Autonomous Traffic Management System (Garud)

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***Abstract*: An average Indian travels more than ninety minutes on any given day. Survey conducted by IIM Calcutta and Boston Consulting Group shows us that we lose over sixty thousand crore only in. Traffic costs us not just time but money as it poses economic threat. It's high time we develop a smart traffic management system. This paper describes a system which uses the state of deep learning and machine learning. Cameras in corners and squares will count all the vehicles on every side of the road through object recognition and this data is passed through deep learning and it will calibrate the duration of the traffic signals and predict the traffic on adjacent corners and squares which may have caused due to accident or road block.**

***Keywords*: Traffic management, time calibration, object recognition, machine learning, smart cities**

I. Introduction

In recent years number of vehicles have increased exponentially in India, which has affected traffic congestion by 149%. This value is greater than Asia's average. Traffic not only wastes time and money but is a huge economic threat to the world. Metro cities waste Rs 1.5 lakh crore due to traffic congestion each year. This is all caused due to old and inefficient traffic management techniques and technology. At a traffic signal vehicles on one side have to wait for the whole duration irrespective of the traffic on the other side. According to the report, Delhi has the highest share of 45% of people using their private cars for commuting while in Bengaluru their share is 38%. Mumbai tops the list when it comes to using public transport for commuting followed by Kolkata and its worst in Bengaluru. Thus we started working on Garud. Garud comes from the Hindu Mythology which is a symbol of speed and protector with power to swiftly watch over anything. Thus we decided to build an efficient alternative that could solve the existing problems using the power of computers. This "Traffic Management System" is supported to eliminate and in some cases reduce the hardship faced by existing system. Moreover this system is designed to carry out operations in a smooth and effective manner. We used Machine Learning, concepts of Artificial Intelligence and Object Recognition to facilitate error-free, secure, reliable and fast management system. The existing traffic system affects the entire population and the consequences can be exhausting economically or otherwise. Although traffic at large scale is only experienced in Metro cities, other semi-Metro cities have considerable amount of traffic. The peak hour is between 7 and 9 in the morning and 6 to 8 in the evening, which is due to large number of people commuting to their workplace or home respectively. The traffic is primarily caused by the sheer number of cars on the road but also the total duration of traffic lights. People not obeying traffic laws is a significant cause too.

II. Literature Survey

There have been many attempts to resolve the problem of traffic congestion using computer science and technology. In 1956, US funded $114 billion for its interstate highway system which completed in 1991. Several institution have proposed systems that enable users to be better informed and make safer, more coordinated, and smarter use of transport networks. Intelligent Transportation System and Advance Transportation System have been developed and introduced in some countries. Q learning method used by Sunil Ghane, Vikram Patil, Kumaresan Mudliar & Abhishek Naik [1] explored the use of reinforcement learning (based on reward and punishment system) also known as "Markov Decision Process". The formula for the process accounts for the various states, actions, rewards and the learning rate which represents the "discound factor" (degree of tendency to move to another state). Safeeullah Soomro, Mahdi H. Miraz , Anupama Prasanth and Mirza Abdullah [2] discussed the importance of an efficient and automatic transportation system in Smart Cities and proposed a suitable pseudocode for the congestion problem. Although the paper by Nathaniel Fairfeld & Chris Urmson [3] is not particularly related to Traffic management (it discusses detection of traffic light using cameras on onboard cars), the concepts of Automatic Labeling, Camera Configuration, Classification, Position Estimation can be helpful in our study of Object Recognition. Ritesh R.N., Vignesh R, Anala M.R. in their paper discussed an autonomous traffic signal control system using decision trees. The paper clearly explains concepts of Object recognition and Vehicle Counting.

III. Objectives

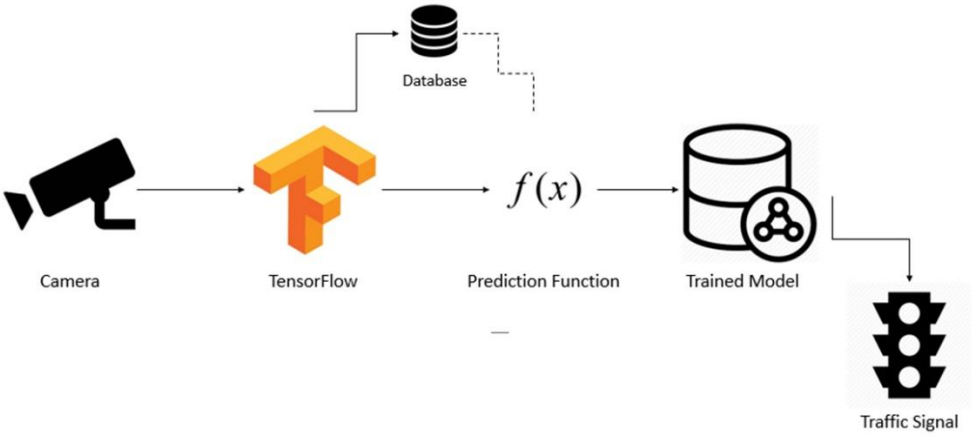
For an efficient system, its objectives should be clearly established:-

- The counting of number of cars need to be efficient to avoid inaccuracies in the long term.
- The data communication between various components such as sensors (such as camera), actuators (such as traffic signal), central processing system, database warehouse etc.
- Calibration of traffic signal based on previous and current data needs to be error-free.

