



# Real-Time Traffic Signal Optimization with Pedestrian Detection and Emergency Vehicle Priority

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**Abstract:** Gridlock in metropolitan areas is the severe problem regarded within the gift lifestyles. The motors are extended at a excessive rate prompts gridlock at both pinnacle and non-pinnacle hours. This reasons much less powerful site visitors signal administration of streets. Traffic sign control frameworks depend upon a decent time span visitors lighting fixtures. These time touchy signs and symptoms will burn through the proper opportunity for the side of few vehicles out and approximately which surpasses one more avenue of vehicles at a high price to grasp tight for quite some time. The development framework facilities around time squandered for motors of a street at a low fee. It dispenses signal to tune down the thickness of the vehicles. Utilizing photograph dealing with ml python code with ML to compute the thickness of traffic on each path. Constantly A camera is about in every path to be able to seize pics of road. In out model we want to transfer every direction photographs of street. Our framework will song down items in every picture and count the quantity of cars, man or woman walking and emergency car. In view of variety of cars, character on foot and rescue car popularity our framework will accord manipulate traffic signals of separate course. In this venture we've utilized the model like the green and red signs are addressed making use of LEDs.

**Keywords:** Adaptive Traffic Signal Control, Pedestrian Detection , Emergency Vehicle Preemption, Computer Vision.

## 1. Introduction

With the uncontrolled population development, going has ended up being a virtually furious errand in this day and age. The expansion in voyaging individuals has prompted an intense development in rush hour gridlock at every niche and nook of the metropolis. Subsequently, the wastage of costly fuel and time leads to greater nervousness causing individuals to face dissatisfaction. Gridlock is an average issue that has emerged due to the elevated variety of cars out and approximately. To manipulate this trouble, specialists have proposed severa preparations. No, one of the widely used models currently is a clock model. Traffic is generally controlled using signal timings at every phase of the traffic cycle. Thirdly, we could put digital sensors in place that can sense the presence of vehicles and send appropriate traffic signals from the information received. Traffic congestion results from multiple factors which include peak travel times and special days and seasonal weather patterns and severe weather events and unpredicted situations which include vehicle accidents and large public events and construction

work. During the time when the vehicles are jammed in the rush hours, commuters have to wait for an unnecessarily long time before things start to move again. We can take care of this problem normally through executing this thickness primarily based traffic signal framework making use of photo dealing with which regularly offers with the traffic indicators in view of visitors. This framework utilizes photograph coping with techniques, as an instance, basis deduction to peer as the rely of automobiles present out and about (site visitors thickness) which may be applied to manipulate the visitors mild. The picture handling devices which might be to be had in python may be utilized to program the code for tracking down the include of automobiles in a direction. This notion can be addressed using LEDs rather than genuine visitors sign.

## 2. Literature Survey

Many studies for the traffic management strategies have been considered inappropriate for favorable



outcomes. Shibin Balu et al. [1] suggested an image processing-based tactic to count the vehicles by making use of MATLAB. Cameras are deployed as another input device which captures video records from different positive channels and transmits them to MATLAB for processing. The recorded data is analyzed periodically to gauge the traffic conditions. Such a model demands a certain amount of investment owing to constant video recording and processing.

Wahban Al Okaishi et al. [2] developed a traffic management model which uses brightness analysis and edge detection techniques from image processing to control traffic flow. The algorithm relies on the change-of-brightness model, feature-detection techniques, and volume estimation techniques for embedded traffic data from sensor data collection. In this context, the corresponding width-edge subtraction process helps in determining the vehicle width as distinct from any background edge.

Bilal Ghazal et al. (2016) developed a system for reducing traffic congestion and blockages through the construction of their model. The systems use a PIC microcontroller together with IR sensors to measure traffic density which allows them to control traffic signal timings during each phase of the traffic cycle.

Anna Merine George et al. devised a system that employs the interconnection of the "Internet of Things" with the "Adaptive Neuro Fuzzy Inference System (ANFIS)" for management of traffic. A digicam is utilized to seize the photograph and making use of Arduino UNO and Think Speak Stage the photograph is moved to cloud. Then those photos are broke down using ANFIS regulator. The process requires multiple stages which lead to extended duration for its completion.

Elizabeth Basil et al. [5] have proposed an arrangement of site visitors light in view of IOT. This framework conveys and actions the matter of vehicles to the following site visitors intersection for manipulate the following sign. It entails unique innovation for each piece of the framework. The researchers employed image processing methods together with MATLAB software to examine traffic videos while using machine learning techniques for vehicle detection according to their study [6].

The system developed by Prof. Vikram Deshmukh and Shruti Pantawane and Sonali Hajare and Anushree Kale uses standard traffic signals which operate according to predefined time schedules that do not change based on actual traffic patterns at the intersection. The Journal of Emerging Technologies and Innovative Research (JETIR) published a study in its September 2022 Volume 9 Issue 9 with ISSN 2349-5162 and JETIR2209563 that reported the

approach succeeded in solving the problem through its method of capturing traffic images which it transformed into grayscale images. Limit esteem is decided with a purpose to display the quantity of cars gift on the particular course. MATLAB and AT89S52 microcontrollers are combined for image processing applications. The benefits encompass the use of a microcontroller to prevent internal system errors and make operations more reliable and hassle-free.

