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ADAPTIVE TRAFFIC SIGNAL TIMER

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ABSTRACT

Traffic congestion will become one of the major problems as the city population and vehicles increase. traffic jams cause additional delays and stress for drivers and increase fuel consumption and air pollution. It seems to be everywhere, but megacity is the hardest hit. And due to its ever-increasing nature, there is a need to calculate real-time road traffic density for better signal control and effective traffic management. The traffic controller is one of the key factors affecting traffic flow. Therefore, traffic control needs to be optimized to better meet this growing demand. Our proposed system aims to use live images from cameras at intersections to calculate traffic density using image processing and AI. It also focuses on algorithms for switching traffic lights based on vehicle density to alleviate congestion. This allows people to move more quickly and reduce pollution.

Keywords: Traffic control, Traffic light system, Traffic management, Intelligent transport systems, Smart surveillance, Machine Learning, Computer Vision.

I. INTRODUCTION

With the increasing number of vehicles in urban areas, many road networks are facing the problem of reduced road capacity and corresponding service levels. Many traffic-related problems are caused by traffic control systems at intersections that use fixed signal timers. They repeat the same phase sequence and their duration is unchanged. The increasing demand for road capacity has also increased the need for new traffic control solutions found in the intelligent traffic system area. In recent years, video surveillance and surveillance systems have been widely used in traffic management for safety, ramp measurement, and providing real-time information and updates to travellers. Traffic density estimation and vehicle classification may also be accomplished using a video surveillance system, which is used to control traffic light timers Our proposed system aims to design a computer vision-based traffic light controller that can adapt to the current traffic situation. Using live images from CCTV cameras at intersections, the calculates traffic density in real-time by detecting the number of vehicles at traffic lights and adjusting green light times accordingly. Use YOLO to detect the number of vehicles and set timers for traffic lights in the appropriate direction according to the vehicle density. This optimizes green light times, clears traffic much faster than static systems, reduces unnecessary delays, congestion, and latency, and reduces fuel consumption and pollution.

II. OBJECTIVE

The objective is to design an intelligent traffic signal control system algorithm with the use of sensing devices and image processing systems. The captured images were to be processed in real-time using an image processing toolkit such as YOLO, and various parameters have to be calculated to estimate the density of vehicle traffic in all four directions. The controller has to execute the developed algorithm on the traffic signal timer to vary its period.

III. LITERATURE SURVEY

Reference [2] 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] proposes an Arduino-UNO-based system that aims to reduce traffic congestion and waiting time. This system acquires images through the camera and then processes the image in MATLAB, where the image is converted to a threshold image by removing saturation and hues, and traffic density is calculated. Arduino and

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MATLAB are connected using USB and simulation packages, which are preinstalled. Depending on traffic count and traffic density, the Arduino sets the duration of the green light for each lane. But this method has several flaws. The cars often overlap, and it is difficult to get a proper count of how many vehicles are on the road. Moreover, different objects interfered with the detection as they too were converted to black and white and there was no way of making a distinction between regular objects like billboards, poles, trees with vehicles.

Reference [4] proposes a fuzzy logic-controlled traffic light that can be adapted 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 [5] proposes a smart traffic light system using ANN and a fuzzy controller. This system makes use of images captured from cameras installed at the traffic site. The image is first converted to a grayscale image before further normalization. Then, segmentation is performed using the 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 the fuzzy controller to set timers for red and green lights using crisp output. Results had an average error of 2% with an execution time of 1.5 seconds.

Reference [6] uses a support vector machine algorithm and 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.

IV. HARDWARE AND SOFTWARE REQUIREMENTS

Table 1. Hardware Requirements

SR. No.	Hardware	Description
1.	Processor	Intel Core i7 @ 2.70 GHz
2.	Memory	8.00 GB
3.	Hard Disk Space	256 GB
4	Device	HP Pavilion
5.	Others	CCTV: C – Mount CameraC ANPR/LPR Camera Cloud – Azure, Google Cloud, AWS

Table 2. Software Requirements

Sr. No.	Software	Description
1.	Operating System	Microsoft Windows 10
2.	Database server	MySQL
3.	Programming IDE	Jupyter Notebook, Google Collab
4.	Technology and Framework	Python, GoogleColab, YOLO v2

V. METHODOLOGY

Vehicle Detection Module

The proposed system uses YOLO (which appears only once) for vehicle detection. This will give you the accuracy and processing time you need. A custom YOLO model was trained for vehicle detection. They can recognize various class vehicles such as cars, bicycles, heavy vehicles (buses and trucks), and rickshaws. YOLO is a clever convolutional neural network (CNN) that performs real-time object recognition. The algorithm applies a single neural network to the entire image, partitions the image into regions, and predicts bounding boxes and probabilities for each region. These bounding boxes are weighted by the predicted probability. YOLO is popular because it can do in real time while achieving high accuracy. The algorithm looks at the image "just once" in the sense that it requires only one forward propagation pass, through the neural network to make a

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prediction. After maximum suppressions (which ensures that the object detection algorithm finds each object only once), we output the detected objects along with their bounding boxes. In YOLO, a single CNN predicts multiple bounding boxes and their class probabilities simultaneously.

