Research Article

Smart Traffic Prediction and Congestion Reduction in Smart Cities

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Abstract-
Rising incidents of traffic congestion among the increasing usage of vehicles have a high concern in an urban area. Smart Traffic prediction helps in reducing the traffic level in urban areas. Through Wi-Fi, Bluetooth, Zig Bee technologies, signals from the smart devices used in vehicles are received. Received signal stored as digital data and used for analyze the traffic pattern by vehicle count. From the input received signal, the traffic patterns are identified from the prediction process using a machine learning algorithm. People can easily view the result of the traffic level in pictorial or graphical form. It is the technology to support the monitoring and controlling system in the road traffic using sensors and cloud-based prediction algorithms. In this proposal, to minimize the traffic congestion in certain areas by diverting or redirecting the upcoming vehicles into the shortest path or alternate path based on prediction methods. Accuracy level of prediction methods are compared for better result. Traffic prediction and rerouting reduces the level of traffic flow and air pollution (gasoline emission) and give us traffic-free urban roadways.

Keywords- IoT, Sensor, Traffic flow prediction, Congestion reduction, Traffic congestion, Traffic level, Traffic pattern deduction.

I. INTRODUCTION

The main aim is to minimize traffic congestion in the smart city by implementing the Internet of Things. Internet of thing (IoT) convert a simple thing into a smart thing by using the internet. Sensors are placed on the roadside to receive input from the user vehicle. Collecting inputs through Bluetooth, Wi-Fi, ZigBee from the traveler mobile phones and smart devices. Input data are collected together and store in the cloud platform. Cloud reduces the maintenance cost of the physical data center and it is an open-source platform. Those data can access whenever wherever it is needed and also it has high-security performance in maintaining a database. Using various machine-learning algorithms like AdaBoost, random forest, logistic regression, the traffic pattern is extracted and analyzed through a machine learning algorithm on the jupyter platform using a python programming language. Random forest algorithm gives an accuracy of 81%, AdaBoost algorithm gives an accuracy of 89%, logistic regression gives an accuracy of 91%. The predicted output result will be displayed as a percentage level of traffic as high as 1, medium as 0.5, low as 0 according to the traffic pattern. If more traffic is detected then it diverts the upcoming vehicles into the alternate or shortest path to reach their destination. It helps the traveler to know the exact result of traffic level before starting their journey, they can easily know the information. Traffic congestion in a metro city is occurring everywhere to reduce traffic the smart traffic congestion reduction plays an important role. In smart traffic the internet of thing act as a major source. It removes all barriers and makes the road traffic free flow. However urban areas people are suffering from traffic daily, so here smart traffic plays an important role to minimize the traffic. This makes a crowd-free road or traffic-free road in a metro city. It helps many people to reach their destination on time without any hesitation.

II. RELATED WORK

Metro city has a large population increase in the number of automobiles on the road which results in heavy traffic. Various technologies are used to improve the traffic management system. It identifies the problem area and rectifies the avoidance of congestion[1]. Traffic level predicts under advanced traveler information system and advanced traffic management system by using naive Baye's classifier it provides the best path, timing decision[2]. V2X (vehicle to everything) is a combination of V2V (vehicle to vehicle) and V2I (vehicle to infrastructure) focused on sending messages and also able to know the density of vehicles[3]. The RFID tags are installed in each vehicle to detect the vehicle count. The receiver will receive the signal and calculate the vehicle count[4]. Proposed an algorithm for better traffic and also handles the emergency by using message protocol from SDN[5]. Cognitive IoT runs under a kind of self-learning algorithm. This technology predicts traffic for autonomous vehicles[6]. Using geographic pattern the volume of traffic congestion are easily identified and prevent the upcoming traffic crashes[7]. V2V aims in minimizing the average traveling time by using DisTrac which is a protocol for autonomous vehicle ad-hoc networks [8]. Communication between traffic authority and driver enable better urban transportation and also reduce the transportation risk from cybersecurity[9]. Reduce the traffic in peak hours in an urban area is to minimize the issue of company employees work from home/anywhere[10]. The daily traffic pattern is stored process consuming a large amount of data[11]. Using feature extraction the traffic pattern is fetched and grouped to form a pattern to reduce highway congestion[12]. Using sensors traffic data are collected, analyzed using a reduction strategy which is based on an intelligent transportation system to prevent traffic accidents[13].

