A HYBRID DEEP LEARNING MODEL FOR MANAGEMENT OF TRAFFIC

M.tech. Scholar Yash Sethi, Asst. Prof. Ajeet Singh Rajput
Department of Computer Science and Engineering
Rishiraj Institute of Technology (RIT),
Indore, India

Abstract: Some of the many uses of reliable traffic flow information include traffic forecasts, vehicle navigation devices, vehicle routing and congestion management. The management of traffic congestion is another example of an application. Unfortunately, because so few areas are equipped with sensors, getting real-time data on traffic flow is nearly impossible. Accidents and public events can have a significant impact on traffic flow and are difficult to foresee, making it difficult to predict traffic flow effectively. To make things more difficult, this is a factor. To begin, we'll utilise a dynamic traffic simulator to generate traffic on all of the links in the network using existing traffic data, demand predictions, and historical traffic data collected from sensors on the links themselves. To propose the use of hybrid deep learning to anticipate traffic flow on the road.

Keywords: Road Traffic, deep learning, Flow Prediction, Intelligent Transportation System

I. INTRODUCTION

Access to information regarding traffic patterns is required for the planning of travel by individuals, businesses, and government agencies alike. By supporting passengers and drivers in making better travel selections, it helps reduce traffic congestion, which in turn improves traffic operations and leads to a reduction in the emissions of carbon dioxide. With the development and implementation of Intelligent Transportation Systems (ITS), it will be possible to more accurately estimate the flow of traffic (ITSs). It is recognised as an essential factor for success in the management of traffic and in the operation of mass transit systems in the modern world. [1]. The flow of traffic can be affected by a variety of factors, including inductive loops, radars, cameras, mobile GPS, crowdsourcing, and social media. In this new era of information transportation, the widespread use of both conventional sensors and cutting-edge technology has led to an increase in the amount of data that is being collected on the flow of traffic. The collection and analysis of data for the purpose of transportation management and control is becoming increasingly common. [2] and [3]. Even yet, there are already a number of systems and models that can anticipate traffic flow; the most of them adopt shallow traffic models, and despite their best efforts, they are still not totally accurate due to the huge dataset dimension of these systems. Because of its ability to handle classification problems, understanding natural language, reduce dimensionality, recognise objects and model motion, deep learning principles have recently piqued the interest of academics and industrialists alike. For this, we'll need to draw on ideas from deep learning. DL uses multi-layer neural network techniques to harvest the underlying properties of data at all levels, from the most fundamental to the most advanced [4]. As a result, they can vast quantities of structure in the data, allowing us to better visualise it and get valuable insights from it. Autonomous vehicles, which have the potential to make transportation systems more cost-effective and reduce the danger of deaths, are also a key concern for ITS departments and researchers. This concept has the added benefit of decreasing the amount of time that is squandered in the process. There has been a tremendous rise in the amount of attention paid to the safe operation of autonomous cars during the past few decades. In order to produce accurate forecasts about traffic flow while lowering the amount of complexity needed, the data involved in traffic flow has a very large dimension.

II. RELATED WORK

Numerous researcher have investigated a huge variety of algorithms and approaches to try to forecast the occurrence of traffic accidents in both urban and rural settings. to the information that was inadvertently gathered, passengers were able to avoid getting into a crash in the middle of a busy crossroads. This section focuses on a selection of literary works that are considered to be classics.

Meena, G., Sharma et al.[1] anticipated that by merging several types of learning, such as machine learning, genomics, soft computing, and deep learning, we could make the study of huge amounts of transportation data more manageable. Through

the use of image processing techniques, autonomous vehicles of the future may one day be able to learn to recognise various types of traffic signs.

L. Xu, et al[2] In order to effectively manage traffic and cut down on congestion, accurate short-term traffic flow forecasting is absolutely necessary. The vast majority of contemporary methodologies forecast short-term traffic flow by employing either time-space parameters derived from conventional traffic flow models or feature extraction carried out with the assistance of deep neural networks. Altering your lane position has an immediate and more significant effect on the flow of traffic as a result of the increased number of vehicles on the road. It has been proposed to develop short-term traffic flow forecasting systems that make use of deep learning and have the capability of determining when vehicles switch lanes. Deep learning and image processing are both components of this approach to problem solving. The predictions of the model were found to be quite accurate when they were tested against datasets taken from the real world.

