Smart Density Based Traffic Light System Using Image Processing

Samreen Mansoori[1], Kaushal Shigwan[2], Sunny Sharma[3], Saurabh Wadekar[4], Prof. Nargis Shaikh[5]
[1, 2, 3, 4] Dept of Electronics
[5]H.O.D, Dept of Electronics
[1, 2, 3, 4, 5] Rizvi College Of Engg., Mumbai, India

Abstract- *Traffic congestion is a condition on transport networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queueing. This project demonstrates the automated traffic surveillance without any human intervention using image processing techniques based on information received from images of roads taken by video camera. We extract traffic density which corresponds to total area occupied by vehicles on the road in terms of total amount of pixels in a video frame using edge detection technique of image processing. The traffic is analysed and the lights are transferred according to the traffic density. The primary aim is to eliminate waiting time, during peak hours. As the time is varied in proportional to the traffic density. Using this model will eliminate unwanted waiting time in peak traffic hours.*

Keywords- Traffic light control, Traffic density, Video surveillance, Image processing, Edge detection.

I. INTRODUCTION

Traffic congestion has become a major problem in every large city of the world. To ensure a reliable transportation system it is important to have an intelligent traffic control system. The very first step to do that is to acquire traffic data. Traffic data may come from different sensors. Some examples are use of induction loop, infra-red light sensor, optical flow etc. However in recent days, image processing techniques has been very important and promising topic to deal with traffic related problems because of its ease of maintenance and being more intelligent system. Different techniques have been proposed to acquire traffic information. Most of the work detects edge of the vehicles and counts the number of vehicles as traffic on the road. However the disadvantage of the method is that counting the number of vehicles may give faulty results when space between the vehicles on the road are very small (i.e. two cars very close to each other may be counted as one vehicle.

Traffic signal preemption is a type of system that allows the normal operation of traffic lights to be pre empted, often to assist emergency vehicles. The most common use of these systems is to manipulate traffic signals in the path of an emergency vehicle, stopping conflicting traffic and allowing the emergency vehicle right-of-way, to help reduce response times and enhance traffic safety. The system developed is able to sense the presence or absence of vehicles within certain range by setting the sensors. The camera is fixed to identify the amount of vehicles present. According to the output of the camera the traffic signal gets changed.

Image Processing is a technique to enhance raw images received from cameras/sensors placed on space probes, aircrafts and satellites or pictures taken in normal day-today life for various applications. Many techniques have been developed in Image Processing during the last four to five decades. Most of the methods are developed for enhancing images obtained from unmanned space probes, space crafts and military reconnaissance flights. Image Processing systems are becoming widely popular due to easy availability of powerful personnel computers, large memory devices, graphics software and many more.

We propose a system for controlling the traffic light by image processing. The vehicles are detected by the system through images instead of using electronic sensors embedded in the pavement. A camera will be placed alongside the traffic light. It will capture image sequences. Image processing is a better technique to control the state change of the traffic light. It shows that it can decrease the traffic congestion and avoids the time being wasted by a green light on an empty road. It is also more reliable in estimating vehicle presence because it uses actual traffic images. It visualizes the practicality, so it functions much better than those systems that rely on the detection of the vehicles' metal content.

In this project we propose a method that finds out total amount of pixels in a video frame which corresponds to the amount of area of occupied by vehicles on the road rather than finding number of vehicles. The greater the amount of area occupied by vehicles on the road the greater the amount of traffic congestion. This way every kind of vehicles can be accounted for traffic density. Using this traffic data we propose a model for traffic signal control depending on the

amount of traffic on the road. Time allocated for each road is made variable by weighing its time allocation depending on the traffic density.

II. RELATED WORK

In [1] a system is proposed to improve efficiency of existing automatic traffic signalling system. The system will be image processing based adaptive signal controlling. The timing will be calculated each time change automatically depending upon the traffic load. Proposed system will be functioning based on traditional system along with automated signalling. System will have artificial vision with the help of digital camera mounted on motor for its rotation to face lanes and sense the traffic on the road. The camera is controlled by PC through microcontroller to change its direction in steps of 90 degree to face each lane and capture image. This single image of lane will be processed using image processing techniques to estimate traffic load. Estimated traffic load on particular road will be used to calculate the required time duration for controlling of signal lights based on in comparison with experimental results. System will be intelligent and will calculate the time every time and operate in a cyclic clockwise signal lights control.

In [2] a system is proposed for controlling the traffic light by image processing. The vehicles are detected by the system through images instead of using electronic sensors embedded in the pavement. A camera will be placed alongside the traffic light. It will capture image sequences. Image processing is a better technique to control the state change of the traffic light. It shows that it can decrease the traffic congestion and avoids the time being wasted by a green light on an empty road. It is also more reliable in estimating vehicle presence because it uses actual traffic images. It visualizes the practicality, so it functions much better than those systems that rely on the detection of the vehicles' metal content.