Grouping a similar traffic pattern & analyzing the congestion in a smart city by using neural networks[14]. Traffic reduced using context-based prediction by using some trajectory patterns performing under RCNN[15]. Parallel vehicles are distributed to reduce traffic[16]. To reduce the travel time use deep CNN will telecast the traffic congestion level[17]. The densely populated area where more pedestrians can see also more traffic will produce and also climate condition will be displayed[18]. For short-term traffic flow, the dimensionality reduction method is applied for better traffic[19]. Urban area traffic status is analyzed using a quantitative method to reduce the traffic flow[20]. Occupying the space or sharing the space in the road reduces the traffic[21]. Traffic congestion is reduced by a one-dimensional model[22]. Transition characteristic is analyzed as the traffic processed pattern in an urban area to reduce the congestion[23]. Traffic flow in a smart city is enabled by a cooperative bargain that automatically separates the lane[24]. Smart transportation involves smart vehicles performing better traffic-free lanes[25]. The global maximum level is reached when analyzing the traffic pattern that is reduced from simulated annealing[26]. V2V communication identifies and enables the traffic pattern which gives traffic-free roadway[27]. Analyzing the traffic level using prediction based management in smart city traffic[28].

III. IOT BASED SMART TRAFFIC

Figure 1 source from smart traffic management in smart cities and from which shows the Unique insights on the role of the internet of things for smart cities.

The internet of things (IoT) used to convert a simple thing into a smart thing by using the sensors and connected it with internet. In smart traffic system IoT plays an important role by collecting information from the sensors placed near the roadside for travelers' signals from their electronic gadgets such as mobile phones, tablets, laptops, smartwatch, etc. BlueTooth, WiFi, ZigBee enabled smart devices information captured from their sensor and stored in a cloud database. Prediction algorithms are used to identify the traffic pattern expected to arrive in specific identified areas. Based on the results, further traffic will be redirected to some other alternative roots without making looping or additional traffic in that area. The logistic regression machine learning algorithm is performed through Jupyter Notebook (anaconda 3) by using the python programming language. The results will be displayed whether the traffic level is high/medium/low (1, 0.5, 0).

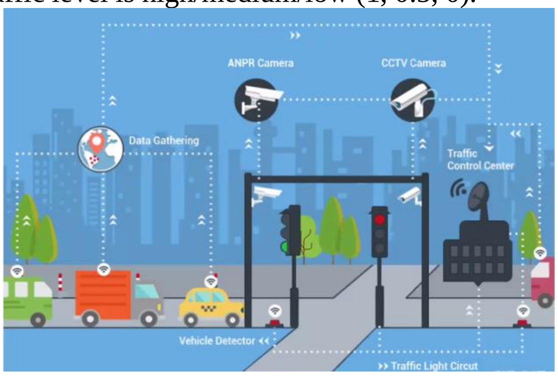

Fig. 1. Smart Traffic System

IV. SYSTEM DESIGN AND IMPLEMENTATION

In a large city, traffic is the main problem which is faced by many people. To address this, a prediction system with support of logistic regression machine learning algorithm used here and also used to analyze the traffic flow.

Figure 2 show the architecture of the smart traffic system along with supporting technologies. Data collected through the smart devices are stored in cloud and processed. The prediction results are considered for identifying forthcoming traffic pattern and forecasting system makes alternate paths for the same to avoid traffic over flow.

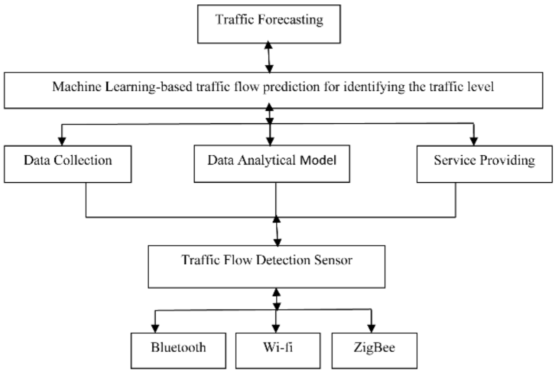

Fig. 2. The architecture of smart traffic flow

Placing sensors near the roadside to monitor the traffic congestion level using IoT platform. Detect how many vehicles are passing through the lane by recording time-wise, after getting inputs such as vehicle and their timing. Input data are fetched from the cloud database. Using machine learning algorithms such as logistic regression, random forest, Adaboost by performing the algorithmic calculation, and getting the final output result and the result from jupyter Notebook under python programming.

