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Density Based Traffic Light Control System

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ABSTRACT: In city development, well infrastructure and management of the roads will allow the citizens to travel efficiently from one place to another, especially during peak hours, to improve the traveling experiences and enjoy safety traveling. Designing an intelligent traffic light system that 100% fulfills the city's requirement is critically hard for governors and stakeholders. Traffic jams not only cause extra delay in time and stress for the drivers, but also increases fuel consumption and air pollution. As a result, there is a need for optimizing traffic control. Our proposed system aims to utilize live images from the cameras at traffic junctions for traffic density calculation using image processing and AI. It also focuses on the algorithm for switching the traffic lights based on the vehicle density to reduce congestion, thereby providing faster transit to people and reducing pollution.

KEYWORDS: Object detection, YOLO, Traffic Light Control, Traffic Management, Machine Learning.

I. INTRODUCTION

Today in the present time every city is growing rapidly. As a result, number of vehicles are increasing considerably. With the increasing number of vehicles in cities, many road networks are facing problems with traffic congestion and current technology has some solutions to overcome the traffic congestion. Densitybased Smart Traffic Light Control System based on IOT is not a new system, but it needs a lot of improvements.

There are currently three standard methods used for traffic control:

- 1) **Manual Controlling:** As the name suggests, it requires manpower to control the traffic. The traffic police are allotted for a required area to control traffic. The traffic police carry signboard, sign light, and whistle to control the traffic.
- 2) **Conventional traffic lights with static timers:** These are controlled by fixed timers. A constant numerical value is loaded in the timer. The lights are automatically switching to red, yellow and green accordingly based on the timer value.
- 3) **Sensors:** Another advanced method is placing some proximity sensors on the road. This sensor gives data about the traffic on the road. According to the sensor data, the traffic signals are controlled.

These conventional methods face certain drawbacks. The manual controlling system requires a large amount of manpower. As there is poor strength of traffic police, we cannot have them controlling traffic manually in all areas of a city or town. Many traffic-related issues occur because of traffic control systems on intersections that use fixed signal timers. They repeat the same phase sequence and its duration with no changes. While using sensors i.e., proximity sensors, the accuracy to detect objects is not so high. Moreover, due to the limited effective range of most sensors, the total coverage on a network of facilities usually requires a lot of sensors.

II. RELATED WORK

Reference [2] by Khushi proposes a solution using video processing. The video from the live feed is processed before being sent to the servers where a C++ based algorithm is used to generate the results. Hard code and Dynamic coded methodologies are compared, in which the dynamic algorithm showed an improvement of 35%.

Reference [3] by A. A. Zaid proposes a fuzzy logic-controlled traffic light that can be adapt to the current traffic situations. This system makes use of two fuzzy controllers with 3 inputs and one output for primary and secondary driveways. A simulation was done using VISSIM and MATLAB and for low traffic density, it improved traffic conditions.

Reference [4] by Saili Shinde reviews various techniques used for traffic light management system. This paper observes that each technique has a common architecture: choose input data, acquire traffic parameters from input data, process it, determine density, and update parameters.

Reference [5] by A. Kanungo makes use of a support vector machine algorithm along with image processing techniques. From live video, images in small frames are captured and the algorithm is applied. Image processing is

done using OpenCV and the images are converted to grayscale images before SVM is applied. This system not only detects traffic density but also detects red light violations.

Reference [6] by Siddharth Srivastava proposes the use of adaptive light timer control using image processing techniques and traffic density. This system consists of microcontroller-controlled traffic light timer, high image sensing devices, MATLAB and transmission using UART principles. However, this system fails to prioritize the authorized emergency vehicles nor to detect accidents on the intersection.

Reference [7] by Renjith Soman proposes a smart traffic light system using ANN and fuzzy controller. This system makes use of images captured from cameras installed at traffic site. The image is first converted to a grayscale image before further normalization. Then, segmentation is performed using sliding window technique to count the cars irrespective of size and ANN is run through the segmented image, the output of which is used in fuzzy controller to set timers for red and green light using crisp output. Results had an average error of 2% with execution time of 1.5 seconds.

III. METHODOLOGY

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 number of vehicles of each class, such as car, bike, bus, tractor and trucks is detected, which is to calculate the density of traffic. The signal switching algorithm uses this density, among some 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 in order to avoid starvation of a particular lane.