In [3] as the number of road users constantly uprighed, and resources provided by current infrastructures are not get satisfied, intelligent control of traffic will become a very important research criteria in the future. However, some limitations to the usage of intelligent traffic control exist. There are several models for traffic simulation; we focus on optimization of traffic light controller using image processing and microcontroller. The traffic control system reduces possibilities of traffic jams based on vehicle density calculation to an extent.

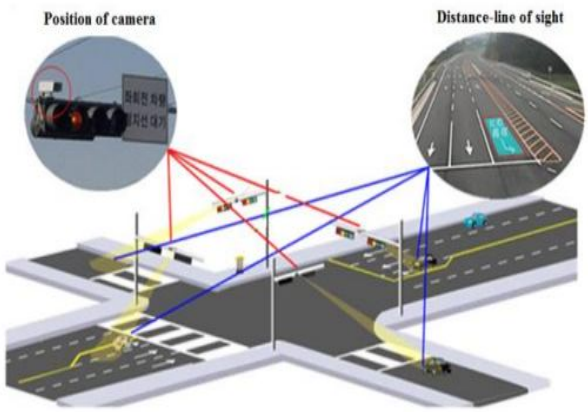

Fig1. System Representation.

III. SYSTEM REPRESENTATION

In this architecture camera is placed on the top of the signal to get the clear view of traffic on the particular side of the signal so that it will capture the image and analyse the traffic in that particular side and get the count of the number of vehicle. With this count the density of that particular side will be determined and corresponding signal will be provided. Fig 1

IV. MATERIALS AND METHODS

A. *Arduino Uno*

We can use the different development board for the execution of the project. Different developments like Arduino, Raspberry pi, ARM development kit etc. The PC, Camera and the different signal lights are connected to the development board.

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by Arduino.cc [4]. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits [5]. The board features 14 Digital pins and 6

Analog pins. It is programmable with the Arduino IDE(Integrated Development Environment) via a type B USB cable.

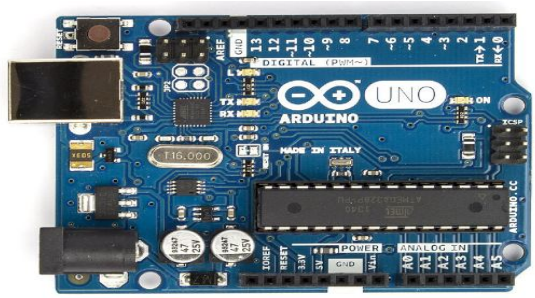

Fig3. Arduino Uno

B. Cameras

A traffic camera is a video camera which observes vehicular traffic on a road. Typically, these are put along major roads such as highways, freeways, motorways, autoroutes and expresswa ys, as well as arterial roads, and are connected with optical fibers buried alongside or even under the road, with electrical power either provided by mains power in urban areas, or via solar panels or another alternate power source which provides consistent imagery without the threat of a power outage during inclement conditions.

A monitoring center receives the live video in real time, and serves as a dispatcher if there is a traffic collision or some other disruptive incident or road safety issue.

Four Cameras are installed for four lanes so that they can capture the images from all four lanes at the same time. Also the image processing tool can perform the operations on the images immediately.

Fig Traffic Camera

C. MATLAB 2014a-

The MATLAB software [6] is used as the integrating platform for acquiring, processing and transmitting the physiological data; it is an excellent graphical programming environment to develop sophisticated measurement, test and control systems using the graphical icons and wires that resemble a flowchart. The software also includes number of advanced mathematics blocks for different functions such as integration, filters and other specialized capabilities.

Matlab is the key software in the project, which is used for the image processing.

Image will be read by the Matlab and then converted to grey scale image and all the image enhancement and edge detection will be done by the Matlab only.

It will compare the images found at all the lanes and identify the density of the lanes and will give command to the s development board to show green signal to the respective lane.

