Traffic Control Using Digital Image Processing

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Abstract **– Traffic congestion is a condition on road networks that occurs as use magnifies, and is described by slower speeds, longer trip times, and augmented conveyance queuing. The most communal example is the physical use of roads by vehicles. When traffic postulate is great enough that the interaction between vehicles slows the speed of the traffic pour, this results in some congestion. As demand approaches the competency of a road (or of the intersections along the road), extreme traffic jam sets in. When vehicles are fully stopped for epoch of time, this is conversation is known as a traffic jam or traffic snarl-up. For this, we must need an efficient traffic control system. Automatic traffic control and surveillance are important for road usage and management. Timers for each stage are the simplest way to control the traffic. Another way is to use electronic sensors in order to find out vehicles, and produce signal. Here we suggest a system that implement image processing algorithm in real time traffic light control which will control the traffic light efficiently. A web camera is placed in each stage of traffic light that will capture the still images of the road where we want to control the traffic. Then those captured images are successively matched using image matching with a reference image which is an empty road image. The traffic is governed according to percentage of matching.**

Keywords – Traffic light control,, Electronic sensors, Image Processing, Image matching, edge detection

I. INTRODUCTION

In modern life we have to face with many problems one of which is traffic congestion becoming more serious day after day. It is said that the high tome of vehicles, the scanty infrastructure and the irrational distribution of the develpoment are main reasons for augmented traffic jam.The major cause leading to traffic jam is the high number of vehicle which was caused by the population and the development of economy. To unravel this problem, the government should encourage people to use public transport or vehicles with small size such as bicycles or make tax on personal vehicles. Particularly, in some Asian countries such as Viet Nam, the local authorities passed law limiting to the number of vehicles for each family.The methods mentioned above is really efficient in fact. That the inadequate infrastructure cannot handle the issue of traffic is also an decisive reason. The public conveyance is available and its quality is very bad, mostly in the establishing countries. Besides, the highway and roads are incapable of meeting the requirement of increasing number of vehicle.

1.1 Standard Traffic Control Systems:

1.1.1 Manual Controlling

Manual controlling the name instance it require man power to control the traffic. Depending on the countries and states the traffic polices are allotted for a required area or city to control traffic. The traffic polices will carry sign board, sign light and whistle to control the traffic. They will be instructed to wear specific uniforms in order to control the traffic.

1.1.2 Automatic Controlling

Automatic traffic light is controlled by timers and electrical sensors. In traffic light each phase a constant numerical value loaded in the timer. The lights are automatically getting ON and OFF depending on the timer value changes. While using electrical sensors it will capture the availability of the vehicle and signals on each phase, depending on the signal the lights automatically switch ON and OFF.

1.2 Drawbacks:

In the manual controlling system we need more man power. As we have poor strength of traffic police we cannot control traffic manually in all area of a city or town. So we need a better solution to control the traffic. On the other side, automatic traffic controlling a traffic light uses timer for every phase. Using electronic sensors is another way in order to detect vehicles, and produce signal that to this method the time is being wasted by a green light on an empty road. Traffic congestion also occurred while using the electronic sensors for controlling the traffic.

1.3 Need for Image Processing in Traffic Light Control

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.

II. INTRODUCTION TO IMAGE PROCESSING

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, spacecrafts and military reconnaissance flights. Image Processing systems are becoming widely popular due to easy availability of powerful personnel computers, large memory devices, graphics softwares and many more.

2.1 IMAGE ACQUISITION:

Generally an image is a two-dimensional function f(x,y)(here x and y are plane coordinates).The amplitude of image at any point say f is called intensity of the image. It is also called the gray level of image at that point. We need to convert these x and y values to finite discrete values to form a digital image. The input image is a fundus taken from stare data base and drive data base. The image of the retina is taken for processing and to check the condition of the person.We need to convert the analog image to digital image to process it through digital computer. Each digital image composed of a finite elements and each finite element is called a pixel.