Signal Switching Module

The algorithm receives input information about vehicles detected by the detection module, as described in the previous section. This is in JSON format, where the label of the detected object is the key and the confidence and coordinates are the values. Next, parse this input to compute the total number of vehicles in each class. The signal's green time is then calculated and assigned, and the other signal's red times are adjusted accordingly. The algorithm can be scaled up or down to any number of signals at the intersection. The following factors were considered while developing the algorithm:

1) The processing time of the algorithm to calculate traffic density and then the green light duration – this decides at what time the image needs to be acquired.

2) The number of lanes.

3) Total count of vehicles of each class like cars, trucks, motorcycles, etc. 4) Traffic density calculated using the above factors.

5) Time added due to lag each vehicle suffers during start-up and the non-linear increase in lag suffered by the vehicles which are at the back.

6) The average speed of each class of vehicle when the green light starts i.e. the average time required to cross the signal by each class of vehicle.

7) The minimum and maximum time limit for the green light duration - to prevent starvation.

Simulation Module

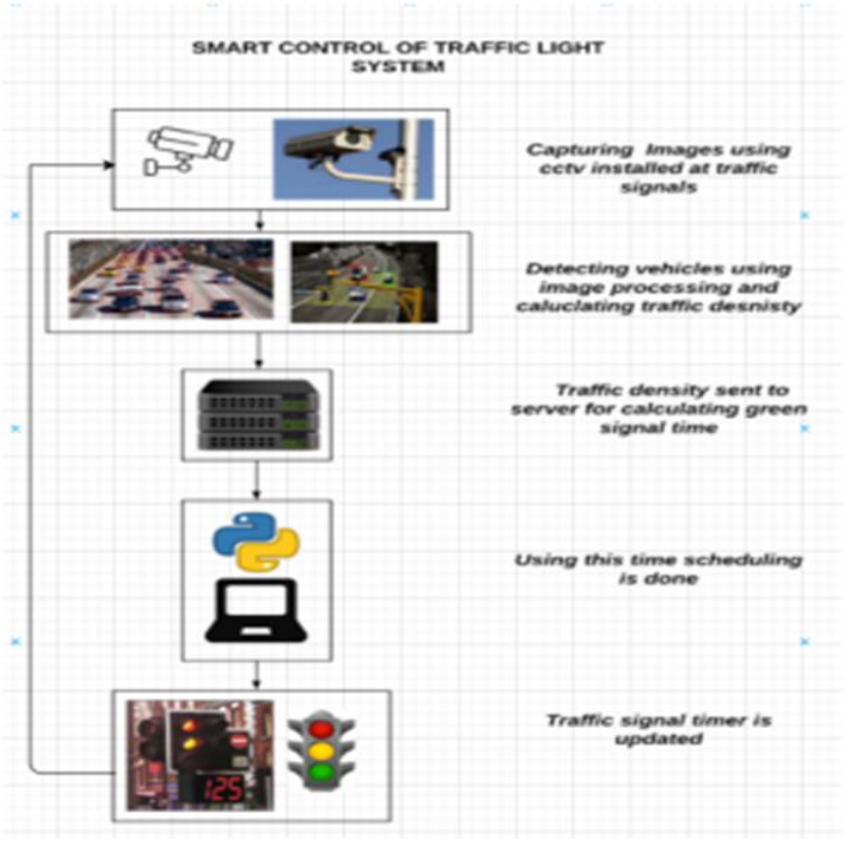

Fig. 1. Proposed System Model

The signal's green time is then calculated and assigned, and the other signal's red times are adjusted accordingly. The algorithm can be scaled up or down to any number of signals at the intersection. A simulation was developed from scratch using Pygame to simulate real traffic. It helps you visualize your system and

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compare it with an existing static system. Contains four-way intersections with four traffic lights. Each traffic light has a timer that indicates the time remaining before the traffic light switches from green to yellow, yellow to red, or red to -green. The number of vehicles that crossed the intersection is also displayed next to each traffic light. Vehicles such as cars, bicycles, buses, trucks and rickshaws come from directions. To make the simulation more realistic, some vehicles in the rightmost lane are about to turn and cross their intersection. Whether the vehicle turns is also determined by the random numbers when the vehicle is generated. Also included is a timer that indicates the elapsed time since the simulation started.

VI. CONCLUSION

Finally, the proposed system adaptively adjusts the timing of the green light according to the traffic density of the light, resulting in a longer green light in the high-traffic direction compared to the low-traffic direction. Allow time to be allocated. This reduces undesirable delays, reduces congestion and waiting times, and reduces fuel consumption and pollution.

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