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AUTOMATED DENSITY BASED TRAFFIC MANAGEMENT SYSTEM WITH EMERGENCY VEHICLE DETECTION

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Abstract— The problem of urban traffic congestion is constantly spreading. The increase in traffic is due to the growing number of vehicles and the limited expansion of roads. Present day traffic signaling system is fixed time based which may render inefficient if one lane is operational than the others. To optimize this problem, a framework for an intelligent traffic control system needs to be designed. Higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. Also, emergency vehicles such as ambulance, fire extinguishing engines etc. should be prioritized. Therefore, proposed here is a mechanism in which the time period of green light and red light is assigned on the basis of the density of the traffic present at that time and if emergency vehicle is present in any lane, that particular lane is cleared first. This is achieved by using Image Processing techniques such as Background Subtraction Algorithm and Image Segmentation. The images of the roads are captured by the camera, that are processed in python and the information about the emergency vehicle and the density of each road is sent to the microcontroller. Once the density is calculated, the glowing time of green light is assigned with the help of the microcontroller (Arduino UNO). The microcontroller will control the signal lights.

Introduction

Fast transportation system and rapid transit system are important for economic development of any nation. Mismanagement and traffic congestion results in wastage of time, loss of fuel and money, there is a need for fast, efficient and economical traffic management system. The monitoring and controlling traffic become a major problem nowadays. The numbers of users are increasing day by days due to this proper management is being required and there is a need for smart traffic control system. To have proper traffic management there are several techniques are available. But no technique is perfect itself as the real-time situation is continuously changing and the no system is
suitable to adopt the change continuously. There is two standard traffic control system such as
1) Manual controlling: It requires manpower to control the traffic. Traffic police are allocated to that particular area and he will carry the signboard, sign light, Whistle.
2) Automatic controlling: Controlled by the timers and electronic sensors. The sensor detects the availability of the vehicle and according to that the timers are adjusted. But it has too many drawbacks not adaptable and not an efficient system. We proposed a system for controlling density based smart traffic light control system in these is aims are to achieve goals:

- Distinguish presence and absence of vehicles in capture road image.
- Signal traffic light goes red when the road is empty.
- Signal the traffic light go green accordingly to the density of the vehicle and the duration of green light adjusted based on calculation.
- Detect Emergency Vehicles and give priority

This proposed system can be done by using python software and aim to have proper traffic management. The camera is installed in the particular area where all the lanes are visible just above the traffic light. The film comes in the form of consecutive frames and each frame is compared with the first frame from which the density of car specified, further, the number of vehicles are displayed on the screen. According to that traffic control algorithm is used to display the allocation time. Accordingly, the green light adjusted. Then the use of emergency vehicle detection is made which helps to detect the ambulance and the emergency vehicle accordingly the lane is given higher priority. These are passed on the hardware which is consists of microcontroller for controlling traffic light. According to that, the traffic signal is being controlled. Using the information of traffic density is passed on the android application user can select the location as per his choice. It gives various locations along with the traffic status. This status provided information can use to choose the particular location to the destination. This application is easy and no extra cost is required.

II-RELATED WORK

Pallavi Choudekar, Sayanti Banerjee in the year 2011[1] Proposed a model "Implementation of Image Processing in Real Time Traffic Light Control". Here the reference image is compared with the captured image and it goes through the different technique. In these RGB to the grayscale conversion of these two images are done further the binary conversion is made. Than gamma correction to remove the error and the edge detection technique using Prewitt edge detection technique. These two images are matched using image matching technique and further the percentage of image matching is used, to indicate the time allocation of a traffic light.

Uma Nagaraj, Prachi Patil, Sayali Thakur, Utsav Sharma, in the year 2013[2] Proposed a model "Traffic Jam Detection Based on Image Processing". When the count of the vehicles is detected these are passed over the server its updates status as high traffic or medium traffic or small traffic. A new application user is required to update the information during login into the application. Then the application returns the various locations and update of the new location is also available. The user can use the status provided by the server to update the alternative paths to the destination.

