DYNAMIC TRAFFIC MANAGEMENT SYSTEM

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Abstract

The Traffic Management System is a cornerstone of a Smart city. In the current problems of the world, urban mobility is one of the major problems, especially in metropolitan cities people spend around 243 hours on average in traffic per year. Traffic jams not only cause extra delay and stress for the drivers but also increase fuel consumption and air pollution. This has turned out to be a daily problem in current times. It is necessary to calculate the road traffic density in real-time for better signal control and effective traffic management. Previous traffic management systems are not capable enough to tackle this growth of traffic on the road networks. Our proposed system aims to count the number of vehicles by using computer vision on images from the traffic camera. It also focuses on the algorithm for switching the traffic lights based on the vehicle density using the captured images to reduce congestion, thereby providing faster transit to people and reducing pollution. The second system uses a recognition system to capture the number plate of vehicles. The third system uses a sound detector to prioritize emergency vehicles. This system comprises the whole traffic light system and functions for emergencies to reach the destination without delay. The purpose of this paper is to propose a dynamic traffic light management system to reduce the pressure on a traffic policeman and a decentralized approach to optimize traffic on the roads. Through this system, we can save fossil fuels and increase the productivity of citizens.

Keywords - *Digital Image Processing, Siren detector, Automatic (or automated) license-plate recognition (ALPR), Computer Vision, Machine Learning, Object detection, YOLO.*

I. INTRODUCTION

In any existing metropolitan area with a large population, traffic congestion has been a common occurrence. Any country's growing population and high personal economic levels affect the country's current transportation systems. As the name says, traffic management is one of the common issues faced by society every day. People nearly spend 234 hours on average in traffic per year.

At present, traffic is being monitored manually or by an open loop controller without detection. It involves so much time and manpower that we do not have sufficient people to monitor/control and the technologies are not that sufficient.

Due to this, people tend to violate traffic rules and it often leads to many road accidents. It also acts as a significant disadvantage for all the Emergency Vehicles and fire authorities.

The agenda that has to be addressed:

i. Traffic jams, have become one of the main challenges for engineers and traffic planners to come up with an intelligent traffic management system
that can effectively detect and reduce the overall density of traffic.

ii. Prioritizing vehicles, like ambulances and fire brigades, is important for its emergency aid capabilities.

iii. Violation of traffic Rules, is a crime and might lead to accidents resulting in an unexpected fatality.

Hence, to solve these issues - This paper has come up with an idea to address these issues efficiently.

Static traffic control employs a traffic signal with a timer for each fixed phase and does not change depending on the amount of traffic on that particular road in real-time. Also, emergency vehicles such as ambulances, police cars, and fire engines get stuck in a traffic jam and face delays in reaching their destination, which can lead to loss of property and valuable lives.

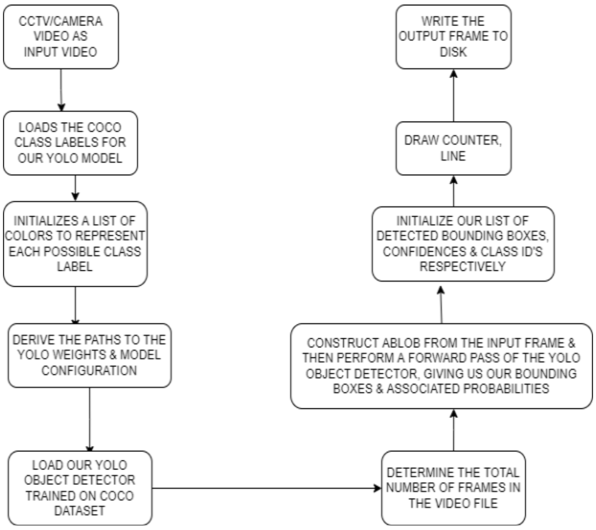
Our suggested method intends to provide a computer vision-based traffic signal controller that can adjust to the current traffic situation. By calculating the number of vehicles at the signal and adjusting the green signal timing accordingly, it uses real-time photos from the traffic cameras at traffic junctions to determine

the traffic density.
It employs the YOLO algorithm to count the number of vehicles present before adjusting the traffic signal's timer per vehicle density in the appropriate direction.
To overcome the problem of prioritizing emergency vehicles, we use a siren detector. This sensor detects the siren and prioritizes the particular lane by changing the green signal for that lane.
We also use ALPR to trap people who violate traffic laws. Using Optical Character Recognition (OCR), Automated License Plate Recognition (ALPR) technology automatically reads the characters on a license plate. Once we get the license plate number, we check the database for the particular number. When a match of the offender's license plate is found in the database. The perpetrator is sent a warning message to the registered mobile number.
This will give us a solution for wasting time and manpower, decreases road accidents compared to before, and provides a clear path for all the Emergency Vehicles and Fire authorities.