IV. EXPERIMENTAL RESULTS

Vehicle Detection Module:

The proposed system uses YOLO (You only look once) for vehicle detection, which provides the desired accuracy and processing time. A custom YOLO model was trained for vehicle detection, which can detect vehicles of different classes like cars, bikes, tractors, heavy vehicles (buses and trucks), and rickshaws.

YOLO is a clever convolutional neural network (CNN) for performing object detection in real-time. The algorithm applies a single neural network to the full image, and then divides the image into regions and predicts bounding boxes and probabilities for each region. These bounding boxes are weighted by the predicted probabilities. YOLO is popular because it achieves high accuracy while also being able to run in real-time. With YOLO, a single CNN simultaneously predicts multiple bounding boxes and class probabilities for those boxes.

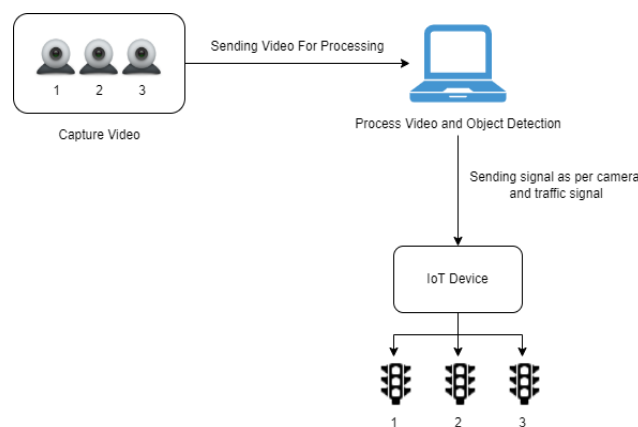


Fig1

So basically Fig1 shows that there are three cameras which captures the real time video on the signals respectively for their lane then the captured video is sent to the laptop for processing then the system processes the video and detects the number of vehicles using Object Detection.

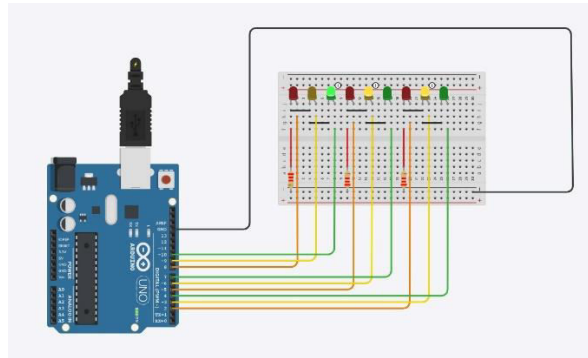


Fig 2(Circuit Diagram)

Then after detecting the number of vehicles present in the 3 cameras our algorithm finds the lane where the density of vehicles is more than the others. After finding the more dense lane, the data is then sent to the IOT device i.e in our case is Arduino Board. The Arduino Board then adds some more seconds to the green light of the signal where the density of vehicles noted was high as shown in Fig2.

So, for our dataset we have gathered images using Google.

For labeling our images we have used ROBOFLOW, a Computer Vision developer framework for better data collection to preprocessing and model training techniques.



Fig 3(Vehicle Detection)

Above fig2 shows test images on which our vehicle detection model was applied. The left side of the figure shows the original image and the right side is the output after the vehicle detection model is applied on the image, with bounding boxes and corresponding labels.

V. CONCLUSION

In conclusion, the proposed system sets the green signal time adaptively according to the traffic density at the signal and ensures that the direction with more traffic is allotted a green signal for a longer duration of time as compared to the direction with lesser traffic. This will lower the unwanted delays and reduce congestion and waiting time, which in turn will reduce fuel consumption and pollution.

VI. FUTURE SCOPE

The project can be further expanded to include the following functionalities to enhance traffic management and bring down congestion:

- 1) Identification of vehicles violating traffic rules: The vehicles running red lights can be identified in an image or a video stream by defining a violation line and capturing the number plate of the image if that line is crossed when the signal is red. Lane changing can also be identified similarly.
- 2) Adapting to emergency vehicles: Emergency vehicles such as an ambulance need to be given quicker passage through the traffic signals. The model can be trained to detect not just vehicles but also be able to recognize that it is an



emergency vehicle and accordingly adapt the timers such that the emergency vehicle is given priority and is able to cross the signal at the earliest.

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