Naeem Abbas, Muhammad Tayyab, M.Tahir Qadri, int the year 2013[3] Proposed a model "Real Time Traffic Density Count Using Image Processing". Here the input is taken via the camera of the reference image and the real-time image is passed through the grayscale conversion. Further, the grayscale converted reference image is cropped and is multiplied using the real-time image and the required area is only considered. Then the binary conversion is done the traffic density is detected by making the bounding box property the accurate number of vehicles can be detected. In order to deal with the noise added in different lighting condition at different times of a day, the set of the reference image is captured and stored accordingly different time slots of a day. The system cycles these reference image accordingly the current set of the day.

Chandrasekhar. M, Saikrishna.C in the year 2013[4], Proposed a model "Traffic Control Using Digital Image Processing". This is the new technique is developed to detect the emergency vehicle detection in these the obtained binary image is a threshold in such a way that only red light can be detected. The headlight of the vehicle can be detected, so further the processing is done so that the blinking of red-light should be visible. When this red light is detected that lane is given the higher priority and the entire system is halted for that period of time so that the vehicle can pass easily through that lane. This is helpful to detect the ambulance, fire vehicle etc.

Adam Khan, Muhammad Tariq in the year 2015[5], Proposed a model "Modeling, Design and Analysis of Intelligent Traffic control System Based on Integrated Statistical Image Processing Techniques". There are four steps such as Vehicle detection system, Vehicle counting classification system, Traffic signal control system and Data display system. Traffic signal control system detects the number of vehicles on the road and accordingly, the priority is assigned to the particular lane. Data display system display the total number of vehicles and the number of pixels each vehicle contains. Accordingly, the number of vehicles falls in which category is considered.

III-EXISTING SYSTEM

Two different existing standard traffic control systems are

- Manual Controlling
- Automatic Controlling

Manual Controlling:

Manual controlling as the name itself implies that it requires man power to control the traffic. A traffic guard, traffic controller, flagman, or flagger is a person who directs traffic through a construction site or other temporary traffic control zone past an area using gestures, signs or flags. The person directing traffic is responsible for maintaining the safety and efficiency of traffic, as well as the *safety* of road workers, while allowing construction, accident recovery or other tasks to proceed. In addition, they have to moderate the traffic density to not cause traffic jams. They guide motorists to follow the traffic laws; but may not be able to enforce the law.

Automatic Controlling:

The normal function of traffic lights requires more than slight control and coordination to ensure that traffic and pedestrians move as smoothly, and safely as possible. A variety of different control systems are used to accomplish this, ranging from simple clockwork mechanisms to sophisticated computerized control and coordination systems that self-adjust to minimize delay to people using the junction.

Figure 3.1 Automatic Traffic System

Automatic traffic light is controlled by timers and electrical sensors. In traffic light, for each phase a constant numerical value is loaded in the timer. The lights are automatically getting switched ON and OFF depending on the timer value changes. The existing automated traffic control system is shown below:

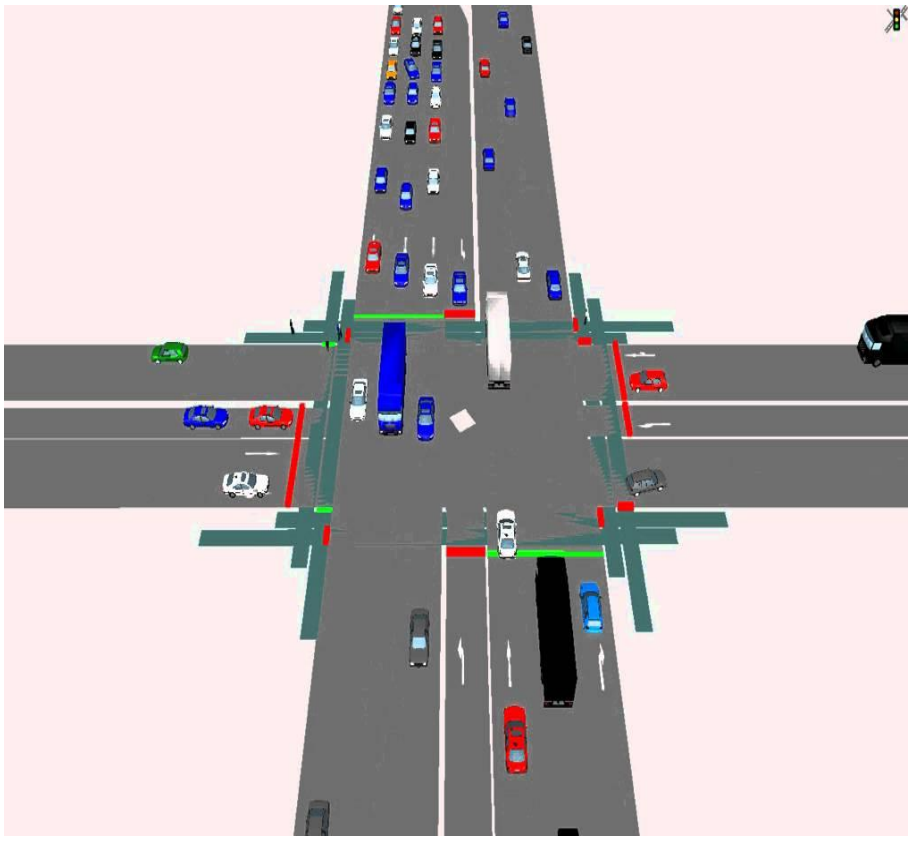


Figure 3.2 Existing traffic control system

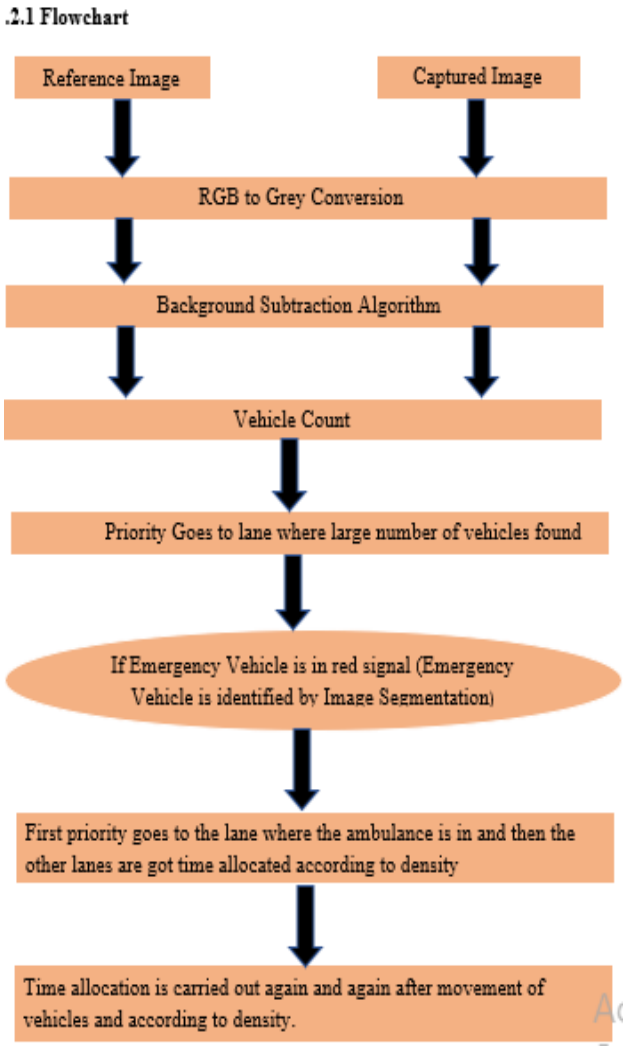
In existing model, less traffic roads will have same green signal time as heavy traffic roads. All lanes will have constant red signal timing and green signal timings. Due to this the vehicles have to wait long time span even if the traffic density is very less.

iv-PROPOSED MODEL

In the Proposed model, Empty Road is taken as reference image. Both the reference image and captured image are converted from RGB to Grey due to Quick Processing. The converted images are then compared using Background Subtraction Algorithm. Now the background images are get subtracted and the vehicles which is in the lane is detected. Thus, the count of vehicles on each lane is identified. After this, Priority Goes to lane where large number of vehicles found and green signal get allotted.