J. Yu, et al[3] The utilisation of a multi-dimensional influence factor that is based on deep learning as a road traffic flow prediction model is something that has been suggested as a solution to the issue of dynamic interference that manifests itself all throughout the procedure of traffic flow prediction. This model analyses the flow of traffic around the city in terms of both time and space, taking into account factors such as working days, holidays, and the weather. After that, the flow of road traffic is quantified, and as a result, a multidimensional state vector is produced.

S. S. Sepasgozar et al[4] First, utilise communication from vehicle to vehicle (V2R) to estimate the flow of traffic inside a network. Next, we use communication from vehicle to vehicle (V2V) and/or vehicle to vehicle (V2R) to estimate the flow of traffic along a route. In the third stage of the hybrid model that has been developed, the machine learning strategy known as Random Forest (RF) is applied in order to select the characteristics from the merged dataset that are the most essential (which includes V2V and V2R communications). For the most accurate results, an approach to deep learning known as Gated Recurrent Unit (GRU) is utilised in the process of anticipating the flow of network traffic.

G. Meena et al.[5] The purpose of this effort is to develop methods for accurately and promptly predicting information regarding traffic flow. The term "traffic environment" refers to any and all circumstances that may have an impact on the flow of vehicular traffic, including but not limited to accidents, rallies, and road repairs. If a driver or passenger has prior knowledge that is somewhat correct about the aforementioned factors as well as the many other aspects of day-to-day living that are known to have the potential to influence traffic, then they are in a better position to make an educated choice. This technique will be beneficial to self-driving cars in the not too distant future. Over the course of the last few decades, traffic data has experienced remarkable growth, which has led to the implementation of big data principles in the transportation sector. Although there are presently a variety of approaches to estimating traffic flow, these methods are not yet enough for use in applications that take place in the real world.

T. Jia et al.[6] In this study, spatiotemporal neural network models that are informed by deep learning are used to make highly accurate forecasts of citywide traffic flow for each individual road segment. It is possible to forecast the flow of traffic by using this method. In order to get started, going to investigate the process of reducing a road network to its two-dimensional representation. This method ensures that the topological connections between the separate stretches of road, each of which is represented by a pixel, are maintained.

C. Chen et al[7] It is crucial for there to be an accurate prediction of traffic flow within the Internet of Vehicles (IoV), as this allows for the evaluation of road conditions and the provision of timely input on traffic conditions to both travellers and those in management positions. Traditional models are incapable of managing large-scale and highly dimensional metropolitan road network data as a consequence of overfitting and manual intervention in traffic flow estimates. This is because traditional models rely on human input. A traffic flow forecasting system for metropolitan road networks that makes use of deep learning is presented.

III. PROPOSED METHODOLOGY

In order to construct a method for predicting the flow of traffic The purpose of traffic flow prediction is to create forecasts about future traffic speeds on the basis of information gathered from a network of sensors. Because of this, it is possible to get travel time estimates that are more accurate. In order to accomplish this goal, the model framework must, to begin, be capable of accurately evaluating the flow of traffic at the present time. After acquiring the traffic data, the first step is to train a graph neural