INPUT IMAGE :

The figure is the captured by a sensor. Here photo diode sensor is used. The sensor is constructed with silicon material. The output voltage waveform of sensor is proportional to light.We can also use filter to improve selectivity.We can also make a output which has one strong color than remaining visible colors using filter.We can generate a 2-D image using single sensor with a displacement in both directions of plane.The arrangement used here is for high precision scanning where film negative is mounted on to a drum which produce mechanical rotation. This mechanical rotation provides displacement in one direction. A sensor mounted on a lead screw is used as it provides motion in perpendicular direction. Using this we can control mechanical motion effectively and images are obtained with high resolution. The sensors a arranged as strips to provide imaging in both direction. The strip provides image in one direction while motion takes care about perpendicular direction. This method is effectively used in airborne imaging. The arrangement is attached to aircrafts during their flights. One dimensional imaging sensor strips that respond to various bands of electromagnetic spectrum are mounted perpendicular to provide perpendicular image so as form a 2-D image.

2.2 FORMATION OF IMAGE:

We have some conditions for forming an image f(x,y) as values of image are proportional to energy radiated by a physical source.

So f(x,y) must be nonzero and finite.

i.e. $0< f(x,y) < \infty$.

2.3 IMAGE FORMED DUE TO REFLECTION:

The function f(x,y) is characterized by two components.

1. The amount of source illumination incident on the scene being viewed, which is called illumination components denoted by i(x,y) and
2. The amount of illumination reflected by the objects in the scene which is called as reflectance components denoted by r(x,y).

We can get the image as product of intensity

$$f(x,y)=i(x,y)r(x,y) \quad (1)$$

$$0< i(x,y) < \infty \quad (2)$$

$$0< r(x,y) <1 \quad (3)$$

(reflection bounded by total absorption and reflection)

The nature of i(x,y) is determined by illumination and r(x,y) nature is determined by characteristics of imaged object.

2.4 RGB to GRAY CONVERSION:

Humans perceive color through wavelength-sensitive sensory cells called cones. There are three different varieties of cones, each has a different sensitivity to electromagnetic radiation (light) of different wavelength. One cone is mainly sensitive to green light, one to red light, and one to blue light. By emitting a restricted combination of these three colors (red, green and blue), and hence stimulate the three types of cones at will, we are able to generate almost any detectable color. This is the reason behind why 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 grayscale images, however, we do not differentiate how much we emit of different colors, 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.

When converting an RGB image to grayscale, we have to conider the RGB values for each pixel and make as output a single value reflecting the brightness of that pixel. One of the approaches is to take the average of the contribution from each channel: (R+B+C)/3. However, since the perceived brightness is often dominated by the green component, a different, more "human-oriented", method is to conisder a weighted average, e.g.: 0.3R + 0.59G + 0.11B.

Original image

Lightness

Average

Luminosity

2.5 IMAGE ENHANCMENT:

Image enhancement is the process of adjusting digital images so that the results are more suitable for display or further analysis. For example, you can eliminate noise, which will make it more easier to identify the key characteristics.

Algorithms for image enhancement:

- Contrast-limited adaptive histogram equalization (CLAHE)
- Decorrelation stretch
- Histogram equalization
- Linear contrast adjustment
- Median filtering
- Unsharp mask filtering
- Noise-removal Wiener filtering

2.6 EDGE DETECTION:

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more technically, has discontinuities or noise. The points at which image brightness alters sharply are typically organized into a set of curved line segments termed edges. The same problem of detecting discontinuities in 1D signal is known as step detection and the problem of finding signal discontinuities over time is known as change detection. Edge detection is a basic tool in image processing, machine vision and computer envisage, particularly in the areas of feature reveal and feature extraction.

2.6.1 EDGE DETECTION TECHNIQUES:

Different colors has different brightness values of particular color. Green image has more bright than red and blue image or blue image is blurred image and red image is the high noise image.