If any Emergency Vehicles enter in the lane, then it is detected by image segmentation technique. After Detecting, first priority goes to the lane where the ambulance is in and then the other lanes are got time allocated according to density. Time allocation is carried out again and again after movement of vehicles and according to density.

Here, the images of the roads are captured by the camera, that are processed in python and the information about the emergency vehicle and the density of each road is sent to the microcontroller. Once the density is calculated, the glowing time of green light is assigned with the help of the microcontroller (Arduino UNO). The microcontroller will control the signal lights. The proposed will reduce the processing delay and increased performance when compared to existing models. The flowchart of proposed model is shown below.



Flowchart of Proposed Model

DESCRIPTION:

In this section we present a process of extracting traffic information from image. We assume that a video camera, placed at appropriate position, is employed for image accusation. From the camera video stream data is processed frame by frame. Our goal is to determine how much traffic is on the road. The amount of traffic will be termed Traffic Density in this project. To accomplish this task, we will use background subtraction method. The background subtraction method is particularly suitable for detecting a foreground objects on fixed background. Here the empty road will be the background image and subsequent frames from the video camera will be the foreground image. By subtracting background image from the foreground image, we can find out traffic density present in a frame. We present two methods to find traffic density and both methods will be used simultaneously. After finding the traffic density we can give priority according to density. If any Emergency Vehicles is detected Suddenly priority is given to lane where emergency vehicle is located. Arduino such as Node MCU is used here to control and managing Traffic Signals.

Pre-processing:

Pre-processing is a common name for operations with images at the lowest level of abstraction --both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing.

Background Subtraction Algorithm:

Background subtraction, also known as foreground detection, is a technique in the fields of image processing and computer vision wherein an image's foreground is extracted for further processing (object recognition etc.). Background subtraction is a widely used approach for detecting moving objects in videos from static cameras. The rationale in the approach is that of detecting the moving objects from the difference between the current frame and a reference frame, often called "background image", or "background model". Background subtraction is mostly done if the image in question is a part of a video stream. Background subtraction provides important cues for numerous applications in computer vision, for example surveillance tracking or human poses estimation.

For example, consider the case of a visitor counter where a static camera takes the number of visitors entering or leaving the room, or a traffic camera extracting information about the vehicles etc. In all these cases, first you need to extract the person or vehicles alone. Technically, you need to extract the moving foreground from static background.

If you have an image of background alone, like an image of the room without visitors, image of the road without vehicles etc. it is an easy job. Just subtract the new image from the background. You get the foreground objects alone. But in most of the cases, you may not have such an image, so we need to extract the background from whatever images we have. It becomes more complicated when there are shadows of the vehicles. Since shadows also move, simple subtraction will mark that also as foreground. It complicates things.

BackgroundSubtractorMOG

It is a Gaussian Mixture-based Background/Foreground Segmentation Algorithm. While coding, we need to create a background object using the function, cv.createBackgroundSubtractorMOG().

It has some optional parameters like length of history, number of gaussian mixtures, threshold etc. It is all set to some default values. Then inside the video loop, use backgroundsubtractor.apply() method to get the foreground mask.

See a simple example below:

```
import numpy as np
import cv2 as cv
cap = cv.VideoCapture('vtest.avi')
fgbg = cv.bgsegm.createBackgroundSubtractorMOG()
while(1):
ret, frame = cap.read()
fgmask = fgbg.apply(frame)
cv.imshow('frame',fgmask)
k = cv.waitKey(30) & 0xff
if k == 27:
break
cap.release()
cv.destroyAllWindows()
```

Figure 4.1 Original Frame

Figure 4.2 Result of Background Subtractor MOG

Image Segmentation:

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation is typically used to locate objects and boundaries in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image . Each of the pixels in a region are similar with respect to some characteristic or computed property, such as colour, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristics. Thus, Image segmentation is used to identify vehicles with the shape, properties etc. Some of Practical applications of Image Segmentation are

- Pedestrian Detection
- Face Detection
- Traffic Control Systems
- Video Surveillance,
- Locate tumours etc.