network in order to generate an optimised feature vector set for the sensor nodes. After the information has been processed by the recurrent neural network, sequence-to-sequence modelling will be utilised to generate a conclusive forecast. As a consequence of this, it is strongly suggested that a model based on sequence-to-sequence relationships be utilized in order to assess the precision of the forecast. [13] The flow of traffic on an urban road network includes three components: a temporal component, a spatial component, and an element of uncertainty. The temporal component refers to the passage of time. These traits can be divided up into the following three categories: According to the findings of this research, the flow of traffic on an urban road network can be analysed and predicted with the use of a dynamic graph convolution network, which is a method that was developed by the researchers who conducted the study. Road sensors and other external factors are used to estimate traffic flow average speed and other parameters based on the time and space data gathered by the urban road network, and to produce a complete time and space network prediction of the urban road system [14]. This is done in order to produce a complete time and space network prediction of the urban road system. The input conversion layer is responsible for both embedding and converting data on traffic flow attributes and external elements. This is because it falls under the scope of this layer. The volume of traffic, the percentage of lanes that are occupied, and the average speed of vehicles are all examples of this type of data. The information obtained from the external factors is broken down into three groups: the period, the day of the week mark, and the accident mark. Separately from one another, each of these categories of data are taken into consideration. The core concepts of the model can be summed up by the model's designers in the following two points: First, think of the sensor data as graph data; then connect the nodes and the nodes that are nearby; and finally, use a graph convolutional network to capture the flow of traffic. This will allow you to visualise the spatial correlation of traffic flow. Second, do an investigation into the temporal dynamics of the flow of traffic by utilising the gated loop unit and the attention mechanism. The data that was obtained from the same node multiple times should be handled as a time series and analysed in the same manner. This is because the data was acquired over the course of time. For the purpose of processing the spatial dependency of the traffic data, both the graph convolutional network and the attention encoder network are put to use. On the other hand, the attention encoder network is the one that should be utilised when it comes to the task of recording temporal dynamics. When performing activities that include the prediction of traffic flow, the nonlinearity and temporal-spatial correlation characteristics of traffic flow are particularly important, and the influence of external elements that are connected to traffic flow is also obvious. These brilliant ideas came up because of research conducted by scientists into the natural flow of traffic. Research conducted into the fundamental aspects of traffic flow led to the discovery of this particular piece of information. This research presents a spatio-temporal dynamic graph convolutional network that takes into consideration the effects of three external parameters in order to successfully cope with these traffic flow characteristics. In addition, this network takes into account the ease with which data may be gathered. This is the reason. There are several things to think about, including the time of day, the weather, and the current state of the roads (time, weekday mark and traffic accident record). The representation ought to be incorporated into the layer that is responsible for the input conversion. Figure 1 provides a more in-depth look at the structure of the model that was used to anticipate the flow of traffic. Deep neural networks are one of the most recent developments in the field of machine learning. Approximators for functions that are useful in a variety of contexts have only recently gained in popularity. This is because modern computers, and especially graphics processing units, have seen a significant boost in their overall capability for computing work (GPUs). There is a large amount of potential in addition to the abundance of data that can be used for training models. Deep neural networks have seen widespread adoption since their implementation of the qualities. Exciting applications of machine learning have emerged as a direct consequence of this development, including the recognition of images classifications,many others. Because of these novel applications, it became possible to draw inferences from experiences that had come before. Deep neural networks are able to recognise patterns in the data that were not visible before since its architecture is modelled after the human nervous system. Using this architecture, it is possible to detect patterns in the data. In order to accomplish this goal, it is necessary to unearth concealed patterns and characteristics inside a particular data collection. With the assistance of deep neural networks, it is possible to come up with approximations of complicated nonlinear functions. This can be accomplished through the use of the networks. An individual neuron is any of the interconnected processors in a hidden layer that is able to generate

a series of "fires" of real-valued activations. Neurons are the basic building blocks of the nervous system. Information is moved in a non-linear fashion from one layer to the next via non-linear transformations, which are responsible for this movement.

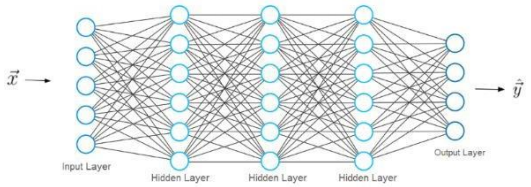

Fig. 1. Deep neural network architecture.