Fig.: Edge detected Picture from MATLAB

In MATLAB by default, edge uses the Sobel method to detect edges but the following provides a complete list of all the edge-finding methods supported by this function:

Matlab Syntaxes: BW = edge(I,'sobel').

BW = edge(I,'prewitt').

BW = edge(I,'roberts').

BW = edge(I,'log').

BW = edge(I,'zerocross',thresh,h).

BW = edge(I,'canny').

In all the above syntaxes I is the Input Image.

2.7 IMAGE MATCHING:

Edge based matching is the process in which two representatives of the same objects are paired together. Any edge or its representation on one image is compared and evaluated against all the edges on the another image. Edge detection of reference and the real time images has been done using Canny operator. Then these edge detected images are matched and accordingly the traffic light durations can be set.

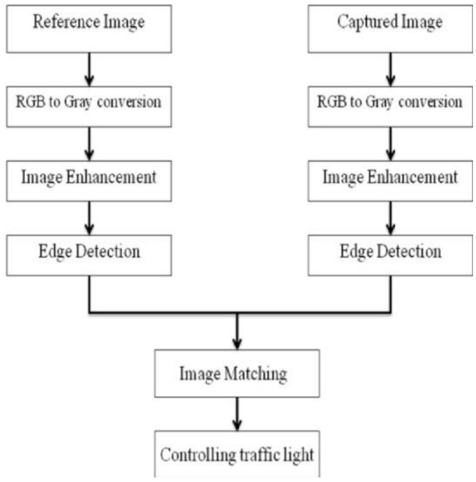
III. IMPLEMENTATION

As mentioned earlier the components required for this system are classified by two different modules and mentioned. They are explained below.

- Hardware and interfacing
- Software module

The software module has been finished with the reference and captured images. Remaining the hardware module and interfacing the software module with hardware module has to be done in future. MATLAB version 7.8 as image processing software comprising of specialized modules that perform specific tasks has been used.

3.1 BLOCK DIAGRAM:



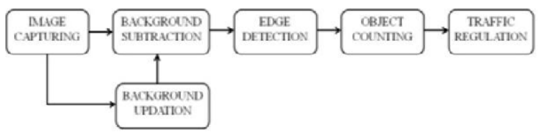
3.2 CALCULATION OF MATCHING AND TIMING ALLOCATION:

After edge detection procedure both allusion and real time images are matched and traffic lights can be controlled based on percentage of matching.

- If the matching is between 0 to 10% - green light is on for 90 seconds.
- If the matching is between 10 to 50% green light is on for 60 seconds.
- If the matching is between 50 to 70% green light is on for 30 seconds.
- If the matching is between 70 to 90% green light is on for 20 seconds.
- If the matching is between 90 to 100% - red light is on for 60 seconds.

IV. EMERGENCY VEHICLE DETECTION

Algorithm:



4.1. BACKGROUND SUBTRACTION:

In the sample image, the background illumination is brighter in the center of the image than at the nether. In this step, the example uses a morphological opening operation to estimate the background illumination. Morphological opening is abrasion followed by lengthy discussion, using the same fabric element for both operations. The overt operation has the effect of removing objects that cannot completely contain the structuring element. For further information about morphological image processing.

```
background = imopen(I,strel('disk',20));
```

To create a more uniform background, subtract the background picture from the primary image, I, and then view the image:

```
I2 = I - background;
```

```
Figure, imshow(I2).
```

CONDITION:

In case a red beacon is detected, the next step is to identify whether it is from an emergency vehicle or not. This is done by identifying the blinking frequency of red light detected in the image sequence and comparing it to the standard used by the emergency vehicles.

The conditions for detection of red light beacon during various periods of the day are shown below. Once they are satisfied, we scan the intermediate frames for the absence of the beacon by the condition as shown below.