II. PROPOSED SYSTEM

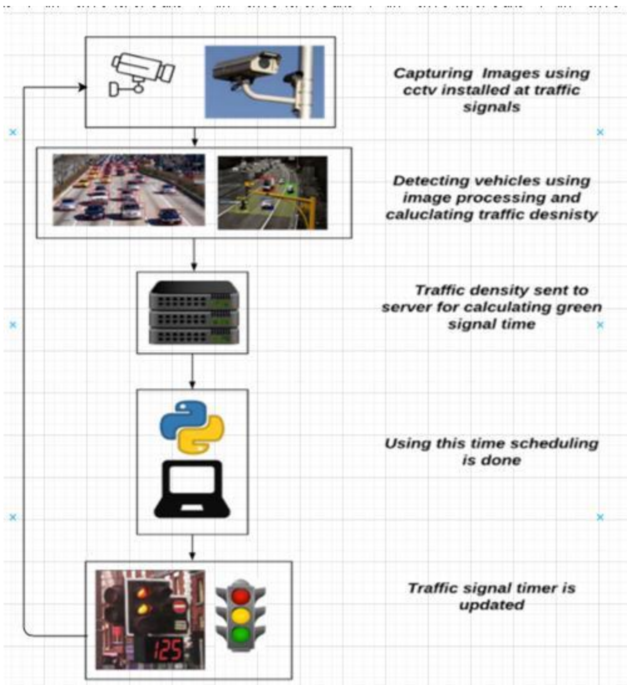
A. Proposed System Overview

Our proposed system takes an image from the CCTV cameras at traffic junctions as input for real-time traffic density calculation using image processing and object detection. The vehicle detection algorithm, which employs YOLO, receives this image. The number of vehicles is counted to understand the density of traffic in a particular lane. The signal-switching algorithm uses this density, among other factors, to set the green signal timer for each lane. The red signal times are updated accordingly. The green signal time is restricted to a maximum and minimum value to avoid starvation of a particular lane. If the sensor at the signal detects a siren, it prioritizes the particular lane first. To show the system's efficiency and contrast it with the current static system, a simulation is also created.



B. Vehicle Detection Module

The proposed system utilizes YOLO (You Only Look Once), which provides the required processing speed and accuracy for vehicle detection. Vehicle detection was trained using a modified YOLO model, which can identify a variety of vehicles including automobiles, bikes, large vehicles (such as buses and trucks), and rickshaws.



Proposed System Model, Figure 1

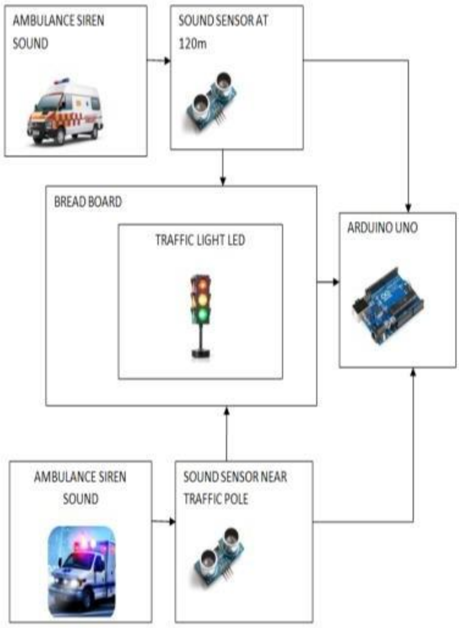
A smart convolutional neural network (CNN) called YOLO is used to identify objects in real-time. The approach applies a single neural network to the entire image, divides it into areas, then predicts bounding boxes for each of those regions. YOLO can run in real-time and attain great accuracy, hence it is well-liked. In the sense that it only needs to perform one forward propagation run through the neural network to produce predictions, the algorithm "only looks once" at the image. It outputs detected objects along with the bounding boxes following non-max suppression (which ensures the object detection algorithm only identifies each object once). A single CNN predicts several bounding boxes and class probabilities for those boxes simultaneously with YOLO.

The backbone CNN used in YOLO can be further simplified to improve processing time. The dataset for training the model was by inputting the images. The images were then imported into code and used for vehicle detection with the help of the OpenCV library. The module then detects the total number of vehicles of different classes. After loading the model and feeding it an image, it outputs the results in a JSON format, or as key-value pairs, where labels are the keys, and their confidence and coordinates are the values. Again, OpenCV can be used to draw the bounding boxes on the images from the labels and coordinates received.

Test images used to apply our vehicle detection model are shown in Fig. 2. The figure's right side displays the results of applying the vehicle detection model to the image, while the left side displays the image as it was originally.