As a consequence of this, we are going to suggest a model for a deep neural network that is capable of predicting the flow of traffic in the future based on the values that were recorded in the dataset that was discussed before. This model was constructed with the help of the data presented, specifically the values that were recorded there. The data that were gathered and kept in the dataset will be used in the presentation of this model. Because the proposed method may be expressed in as a hybrid algorithm, this solution has been given the dee hybrid algorithm. A pre-processed and normalised data matrix, as well as a classification that was generated by the network, are the three inputs that go into the hybrid algorithm. The output is the result of using the hybrid algorithm. The following is a description of the architecture that forms the basis for the hybrid algorithm: To put it another way, there are a total of 128 "hidden" components in the network, and they are distributed across three separate layers.

$$h_i^j, i = 1..128, j = 1..3$$

It is only after a significant amount of trial and error that one can determine the number of hidden layers as well as the number of neurons that are present in each layer. After the hidden layers have been added, the subsequent layer to be added is a Softmax regression layer, which has 5-dimensional outputs. This layer will be added after the hidden layers have been inserted. After the addition of the hidden layers, this layer is brought into the image. The estimation of the likelihood of each class being represented in the output is the job of the Softmax function.

$$\sigma(z) = \frac{e^{z_j}}{\sum_{k=1}^{K} e^{z_k}}$$

layer for output. In this setting, the equation known as Equation.1 represents the Softmax equation.

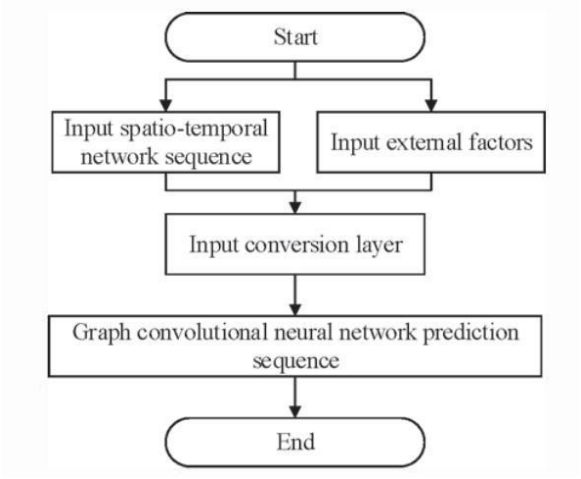

Figure 2. Traffic flow prediction model framework

We have developed a wide variety of machine algorithms and put them through extensive testing in an effort to enhance both the speed and the precision of our work. In order for our team to decide classification and regression, we made use of the K means Clustering , Support vector machine , Hybrid deep learning. If you want to be successful with this strategy, you need to have the ability to make correct predictions regarding the aspects that will be the focus of your inquiry. What we mean when we talk about "decision tree learning" is the process of taking an input vector of attribute values and producing an output "decision" that is the same as a single output "decision." supervised learning can be accomplished with the help of an algorithm. Utilizing it is a viable option for overcoming challenges associated with regression and categorization. DT results can be obtained by conducting a number of tests on the datasets that were utilised in the training of the model. [10]. Support vector machines, often known as SVMs, are a group of supervised learning methods that may also be used for classification and regression. When it comes to locating outliers, we have resorted to using support vector machines (SVMs), which are an assortment of supervised learning methods. If you want outcomes that can be relied on, it is essential to be certain that all of the steps that are required have been completed. The support vector machine, often known as SVM, is helpful for high-dimensional spaces, and it also provides assistance in situations in which the number of samples is lower than the number of dimensions. An great illustration of a machine learning method is the random forest algorithm. This method is typically referred to as bootstrap aggregation when it is

discussed. The approach of random forest is the one that is utilised for data classification the majority of the time. The following is an illustration of this: The following is an illustration of a scenario in which this might be pertinent: Quite a few different kinds of forecasting models are utilised here. The deep learning approach enables the creation of several models from a single set of training data by randomly sampling from that set. The deep learning methodology is to blame for this. The deep learning method was used, and that aspect of the estimation of statistical values was likewise finished successfully. [12]. This is an idea that was generated by our group.

We were able to get the performance of the models shown in Table 1 by making use of the many different machine and deep learning techniques that have been covered throughout this research. The many different approaches to machine learning that were covered in this paper were utilised in order to achieve these findings. With the assistance of this useful table, the terms "Accuracy," "Precision," "Recall," and "Time Taken" were quickly and readily defined.