Night time conditions:

For red light: R>230, G<250, B<250

In the intermediate frames: R<230, G>230, B>230 Day time conditions:

For red light beacon: R>230, G<250, B<250

In the intermediate frames: R<230, G<230, B<230

If matched, the normal system is overridden and the lane is given priority over all the others. The lane is turned green until the vehicle has passed the intersection.

V. EXPERIMENTAL RESULTS:

TRAFFIC CONTROL:

Figure: Reference Image

Captured Image1.

Captured Image2.

VI. EMERGENCY VEHICLE DETECTION RESULTS and DISCUSSION:

To compare between various types of edge detection algorithms we tested their performance for ten images taken from real traffic intersections. After finding the edges, the picture was subjected to an object counting algorithm. The performance of the edge detector algorithms was defined by the number of vehicles accurately detected. The results show that Canny Edge detector was found to be the best among those compared (93.47%).

The Boolean edge detector performs a decent job of marking the locations of edges, however it failed to complete the edges making object detection difficult. The Sobel and Prewitt operators are more adept at recognizing edges that are horizontal or vertical and are susceptible to noise (refer Fig), as also found in . The Marr-Hildreth was found to be the most susceptible to noise and gave a lot of false results. The use of two thresholds by Canny edge detector makes it less likely to be deceived by noise, and more likely to disclose true weak edges, providing a better and fairly noise durable method for the detection of edges. Hence we have used this method of detection in the paper, along with Moore neighbourhood method to count the vehicles marking the final step of our system.

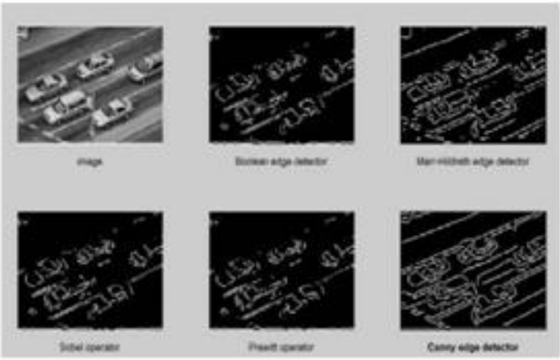


Fig : Output of various edge detection techniques.

Fig: (a)Real-time image (b)Background image (c)Subtracted image (d)No. of vehicles = 3

The video is also analysed for the detection of emergency vehicles through their flashing red lights. By specifying a threshold, we have isolated the areas with high intensity of red light and comparatively lesser intensity of blue and green colour. The resultant image is shown in Fig. (b). As we can see, the headlights of the vehicle were also detected, which led to an erroneous output. Hence the red light must satisfy the additional condition of blinking. This is achieved by taking account for the fact that the red light shall appear in every third frame only. The other lights do not appear in the image sequence with this frequency and hence are eliminated. This leads to the conclusion of the presence of an emergency vehicle as shown in (c).

Our model was tested for ambulance during various times of the day and was found to be successful. In addition, the beacon can be identified even if the emergency vehicle is in an inclined position with respect to the camera as shown in Fig(c).

Fig: a) Image of a vehicle during diurnal, (b) Detection of all lights, (c) Emergency vehicle detected.

VII. CONCLUSION

Past researches have showed a promising result for including image processing in traffic light control. Earlier in automatic traffic control use of timer had a drawback that the time is being wasted by green light on the empty.This technique avoids this problem. we have successfully implemented an algorithm for a real -time image processing based traffic controller. Upon comparison of various edge detection algorithms, it was inferred that Canny Edge Detector technique is the most efficient one. Analysis of various contour tracing and object counting methods revealed the Moore neighbourhood technique to be more robust when compared to the others. The paper demonstrates that image processing is a far more efficient method of traffic control as compared to traditional techniques. We have also implemented a system for emergency vehicle detection based on image processing techniques. The use of our algorithm removes the need for extra hardware such as sound sensors or RFID tags. The increased response time for these vehicles is crucial for the prevention of loss of life.

VIII. REFERENCES

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