been explored, showing promising results in minimizing congestion and enhancing overall transportation efficiency. Furthermore, the continuous monitoring of hazards through computer vision has been lauded for its potential in providing immediate alerts to drivers, thereby mitigating risks and bolstering safety on roadways. As the field advances, these studies collectively point towards the untapped potential of comprehensive Intelligent Transportation Systems, urging the exploration of integrated solutions that synergize time-series data analysis, graph-based route planning, and hazard detection through advanced neural networks. This research, therefore, stands at the intersection of these innovative trajectories, aiming to not only contribute to the existing body of knowledge but to pave the way for a holistic, intelligent, and safer future of urban transportation. The subsequent sections delve into the intricacies of our proposed methodology, the technologies employed, and the tangible outcomes that herald a new era in the evolution of transportation systems.

III .PROPOSED METHOD

There are various approach to prepare or train a model like statistical approach which is used in early 70s , auto-regressive integrated moving average (ARIMA) models—which are simple to use and show higher accuracy than other statistical techniques—have been extensively employed to predict traffic. Apart from statistical we use Machine learning models as a effective approach. The use of ML algorithms to forecast traffic has been the subject of numerous studies. Here are a few effective examples .The random forest method builds several decision trees and combines their data to produce precise forecasts. Given enough training data, it can generate effective results quickly. In this instance, the model's input variables include the weather, time, specific road conditions, road quality, and holidays. Furthermore, the k-nearest neighbors (KNN) method uses the idea of feature similarity to forecast future values. But the ML algorithms have its own limitations that it works efficiently on less amount of data. To overcome this limitations we use deep learning approach. Deep learning (DL) methods have proved highly effective in predicting road traffic in comparison to ML or statistical techniques, consistently showing about 90 percent forecasting accuracy and higher. DL algorithms are based on neural networks.

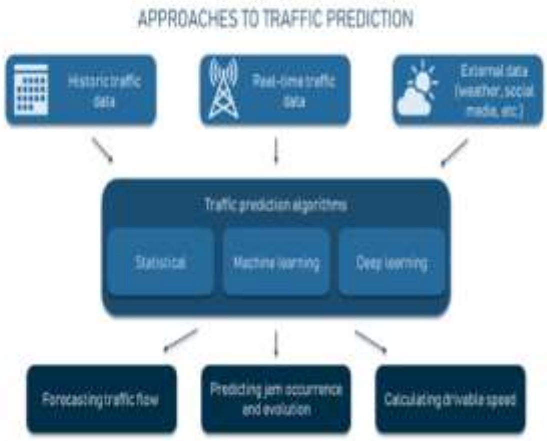
Artificial neural networks (ANN) or neural networks (NN) are made up of interconnected nodes (neurons) organized in two or more layers and are intended to mimic the behavior of the human brain. There are many types of neural networks developed for different purposes. Here are some that were used in traffic analysis and prediction.

Convolutional neural networks (CNNs) are regarded as industry pioneers in image analysis and recognition. Congestion detection utilizing images from on-road surveillance cameras is one of its natural applications to transportation issues. CNN's are not the first choice for traffic forecasts.

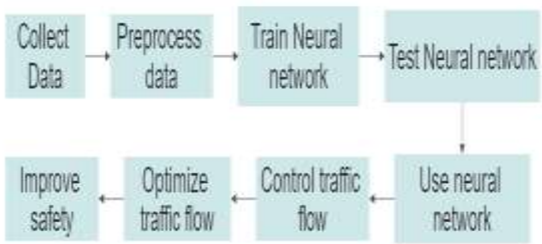
However, attempts to develop CNN-based models for predicting transportation network speed were highly effective. To do this, researchers created a 2-dimensional picture matrix from time and space data characterizing traffic flow.

Recurrent neural networks (RNNs), as compared to convolutional neural networks (CNNs), are designed to analyse time-series data or observations gathered over specific time intervals. Such insights can be seen well in traffic patterns. RNN models have been shown to anticipate congestion evolution with excellent accuracy. The vanishing gradient problem, which is why RNNs are considered to "have a short-term memory", is its disadvantage because it causes some of the data from earlier layers to be lost. Model training is more difficult and time-consuming as a result of this "forgetfulness".

Long short-term memory (LSTM) and gated recurrent unit (GRU) are variations of the RNN that address the vanishing gradient problem. A study that compared the performance of these models showed that the GRU model is more accurate in traffic flow predictions and is easier to train.



Here we have train the Model using simple LSTM Algorithm over Machine learning algorithm to make our model more efficient. The overall framework of our model is as follows.



IV CONCLUSION

The research contributes to the evolving landscape of intelligent transportation systems, emphasizing the role of neural networks in creating a safer, more efficient, and sustainable urban transportation ecosystem. As smart cities continue to evolve, the integration of advanced technologies, particularly neural networks, will play a pivotal role in reshaping the future of urban mobility

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