Table 1: Evaluation matrix for different deep learning algorithm

Algorithm	Accuracy	Precision	Recall	Time
K means Clustering	85%	85.34%	87.34 %	99.4 Sec
Support vector machine	86%	86.66%	86.32 %	93.1sec
Hybrid deep learning	97%	89.45%	81.34 %	90.sec

IV. Conclusion

As a result, we were able to create short-term predictions for the whole transportation network based on our estimates of traffic flows in all connections where traffic data was unavailable. There's a link to the study here. A large section of the local network was used to demonstrate the methodology's effectiveness and precision. A high degree of precision is maintained throughout the process as the prediction system adapts to the new circumstances. Unfortunately, there isn't enough data from real-world traffic circumstances to do additional experiments for this topic. This is a limitation imposed by the paper. An important aspect of future work is the collection of more real-time information. Vehicle-to-infrastructure connections and the development of new traffic sensor technologies will be part of this effort. In addition to testing our technique under various traffic circumstances and network setups, this data could help us improve its precision. Despite the fact that deep learning are essential concerns in the field of data analysis, the machine learning community has not paid much attention to them. As compared to the current methods, the one proposed here is more accurate while also helping to address the dataset's complexity issues. In addition, the web server will be part of the process of integrating the application. In addition, the algorithms for the thing will be improved further in order to improve their accuracy even further.

References

[1]. Meena, G., Sharma, D., & Mahrishi, M. (2020). Traffic Prediction for Intelligent Transportation System using Machine Learning. 2020 3rd International Conference on Emerging Technologies in Computer Engineering: Machine Learning and Internet of Things (ICETCE). doi:10.1109/icetce48199.2020.9091

[2]. L. Xu, W. Kun, L. Pengfei and X. Miaoyu, "Deep Learning Short-Term Traffic Flow Prediction Based on Lane Changing Behavior Recognition," 2020 2nd International Conference on Information Technology and Computer Application (ITCA), 2020, pp. 760-763, doi: 10.1109/ITCA52113.2020.00163.

[3]. J. Yu, Y. Yan, X. Chen and T. Luo, "Short-Term Road Traffic Flow Prediction Based on Multi-Dimensional Data," 2021 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS), 2021, pp. 43-46, doi: 10.1109/ICITBS53129.2021.00019.

[4]. S. S. Sepasgozar and S. Pierre, "Network Traffic Prediction Model Considering Road Traffic Parameters Using Artificial Intelligence Methods in VANET," in IEEE Access, vol. 10, pp. 8227-8242, 2022, doi: 10.1109/ACCESS.2022.3144112.

[5]. G. Meena, D. Sharma and M. Mahrishi, "Traffic Prediction for Intelligent Transportation System using Machine Learning," 2020 3rd International Conference on Emerging Technologies in Computer Engineering: Machine Learning and Internet of Things (ICETCE), 2020,

pp. 145-148, doi: 10.1109/ICETCE48199.2020.9091758.

[6]. T. Jia and P. Yan, "Predicting Citywide Road Traffic Flow Using Deep Spatiotemporal Neural Networks," in IEEE Transactions on Intelligent Transportation Systems, vol. 22, no. 5, pp. 3101-3111, May 2021, doi: 10.1109/TITS.2020.2979634.

[7]. C. Chen, Z. Liu, S. Wan, J. Luan and Q. Pei, "Traffic Flow Prediction Based on Deep Learning in Internet of Vehicles," in IEEE Transactions on Intelligent Transportation Systems, vol. 22, no. 6, pp. 3776-3789, June 2021, doi: 10.1109/TITS.2020.3025856.

[8]. W. Huang, G. Song, H. Hong and K. Xie, "Deep Architecture for Traffic Flow Prediction: Deep Belief Networks With Multitask Learning," in IEEE Transactions on Intelligent Transportation Systems, vol. 15, no. 5, pp. 2191-2201, Oct. 2014, doi: 10.1109/TITS.2014.2311123.

[9]. S. A. Ali Shah, K. Illanko and X. Fernando, "Deep Learning Based Traffic Flow Prediction for Autonomous Vehicular Mobile Networks," 2021 IEEE 94th Vehicular Technology Conference (VTC2021-Fall), 2021, pp. 01-05, doi: 10.1109/VTC2021-Fall52928.2021.9625196.

[10]. Y. Tian, C. Wei and D. Xu, "Traffic Flow Prediction Based on Stack AutoEncoder and Long Short-Term Memory Network," 2020 IEEE 3rd International Conference on Automation, Electronics and Electrical Engineering (AUTEEE), 2020, pp. 385-388, doi: 10.1109/AUTEEE50969.2020.9315723.