The researchers Prakash B. and Sandhya Devi R. and Naveen Kumar S. and Thiyagarajan P. and Shabarinath developed a vehicle counting system which uses microcontroller technology. Traffic signal timings are adjusted by the microcontroller depending on the number of vehicles. The processor utilized is the ARM engineering. The fundamental benefit of the framework is the records like range of automobiles on each route might be recognised due to the sensors. The downsides that may be checked have been the luxurious sensors which motive parcel of aid and the framework is versatile.

The researchers K. Vidhya and A. Bazila Banu [8] developed a system that processes traffic light images through grayscale conversion and subsequent thresholding to count the vehicles that drive on the specific street. After calculating, the results are used to ascertain the highest traffic-density lane. Machine learning has been added to the microcontroller-based traffic light system. The basic good point with this is that OpenCV is being employed, and secondly, fast processing with respect to memory overhead. Hardware efficiency is further enhanced by machine learning. One of the critical things OpenCV is slightly weaker compared to MATLAB is low flexibility. Over and above that, a machine learning model has limited memory capacity.

Prof. Durgesh Shinde, Pallavi Shanbag, Sumitra Mahajan, and Dattray Wagh [9] proposed a system in which the conventional traffic signal framework follows a fixed timing pattern that does not adapt to real-time traffic conditions at the intersection. The project aimed to overcome this by capturing traffic light images and converting the images into grayscale.

Limit esteem is decided in an effort to show the amount of motors gift on the unique direction. This project works on image processing using MATLAB and microcontroller AT89S52. The system benefits from microcontroller implementation because it protects internal operations from system failures while enhancing overall operational reliability and efficiency.

### 3. Implementation

The proposed framework is achieved in Python with a purpose to diminish the visitors in mild of thickness. The system consists of four primary processes which include: (a) image acquisition, (b) RGB to grayscale conversion, (c) image enhancement, and (d) morphological operations. Processing and presenting vision data are accomplished through the installation of a camera on the highway for video footage purposes. The video then is recorded frame by frame continuously, and each of the frames is compared to the initial reference image. The Aggregate of Vehicles of the Video is Derived with Image Processing Algorithms. Whenever the vehicle count exceeds the mentioned predefined threshold, a message 'Heavy Traffic' is displayed. It is indicated in Figure 1 that the block diagram of the proposed system.

#### 3.1. Image Obtaining

The most important step in image processing involves taking the first step of acquiring images. Images are normally displayed as two-dimensional functions which scientists represent with the notation  $f(a,b)$  where  $a$  and  $b$  represent spatial coordinates[6]. The function value at each point—that is, the intensity-gradient called the gray scale—gives the value of the image at that location. These  $a$  and  $b$  values have to be switched over completely to restrained discrete traits to shape a sophisticated picture that's essential to address through a sophisticated PC. Each superior image is produced from pixels which can be restricted components. The webcam is used to capture motion and frames are pulled out to get the photos. Intensity values correspond to transmitted energy of a real source, in that the pixel values have to be finite and non-zero.

$$0 < f(a, b) < \infty \quad (1)$$

#### 3.2. RGB to Dark Change

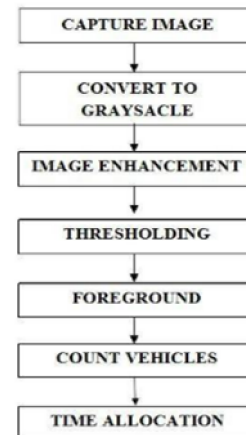
The color images use RGB color space as their format. Grayscale images use 8 bits to represent each pixel, which can display 256 different pixel values that range from 0 to 255. According to equation (2), grayscale values are mediated by a linear combination of individual R, G, and B components.

$$0.3R + 0.59G + 0.11B \quad (2)$$

#### 3.3. Image Improvement

Picture improve is the most common way of converting the pixel upsides of a photo both in the spatial space or in the recurrence place to work at the visible affect of the stuck picture. Picture improvement gadgets in Python are utilized to get the grayscale edition of the caught

picture with valid difference and higher fine. Picture improvement techniques applied in the proposed approach contain clamor evacuation using Wiener channel, Mass examination and enlargement.



**Figure. 1** A block diagram of a density dependent traffic light signal system employing image processing.

#### 3.4. Thresholding

Image thresholding is a simple, effective technique to separate one of two classes of regions applied to a grayscale or color image between the image pixels and the remaining components. It should be chosen as the first starting point to eliminate the majority of the scattering through dispersion. If the histogram has two peaks [ 7], a global threshold is enough to segment it. For each captured traffic image, the threshold value is chosen automatically using Otsu's algorithm as shown in the following way.