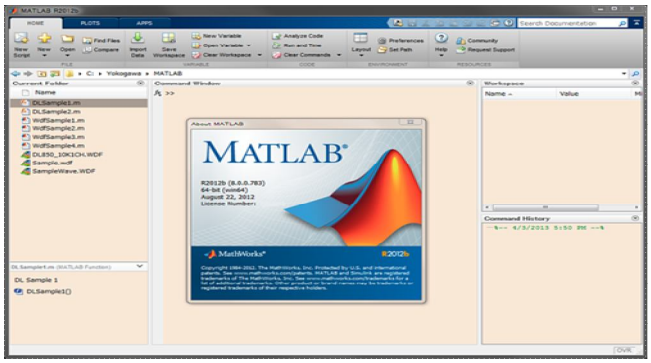

Fig. Matlab Software

V. WORKING PRINCIPLE

A. Algorithm

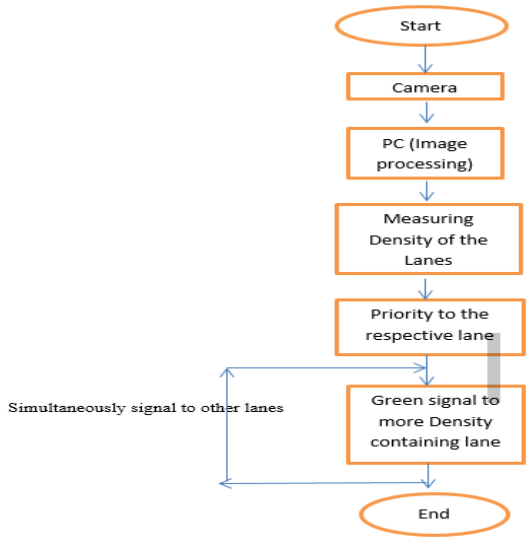

Fig. Flow Chart to Develop Algorithm

The above flow chart shows that the cameras will capture the images from all the four lanes and that images will be given to the image processing tool. The image processing tool will perform the various operations according to the programming and calculate the no of 1s which are egdes of the image. Then it will identify the image containing more number of 1s and then give green signal to that respective lane and then simultaneously to the other lanes containing more number of bits. According to the number of bits containing 1s the time slot will be allotted to the lanes. If number of bits are more then more time will be allotted.

B. Working

From the captured Image we find out total amount of pixels in a frame which corresponds to the amount of area of occupied by vehicles on the road rather than finding number of vehicles. The greater the amount of area occupied by vehicles on the road the greater the amount of traffic congestion. This way every kind of vehicles can be accounted for traffic density.

RGB TO Grey Scale Conversion:

Colour images are often stored as three separate image matrices; one storing the amount of red (R) in each pixel, one the amount of green (G) and one the amount of blue (B). We call such colour images as stored in an RGB format. In greyscale images, however, we do not differentiate how much we emit of different colours, we emit the same amount in every channel. We will be able to differentiate the total amount of emitted light for each pixel; little light gives dark pixels and much light is perceived as bright pixels.

Fig Captured Image

Fig Grey Scale Image

Edge Detection

Edge detection is powerful tool that identifies the edges of the image using the different operators by eliminating the effect of noise. In this project we are using the Canny operator, which is the best operator for the edge detection. It gives the image in the matrix form of 0s and 1s.

Fig Edge Detected Image

VI. EXPERIMENTATION AND RESULTS

We have written and simulated the code and have obtained the results as shown and the Gui representation of our experimentation are shown in the figure-

The Figures indicate the Captured Image its Processing Result along with the Density of the Lanes Calculated

The MATLAB functions used are,

- imread- To read the captured image
- rgb2gray- To convert the image to Grey Scale Image
- edge- to perform edge Detection
- imshow- to display images

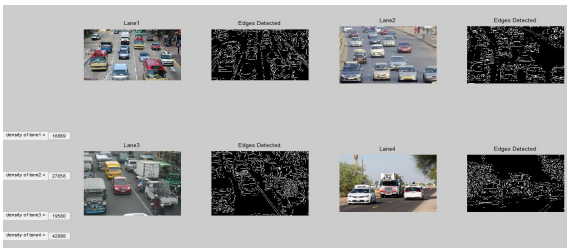

Fig. Traffic Density

The Lanes are assigned priorities according to their Densities The lane with the highest density is assigned Priority 1 and that with the second highest density is assigned Priority 2 and the next highest density Priority 3 and the next dense Priority 4.The traffic light sequence is given in the Table

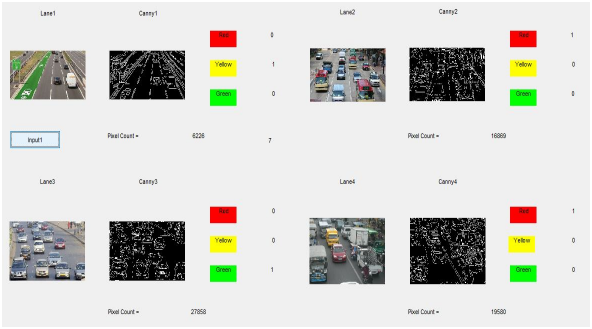

Fig Software Simulation Result

The high dense lane is given more time for Green light compared to the lesser dense lanes so that traffic can pass through effectively.

Timing Sequence

Cycle	Priority 1	Priority 2	Priority 3	Priority 4
First (60 sec)	Green	Red	Red	Red
Second (50 sec)	Yellow	Green	Red	Red
Third (40 sec)	Red	Yellow	Green	Red
Fourth (30 sec)	Red	Red	Yellow	Green

VII. CONCLUSION AND FUTURE WORK

This paper discusses a method for estimating the traffic density on the lane by using image processing. The advantages of this proposed technique is that there is no need to use aerial imagery or complex sensor based systems. The proposed system is very cost effective as it does not require installation of any additional devices, such as sensors.

This work can be enhanced further by proposing a system which identifies the presence of emergency vehicles (like an ambulance or fire brigade) and by giving preference to those emergency vehicles. Secondly, it can be enhanced by using VANETs (Vehicular Ad-hoc Networks) as it provides road safety and intelligent transport system.

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