[11]. A. Thaduri, V. Polepally and S. Vodithala, "Traffic Accident Prediction based on CNN Model," 2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS), 2021, pp. 1590-1594, doi: 10.1109/ICICCS51141.2021.9432224.

[12]. Hu, Y. (2021). Research on City Traffic Flow Forecast Based on Graph Convolutional Neural Network. 2021 IEEE 2nd International Conference on Big Data, Artificial Intelligence and Internet of Things Engineering (ICBAIE). doi:10.1109/icbaie52039.2021.9389951

[13]. Poonia, Pregya; Jain, V. K. (2020). [IEEE 2020 International Conference on Emerging Trends in Communication, Control and Computing (ICONC3) - Lakshmangarh, Sikar, India (2020.2.21-2020.2.22)] 2020 International Conference on Emerging Trends in Communication, Control and Computing (ICONC3) - Short-Term Traffic Flow Prediction: Using LSTM. , (), 1–4. doi:10.1109/ICONC345789.2020.9117329

[14]. Jiber, Mouna; Lamouik, Imad; Ali, Yahyaouy; Sabri, My Abdelouahed (2018). [IEEE 2018 International Conference on Intelligent Systems and Computer Vision (ISCV) - Fez, Morocco (2018.4.2-2018.4.4)] 2018 International Conference on Intelligent Systems and Computer Vision (ISCV) - Traffic flow prediction using neural network. , (), 1–4. doi:10.1109/ISACV.2018.8354066.

[15]. Y. Chen, L. Shu and L. Wang, "Poster abstract: Traffic flow prediction with big data: A deep learning based time series model," 2017 IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), 2017, pp. 1010-1011, doi: 10.1109/INFCOMW.2017.8116535.

[16]. D. Zhang and M. R. Kabuka, "Combining Weather Condition Data to Predict Traffic Flow: A GRU Based Deep Learning Approach," 2017 IEEE 15th Intl Conf on Dependable, Autonomic and Secure Computing, 15th Intl Conf on Pervasive Intelligence and Computing, 3rd Intl Conf on Big Data Intelligence and Computing and Cyber Science and Technology Congress(DASC/PiCom/DataCom/CyberSciTech), 2017, pp. 1216-1219, doi: 10.1109/DASC-PICom-DataCom-CyberSciTec.2017.194.

[17]. H. Tampubolon and P. -A. Hsiung, "Supervised Deep Learning Based for Traffic Flow Prediction," 2018 International Conference on Smart Green Technology in Electrical and Information Systems (ICSGTEIS), 2018, pp. 95-100, doi: 10.1109/ICSGTEIS.2018.8709102.

[18]. Y. Zhang and D. Xin, "A Diverse Ensemble Deep Learning Method for Short-Term Traffic Flow Prediction Based on Spatiotemporal Correlations," in IEEE Transactions on Intelligent Transportation Systems, doi: 10.1109/TITS.2021.3131248.

[19]. L. Yu, J. Zhao, Y. Gao and W. Lin, "Short-Term Traffic Flow Prediction Based On Deep Learning Network," 2019 International Conference on Robots & Intelligent System (ICRIS), 2019, pp. 466-469, doi: 10.1109/ICRIS.2019.00122. [20].C. Zheng, X. Fan, C. Wen, L. Chen, C. Wang and J. Li, "DeepSTD: Mining Spatio-Temporal Disturbances of Multiple Context Factors for Citywide Traffic Flow Prediction," in IEEE Transactions on Intelligent Transportation Systems, vol. 21, no. 9, pp. 3744-3755, Sept. 2020, doi: 10.1109/TITS.2019.2932785.

[21]. H. Zheng, F. Lin, X. Feng and Y. Chen, "A Hybrid Deep Learning Model With Attention-Based Conv-LSTM Networks for Short-Term Traffic Flow Prediction," in IEEE Transactions on Intelligent Transportation Systems, vol. 22, no. 11, pp. 6910-6920, Nov. 2021, doi:10.1109/TITS.2020.2997352.