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Traffic Prediction for Intelligent Transportation Systems using Machine Learning

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ABSTRACT

Over the past few decades, ITS have spiked an increasing research interest as a promising discipline for revolutionizing the transportation sector and solving common traffic and vehicle-related problems. ITS comprise a multitude of interconnected engineering feats that function as an entity for optimizing network-scale travel experiences from a technical, social, economic, and environmental aspect. Such optimizations necessitate the advancement of information and communication technologies, electronic sensors, control systems, and computers, which high-lights the data-driven nature of modern ITS.

In this paper we design a system which uses machine learning algorithm using SVM, KNN and CNN algorithm which is a novel system which will provide intelligence to the current traffic control system present at a four-way junction. This ML technique is mainly aimed to replace the existing traffic light control system with artificial intelligence system. Nowadays most cities are equipped with CCTV cameras on the roads and the junctions, the basic idea is to collect the live video from the CCTV cameras and detect the number of vehicles on each lane and feed the data into another machine learning algorithm. according to the data of each lane changes into the light phase of the green signal. This system mainly aims to increase the traffic efficiency by increasing vehicle flow which will reduce waiting time for the vehicles. We are using HOG algorithm for feature extraction. In the implementation of the proposed architecture, we have achieved an accuracy of 86.34% for binary classification and 90.23% for multi-class classification

KEYWORDS: *Machine Learning, ITS, HOG, SVM, classification, accuracy, binary, multi-class*

1. INTRODUCTION

Intelligent transportation system is used for analyzing the information. ITS is used to control communication technologies for road transportation to improve safety and efficiency. Intelligent transportation system includes a wide range of applications which is used to get information, to control congestion, to improve traffic management, to reduce the environmental effects and increase the benefits of transportation. ITS refers to the different types of needs and the transport field with many others policing. But also due to less connection of traffic flow. Smartphones having different sensors which can be used to detect/track the traffic speed and density.

There are some of the issues inferred from the current implemented system:

- The system relies on the data collection sensors deployed at certain major road locations, which makes it easy to ascertain the traffic average road traffic speeds but at present cannot make a meaningful elaborative system so to make the sense of the nearby links.

- At the current state the system cannot make any prediction from the current data and just displays the instantly averaged speed and generates the control signals specifying the delays for the e-signs on the roads. So, there is a need of latest AI based deep machine learning techniques employment to make the effective forecasting by analysing the behaviours of the closely related traffic flow links data. In this paper we proposed a system which uses machine learning algorithm using SVM, KNN and CNN algorithm which is a novel system which will provide intelligence to the current traffic control system present at a four-way junction.

However, large-scale network traffic prediction requires more challenging abilities for prediction models, such as the ability to deal with higher computational complexity incurred by the network topology, the ability to form a more intelligent and efficient prediction to solve the spatial correlation of traffic in roads expanding on a two-dimensional plane, and the ability to forecast longer-term futures to reflect congestion propagation. Unfortunately, traditional traffic prediction models, which usually treat traffic speeds as sequential data, do not provide those abilities because of limitations, such as hypotheses and assumptions, ineptness to deal with outliers, noisy or missing data, and inability to cope with the curse of dimensionality. Thus, existing models may fail to predict large-scale network traffic evolution

Predicting the future is one of the most attractive topics for human beings, and the same is true for transportation management. Understanding traffic evolution for the entire road network rather than on a single road is of great interest and importance to help people with complete traffic information in make better route choices and to support traffic managers in managing a road network and allocate resources systematically.

To fill the gap, this paper introduces an image-based method that represents traffic as images, and employs the machine learning and HOG to extract spatiotemporal traffic features contained by the images.

2. Related Work

Gaurav Meena, Deepanjali Sharma et.al. [1] In this paper, the author proposed that the development and deployment of Intelligent Transportation System (ITSs) provide better accuracy for Traffic flow prediction. It is deal with as a crucial element for the success of advanced traffic management systems, advanced public transportation systems, and traveler information systems. The dependency of traffic flow is dependent on real-time traffic and historical data collected from various sensor sources, including inductive loops, radars, cameras, mobile Global Positioning System, crowd sourcing, social media. Traffic data is exploding due to the vast use of traditional sensors and new technologies, and we have entered the era of a large volume of data transportation and make meaningful inferences from the data. Alfonso, Oscar et.al. [3] The purpose of traffic forecasting is to predict future traffic conditions on a transportation network based on historical observations. This data can be helpful in ITS applications such as traffic congestion control and traffic light control. Traffic prediction can be divided into two types of techniques: parametric, including stochastic and temporal methods, and non-parametric, such as machine-learning (ML) models [10], recently used to solve complex traffic problems. The experimental results show that the M5P regression tree outperforms the other regression models. The authors in [13] reported some multi-model ML methods for traffic flow estimation from floating car data. In particular, they evaluated the capacity of Gaussian Process Regressor (GPR) to address this issue. The simulations showed a decrease in forecast error in comparison to the results of the mean and Autoregressive Integrated Moving Average (ARIMA) models that used traffic data from previous periods. Back-Propagation Neural Network (BPNN) is one of the most typical architectures of Neural Networks and is widely used in many prediction and classification tasks. Xie, Huang et al. [14] In this paper, the author provided a comprehensive survey of ML techniques applied to SDN. Different types of ML/DL algorithms and their applications in the SDN environment are presented. Nevertheless, they did not review the traffic prediction application. Additionally, the paper lacks several recent approaches as well as a dataset in the literature review. He briefly reviewed the application of AI with SDN. Then, they presented an extensive overview of AI techniques that have been used in the context of SDN.