TABLE 1. THE ACCURACY LEVEL OF EACH ALGORITHM

Algorithm	**Random Forest**	**AdaBoos t**	**Logistic Regression**
Accuracy	81%	89%	91%

The smart traffic congestion reduction has worked with various algorithms like the random forest, Adaboost, but the logistic regression algorithm gives best result.

The Table 1 shows result of the random forest is 81% accuracy. Random forest is based on the bagging concept. It consists of multiple decision trees. In a random forest, each prediction model takes some random rows and random columns for prediction at each iteration. And then perform a decision tree in it. The decision tree tries to find the best predictor variable to split the similar target variable together with the help of hyperparameter tuning, also find the best combination of variables. The final accuracy of the predictive model is the average of all the decision trees.

The result of the Adaboost is 89% accuracy. AdaBoost is an adaptive model based on the boosting concept. It is also known as a weak learner algorithm. It tries to overcome the mistakes made in the previous model. It uses a decision stump to classify the values to reduce the entropy in the model. It is useful in the classification model. It will run until 100% accuracy is attained or max iteration is reached. Their final accuracy is the weighted average of all models. Because it assigns weight to the rows, where the prediction is wrong. In the next model, high importance is given to the wrong ones.

The highest accuracy is logistic regression 91%. The logistic function is also called a sigmoid function, works under the supervised learning technique. It is used to predict the dependent variable from the set of the independent variable. The main purpose is to solve the classification problem. It is a kind of classification algorithm to assign a discrete set of classes based on the probability concept, it predicts the analysis of future outcomes. Logistic regression is similar to linear regression. The limit of the cost function lies between 0 to 1. This algorithm is estimated using the training data and it is done by using maximum likelihood estimation. According to the probability result of the sigmoid curve will be drawn between 0 to 1. The threshold values are noted from the center of the sigmoid curve.

If the target variable has two Outcomes then it is binomial logistic regression. If it is more than that is multinomial least regression. Logistic regression works on basis of the Maximum Likelihood estimation technique, a method to find the co-efficient for the model. In the case of the binary classification model, the P(1) should be 1 or near to 1, and P(0) should be 0 or near to 0. Accuracy is found by f1 score, recall, precision. The goodness of fit can be found using the Akaike information criterion. It is used to compare the two models to find the best model. The model with low AIC has to choose. Logistic regression works on the sigmoid curve high as 1, medium as 0.5, and low as 0. The traffic level is also denoted as high/low/medium.

Logistic regression can be classified as three Types:

Binomial- It has two variables are 0 as low and 1 as high, represent the level of traffic.

Multinomial- It has three Possible type variables which are low-0, medium-0.5, High-1.

Ordinal- This variable is arranged in order wise like Very low, low, medium, high, very high.

The output will be displayed as a sigmoid curve which has a value of 0, 0.5, 1 (low/medium/high). Input data are detected by sensors. Those data are stored in a cloud platform. Placing sensors near the roadside or in a street, post to receive the signals such as Bluetooth, Wi-Fi, ZigBee. Jupyter Notebook is a computational notebook because it is a web tool that allows customized real-time views for various purposes. While working in a jupyter Notebook needs to select a few to upload and navigate. An interesting thing in smart traffic is the result will be displayed as a sigmoid curve value from logistic regression. People can check traffic levels before starting their journey.

Cloud database are paid per use, Cloud platform provides a virtual database to the user, it handles a large amount of dataset without an overloading problem. So smart traffic input data are stored in a cloud database. Those smart traffic attributes are running in a Jupyter Notebook (anaconda 3) in a python programming language. Traffic congestion reduction datasets are up to 870492 has 32 attributes. These datasets are running under machine learning Logistic Regression algorithms. The bar graph has shown output for all attributes.