- Prediction of the next square needs to be optimal.
- This system works on scenario concerning current situation of the traffic. It computes real time data based on feedback of the current data. Although the previous data is used to analyze trends and potential time duration, the current data is given much more priority. The data is collected within a time interval and is then recorded in the database for the intention of training the model and future data mining.
- The system should not react drastically as the total number of cars may fluctuate within a period of interval. A pre-decided threshold is stated on the basis of collected previous data. This threshold is then compared with current situation.
- This system needs to be safe and stable. Lives are at stake and thus stability of the software is extremely crucial. Stability is also concerned with the classification and differentiation of the multiple objects such as cars, trucks, cycles etc. The system can only detect cars but will convey if the concerned object is cause of traffic.

IV. System Design

Flow Chart of the System



Cameras are the essential tools used to collect data. Tensorflow Api is used to convert the raw image data to data which can be numerically analyzed. The camera essentially counts the real time data but also analyzes the traffic as to which path cars are moving to (to calculate the efficient number of cars of neighboring nodes). A prediction function (1) is then used to calculate effective number of cars which is then used to calculate the suitable time duration (2). In the last phase of the data flow, the system sends this data to the traffic signal.

Data Collection

Object Recognition

This refers to technology in the field of computer vision for finding and identifying objects in an image or video sequence. Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different viewpoints, in many different sizes and scales or even when they are translated or rotated. Objects can even be recognized when they are partially obstructed from view. This task is still a challenge for computer vision systems. Many approaches to the task have been implemented over multiple decades. Multiple Sensors (camera) are planted in such a way that the whole sight can be viewed by the computer. Computer vision then recognizes and even further differentiates different types of objects. Multiple images of cars are added in the database for the intention of training which include images of car with minimum sunlight to the same in sunny daylight. This different combination of images are used to train the system to detect the image of a car. This feature makes the system autonomous thus no human intervention is required.

Cameras are primarily used for the collection of data which are planted in the center of junction so that each pathway is clearly visible.

OpenCV (Open source computer vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel. it was later supported by Willow Garage then Itseez (which was later acquired by Intel). The library is cross-platform and free for use under the open-source BSD license. Using OpenCV the system will be able to capture image data which will be further analyzed by Tensorflow.

TensorFlow is an open-source software library for dataflow programming across a range of tasks. It is a symbolic math library, and is also used for machine learning applications such as neural networks. Tensorflow accurately describes the the length of queue (number of cars) which is used to calculate time for each path.

MySql is used for storing of the above mentioned data for further analysis which includes prediction for the next node & machine learning.

DATA ANALYSIS

Machine Learning

Prediction is a sub-topic of predictive analysis which encompasses a variety of statistical techniques from data mining, predictive modelling, and machine learning, that analyze current and historical facts to make predictions about future or otherwise unknown events The data captured by camera is stored in databases with 5 minute intervals (of each node). This data is analyzed using machine learning to predict the number of cars expected based on time & day (weekend or weekday). After using various methods such as linear regression, k-nearest algorithm and decision tree, we chose Random Forest methodology which gave accuracy upto 94%.

Effective Number of Cars

Using the real time data can create exceptional cases thus Effective number of cars is calculated based on real time data, data predicted by machine learning and the number of cars expected to come from neighbouring junctions. The time duration is then calculated using this calculation.
The prediction is done based on following formula:-

$$Nf = (R + M + N) / 3 \qquad (1)$$

Where Nf = Effective number of cars.
R = Number of cars at the moment (Real time).
M = Number of cars calculate using machine learning.
N = Number of cars expected from neighbouring nodes.

Time Calculation

Calibration in measurement technology and metrology is the comparison of measurement values delivered by a device under test with those of a standard of known accuracy. In our system, Calibration refers to the automatic computation of the duration of traffic signal based on number of objects (detected in previous step). Calibration uses number of parameters such as current scenarios which include number of cars on all the sides to previous recorded data to computer an approximate range.
As discussed earlier, Effective number of cars is used to calculate time duration (T) for each path. The time is in seconds unit. Following function is used to calculate (where brackets signify various cases) (2):-

$$T = 15 \qquad (Nf < 20)$$
$$T = 1.5 * Nf \qquad (20 < Nf < 120)$$
$$T = 180 \qquad (Nf > 120)$$

V. FUTURE SCOPE

The project's main objectives are to predict traffic in the next junction and calibrate traffic signals according to traffic. Our system uses the length of the queue as the only attribute to calculate the duration of traffic lights. Other attributes such as speed, the influx of pedestrians, etc. can be added in the future development of systems. Also, other IoT devices can be used for better information fetching. The limitation of the system needs to be explored and tackled as they come. Minimal use of hardware can be encouraged by saving cost.

VI. CONCLUSION

Graud gives a efficient solution to traffic congestion, with the use of machine learning, we have trained model which a specific and optimal in producing predicted values for next squares. A simple but elegant algorithm is designed for calibration of traffic signals time which meticulous handles and resolves traffic congestion. Our main objective was to created a coherent Traffic management system in accordance with real environment which give accurate result, we achieved with the use of appropriate machine learning and by designing a absolute algorithm.

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