3. Block Diagram

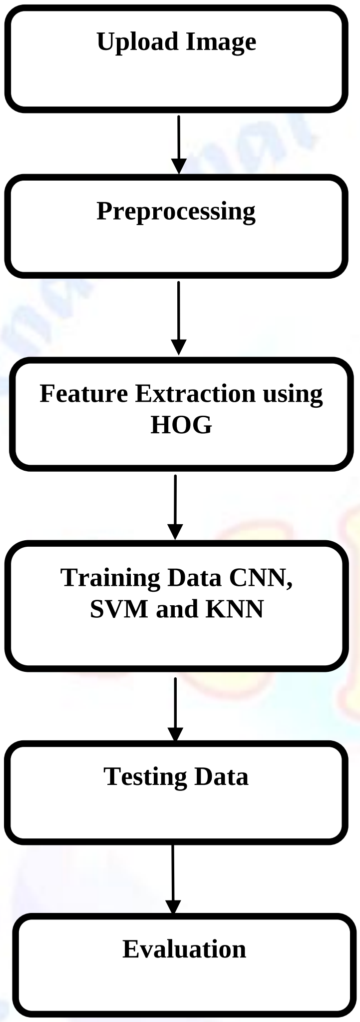

Fig. 1. Architecture of the model

4. Implementation

1. Dataset: -

We generated our own dataset (IITM-HeTra) from cameras monitoring road traffic in Chennai, India. To ensure that data are temporally uncorrelated, we sample a frame every two seconds from multiple video streams. We extracted 2400 frames in total.

We manually labeled 2400 frames under different vehicle categories. The number of available frames reduced to 1417 after careful scrutiny and elimination of unclear images. We initially defined eight different vehicle classes commonly seen in Indian traffic. Few of these classes were similar while two classes had a smaller number of labeled instances; these were merged into similar looking classes. For example, in our dataset, we had different categories for small car, SUV, and sedan which were merged under the light motor vehicle (LMV) category.

2. Preprocessing: -

Images are everywhere in our life. We have many goals from image processing, but the important goal is recognition. Where some images have information are inaccurate these need to improve image data so that human can understand it better, e.g., in vehicle images, we need to adjust and improve the images so the system can take the optimal treatment decision. Others need some pre-processing so that the machine can understand the image and make an appropriate decision without the intervention of the human element, e.g., classification of images to detect vehicle.

3. Feature Extraction: -

HOG is a feature descriptor initially proposed for vehicle detection. It counts the number of occurrences of gradient orientation in a detection window. The main steps to compute HOG features can be summarized as follows.

i. Gradient computation: In this step, the spatial gradients in horizontal and vertical directions are computed. These two gradients are then used to compute the gradient magnitudes and angles.

ii. Orientation binning: In this step, the image is divided into small connected regions called cells. The gradient magnitude of each pixel in a cell is voted into different orientation bins according to the gradient angle.

iii. Feature description: In this step, adjacent cells are grouped into blocks. Each block is normalized by its L2-norm. The normalized block histograms in a detection window are concatenated to form a descriptor.

4. Training and Testing Process: -

The most critical factor affecting the success of machine learning is the training and testing process. An effective training process improves the quality of the developed system. Researchers divide datasets into two parts for training and testing. However, the separation process is done according to specific rules. These are described in detail in section "Sampling Methods." The amount of training and test is the most critical factor in the success rate. If there is a high correlation between the features and the label, the Training-Test set is divided by 70%–30%. This means that 50% of all the data will be used for training and 30% for the test. However, if there is a fear of success falling, the rate of training can be increased. The training-testing ratio used in the literature varies according to the data structure. Less than 50% of the training data is not preferred because the test results will be negatively affected.

After the machine learning model is trained according to the training data, it is also tested using the training data. The purpose of this is to determine how much data is learned. Performance evaluation procedures are performed according to specific criteria. These criteria vary according to the structure of the data. Section "Performance Evaluation Criteria" presents the performance evaluation criteria in detail.

Once the training process is completed, the machine learning model tested with test data has never been seen before. The researcher evaluates the test performance according to the performance evaluation criteria (section "Performance Evaluation Criteria"). The research can be repeated by changing the training and test data in the training and testing process to avoid the situation of unstable data. In this case, the researcher uses the average of performance values.

5.Performance Evaluation Criteria: -

Performance evaluation criteria vary according to the data structure and method. If data labels have categorical variables (such as Heavy Traffic/Medium Traffic and Less/No Traffic).