The Result of Image Segmentation is shown in below figure.

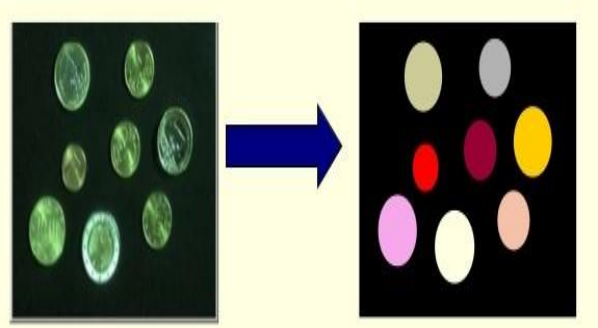


Figure 4.3 Image Segmentation

Hardware connection

Figure 4.4 explains the hardware connection of NodeMCU board with a Traffic Light Controller. In NodeMCU board 8th pin to 13th pin is connected to the
Traffic Light Controller for input pins and Vin pin is connected to the Traffic Light Controller for power supply.

Figure 4.4 Hardware setup using NodeMCU

V. RESULT AND CONCLUSION

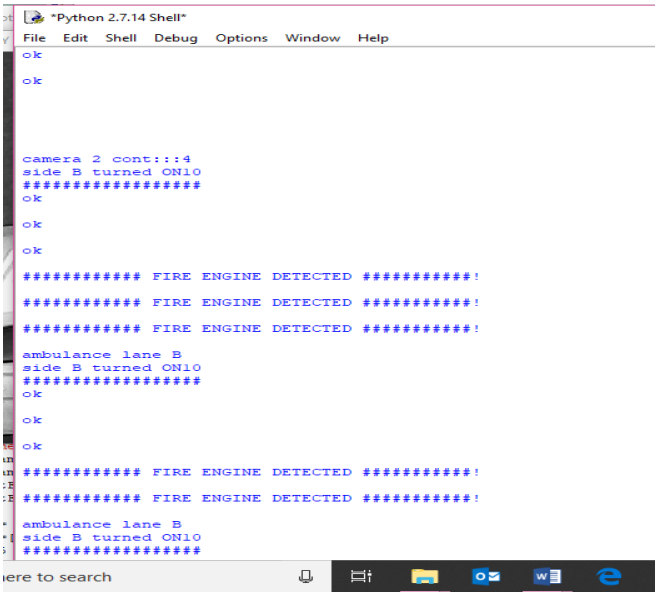


Figure 5.1 Detection of Emergency Vehicle

This Project showed that image processing is a better technique to control the state change of the traffic light. It shows that it can reduce the traffic congestion and avoids the time being wasted by

a green light on an empty road. This project also presents an Automatic traffic density control for vehicles and to clear the traffic in case of any emergency preference will be given to that particular vehicle such as Ambulance and automatically the traffic will be cleared by obtaining a green signal on traffic signal such that all the traffic can be cleared automatically. It is also more consistent in detecting vehicle presence because it uses actual traffic images. It visualizes the reality so it functions much better than those systems that rely on the detection of the vehicles' metal content.

Overall, the system is good but it still needs improvement to achieve a hundred percent accuracy which can be done in future. This work can be enhanced further by using VANETs (Vehicular Ad-hoc Networks) as it provides road safety and intelligent transport system and also in future, we plan on making our system more intelligent such that it can distinguish between the type of vehicles on the road instead of measuring just the traffic density and adjusting accordingly. This is important as there is a pattern that heavy vehicles take more time to cross the light than lighter vehicles. We plan on doing this by using regression models of machine learning which would learn based on the dimensions of the vehicle and the observed time for the vehicles to cross the light. This would make the system more efficient and resource saving.

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