C. Siren Detection Module

It is proposed that a system based on a modified pitch detection technique be utilized for the detection of acoustical signals whose frequency components vary following specific periodic patterns. This type of signal is typically produced by an emergency vehicle's siren. When the ambulance is detected in a particular lane, the value of that lane is given as 1 for the signal switching module. Then it prioritizes the lane.



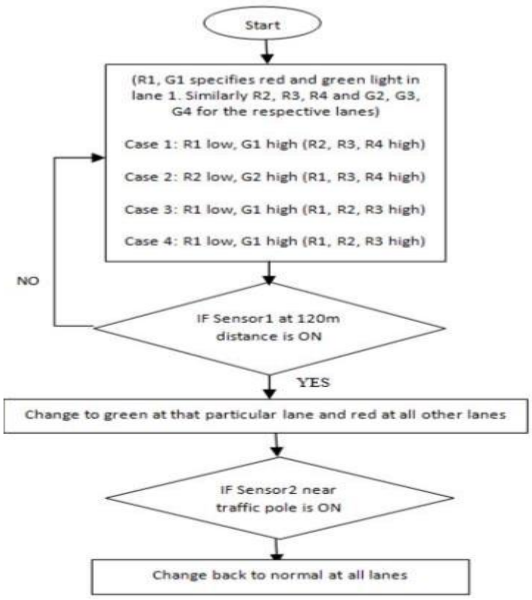
These are the following steps involved in this module,

1. Initial Detection of Ambulance Sound:

When the ambulance passes by the lane and is at a distance of 120m, the sound sensor detects the ambulance by recognizing its sound level which is 120dB.

2.Transmitting signal:

The detected sound is then transmitted by the sound sensor to the traffic controller which is located at the intersection. This in turn enables them to change the signal at the correct time.



3. Switching the lights when an ambulance is crossing:

The traffic light at a particular lane in which the ambulance passes is changed to green and all other lanes are changed to red, thus allowing the uninterrupted passage of the ambulance.

4. Detecting ambulance sound near traffic pole:

When the ambulance crosses the lane and reaches the traffic pole, the sound sensor detects the ambulance by recognizing its frequency.

5. Directing signal after the ambulance crosses:

The detected sound is now transmitted by the sound sensor to the traffic controller again. They can then modify the signal as a result. The traffic light at all the lanes meeting at the junction is changed back to normal form, thus allowing the flow of vehicles in all the lanes.

When multiple ambulances arrive simultaneously on different lanes. The ambulance furthest and with the most vehicle in that particular lane is allowed first.

D. Signal Switching Module

The vehicle detecting module's traffic density data is used by the Signal Switching Algorithm to set the green signal timer and update the red signal timers of other signals. Additionally, it cycles through the signals following the timers.

The detection module's data on the detected cars, as described in the preceding section, is used as input by the algorithm. This data is presented in JSON format, with the confidence and coordinates serving as the values and the label of the object being detected as the key. To determine the total number of vehicles in each class, this data is analyzed next. Following this, the signal's green signal time is determined and assigned, and the red signal times of all other signals are modified correspondingly. To accommodate any number of signals at an intersection, the algorithm can be scaled up or down.

The main thread manages the timer of the current signal, and a second thread is initiated to handle vehicle detection for each direction. The detection threads take a picture of the next direction when the current signal's green light timing reaches 5 seconds. The next signal turns green for the duration specified by the algorithm when the current signal's green timer reaches zero.

When the signal that will turn green next is 5 seconds away, the picture is taken. This provides the system a total of 10 seconds to process the image, count the number of vehicles of each class that are visible in the image, determine the time of the green signal, and then set the times of both this signal and the following signal's red signal in accordance with those results. Based on the number of vehicles in each class at a signal, it is possible to determine the best green signal time.

GST = (Total no. of vehicles + 5) seconds

The signals do not transition in the direction with the most density first; instead, they do so in cycles. This is in line with the current system, which sees the signals turn green sequentially in a predictable fashion without requiring people to change their behavior or create any confusion.

III. CONCLUSION

In conclusion, the proposed system ensures that the direction with more traffic is given a green signal for a longer period of time compared to the way with less traffic by adaptively adjusting the green signal time based on the traffic density at the signal. Due to fewer unnecessary delays, less traffic, and shorter wait times, there will be less fuel use and pollution. When an emergency vehicle is found, the timers are appropriately adjusted so that the emergency vehicle is given precedence and can cross the signal as soon as possible. By creating a violation line and utilizing ALPR to capture the number plate of the image if that line is crossed while the signal is red, A picture or video stream can show the vehicles crossing red lights. Similar signs of lane change might also be found.

iv. REFERENCES

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