Accuracy is defined as the ratio of efficiently classified samples to overall samples. Accuracy is a suitable metric whilst the dataset is balanced. In actual network environments; however, everyday samples are far extra considerable than are unusual samples; hence, accuracy may not be an appropriate metric.

$$Accuracy = \frac{TP + TN}{TP + FP + FN + TN}$$

5. RESULTS

To detect the number of vehicles and classification. For that we are using SVM, HOG and CNN algorithm as the basis of the design. Framework for the machine learning is must before starting to design the algorithm. We used Tensor Flow framework and Keras framework to create a machine learning which will detect number of vehicles and classification. A proposed algorithm is used which is one type of machine learning. The datasets will be fed into the designed algorithm so to train the model in order to get highly accurate results. After the implementation of proposed methodology of our system, we were able to achieve an accuracy of 90.23% with Support Vector Machine (SVM), K-Nearest Neighbors (KNN), Histogram of Oriented Gradients (HOG) and Convolutional Neural Network (CNN) respectively.

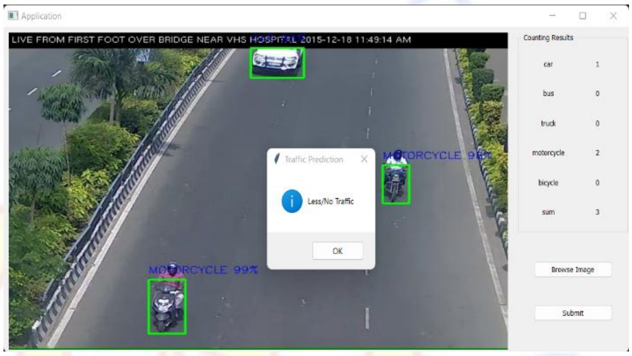

Fig. 2. Traffic Prediction of Less/No Traffic

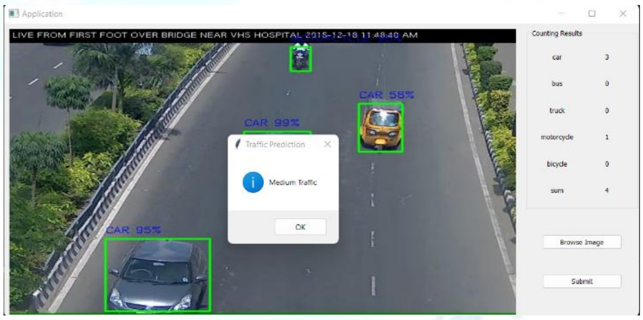

Fig. 3. Traffic Prediction of Medium Traffic

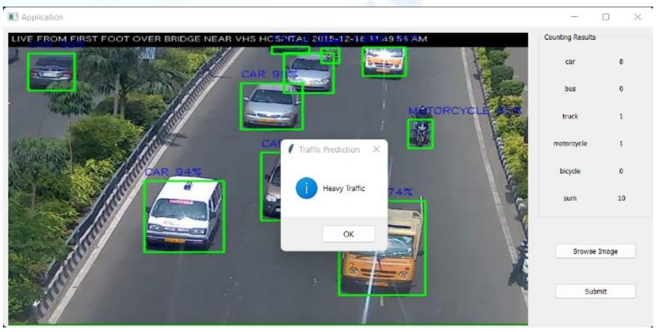

Fig. 4. Traffic Prediction of Heavy Traffic

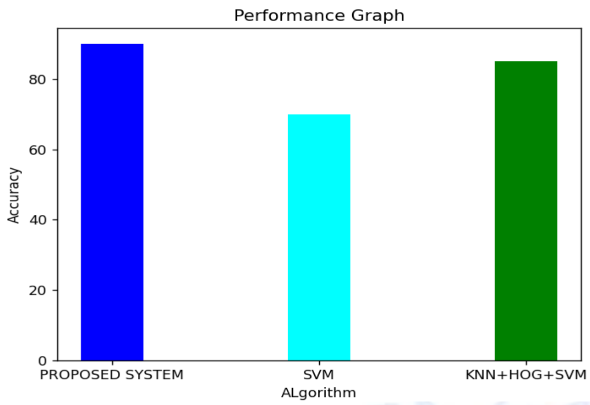

Fig. 5. Performance Graph

Algorithm	Dataset	Accuracy (%)
SVM	IITM-HeTra	70.78
SVM+HOG+KNN	IITM-HeTra	86.34
Proposed System (SVM+KNN+HOG+CNN)	IITM-HeTra	90.23

Table 1. Accuracy Table for existing and proposed algorithm

6. Conclusion

We presented traffic monitoring systems that focus on the key functionality of vehicle detection, classification. By categorizing vehicle classification systems according to algorithms. We discussed various research questions, methodologies, hardware design, and limitations. We also discussed a number of research challenges and future research directions. We anticipated that the rich content of virtually every vehicle classification system developed over the past decade will be useful resources for universities, industry and government agencies in selecting appropriate vehicle classification solutions for their applications. traffic control.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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