- Select an underlying evaluation for the worldwide restricts esteem  $T$ .
- The process of image segmentation uses a threshold value  $T$  to divide the image into two separate pixel groups. The first pixel group  $P1$  contains all pixels whose intensity values exceed the threshold  $T$  while the second group  $P2$  includes all pixels whose intensity values do not exceed the threshold  $T$ .
- Compute the everyday (imply) power values  $a1$  and  $a2$  for the pixels in  $P1$  and  $P2$  one by one.
- Compute every other side esteem:
- $T_{new} = 12(a1 + a2)$  (three)
- Consider points 2 to 4 to be repeated until the discrepancy in regard to the successive threshold values is smaller than a certain predefined maximum tolerance limit  $\Delta T$ .

#### 3.5. Forefront Location

Foreground area detection aims at finding changes in image sequences. Frontal area area is completed to isolate these progressions going on inside the forefront from the

foundation. All vicinity methods depend on putting a reference foundation photograph and identifying changes which happen in one-of-a-kind pics concerning the reference photograph. Characterizing the inspiration becomes testing when the photograph includes shapes, shadows, and shifting articles. The foreground detection system needs to create a strong background model which must maintain its performance under different lighting conditions and ongoing leaf and wave and shadow movements and extended time frame alterations. To identify the foreground region, the method described above uses the threshold value determined through Otsu's method.

### 3.6. Vehicle Counting

Multiple detection techniques exist for identifying vehicles on roadways which use both motion detection systems and roadside laser equipment and other similar technologies that add to system requirements. The proposed system employs Otsu's method and image processing techniques for vehicle counting on the road and hence traffic-density estimation. The number of cars detected can find use as signals for control for the traffic lights. The method described here is to carry out the experiment provided in the text above with the help of provided images of empty and loaded road. The facts photograph is then modified over from RGB to greyscale. Presently the two snap shots are notion about and the component that subjects is taken utilizing foundation deduction and the distinction image is modified over into paired structure. The loads in the twofold image are opened simply while the mass location is extra distinguished than 2000. Utilizing Python, the precise range of, nevertheless up within the air and the depend is proven utilizing a seven segment display.

### 3.7. Signal Assignment

When the quantity of motors is discovered out, then sign element is performed in view of the be counted, emergency vehicle reputation and walkers. Signal component is shown making use of LEDs which might be related to our circuit.

## 4. Experimental Results

The dataset provides its first set of four images which display the four intersection approaches through their first intersection approach display. The observation shows that Path Number 4 receives the highest priority because it includes the most vehicles. Number 1 Path takes precedence as the next path, number 3 follows with an altered version of level III, an original Path Number 2 excludes level I.

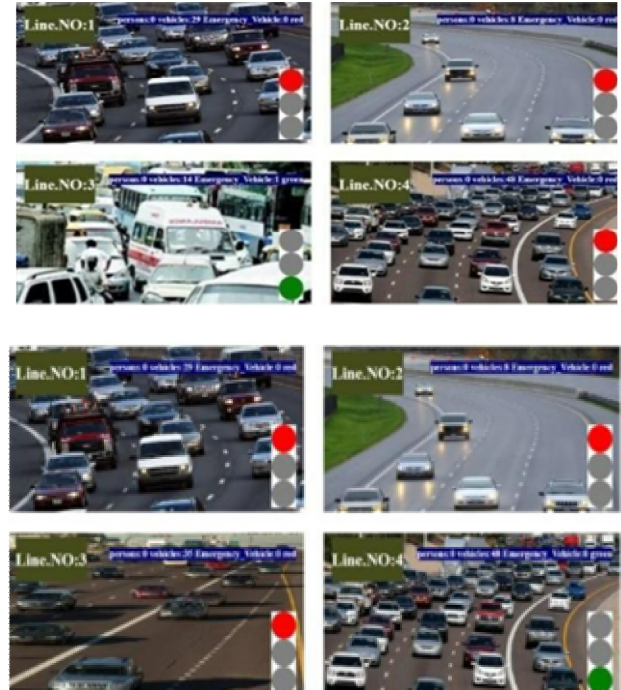


Figure. 2 Lane Number 4 Green (Priority 1)



Figure. 3 Lane Number 3 Green (Priority 1)

## 5. Conclusion

An effective thickness based site visitors signal framework is mimicked and accomplished which offers a decent visitors light component without time wastage. It is also a hugely advanced approach to distinguishing the presence of motors out and about since it utilizes photograph statistics. So it without a doubt works a long way advanced to frameworks which depend on the metallic substance of the cars to understand their presence. Picture coping with strategies overcome the bounds of the every one of the traditional strategies for traffic sign. It will not require any additional hardware and sensors. Having a multitude of surveillance cameras will monitor and regulate traffic within a specified region. It was convincingly proved that the proposed method is better than the existing one in terms of overall accuracy and simplicity. The atmospheric situations aren't considered which may have an impact on the picture excellent while it turns into hazy or in weighty

downpours. The system are further augmentable to detect traffic passing through it, which can help in assessing rush hour congestion.

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## Declaration

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