V. Results and Discussion

Data set available in the data store are applied to the algorithm and the results are shown with different parameters.

By using several attributes from traffic data sets are performed through machine learning algorithms. The bar graph representation has shown the level of traffic from the region, year, direction, types of vehicles like a two-wheeler, bicycle, car, cabs.

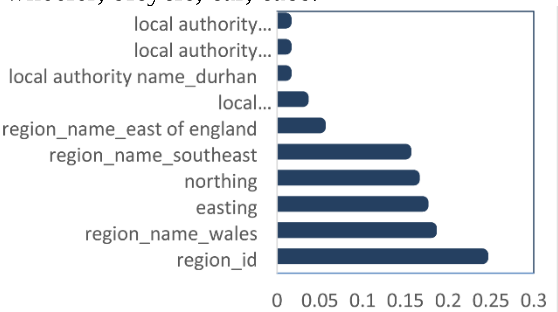

Fig 3. Traffic from east to north direction represented in graphical format.

As shown in the figure 3, the traffic level starts from 0.02 to 0.23.

0.2 is the lowest level of traffic

0.15 is the moderate level of traffic,

0.25 is the highest level of traffic.

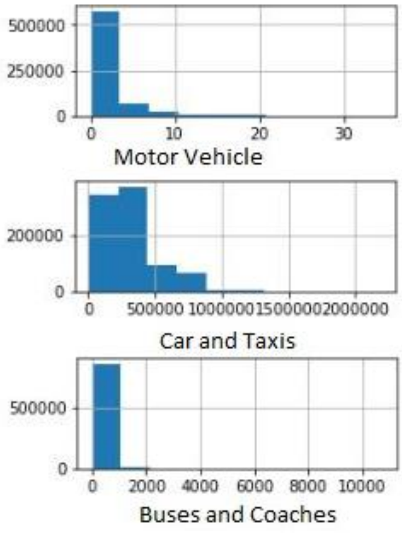

Fig. 4. Graphical representation of vehicles

The graphical representation shows all motor vehicles such as cars, coaches, cycles, motorcycles, etc. The result has displayed the accurate rate of each vehicle is occurring at the traffic congestion level. The figure 4 shows the sample vehicles pattern obtained as result.

The next colored graphical representation used in figure 5, shows four different cluster.

HIGH (represented in blue colour) - Traffic congestion is detected and represented as a very high level of traffic is found. MEDIUM (represented in yellow colour) - Medium level of traffic flow is detected. LOW (represented in green colour) - Low level of traffic flow is identified. VERY LOW (represented in purple colour) - Traffic flow is detected as very low.

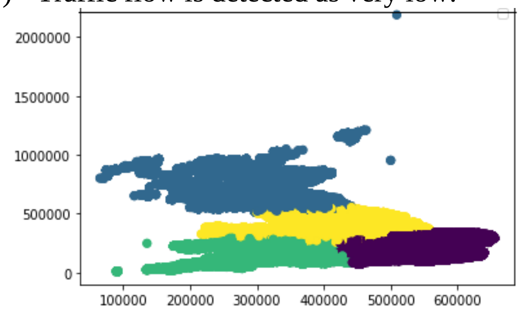

Fig. 5. Traffic level prediction result

VI. CONCLUSION

The smart traffic congestion reduction helps urban people to reach their destination without any hurdles due to traffic the chances of occurring accident level is high. By implementing smart traffic, reduce the journey time by calculating the number of vehicle counts and predict using representation values. To avoid more congestion level it redirects the upcoming vehicle into the shortest path or in an alternate path. Able to identify the traffic level. Improve the proficiency of traffic is still active and challenging research due to the poor infrastructure. Now a day traffic controllers require to provide solutions to improve the traffic flow. It minimizes the traveling time and tackles the related problems such as accidents, noise pollution, and carbon-di-oxide emission to be monitored and informed to the system and end-users. The reduction of traffic level analysis from vehicle count and predict the result to give the shortest path to reach the destination for improving the traffic flow level. It is an opportunity for the researchers to design a traffic controller for future enhancement.

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