REAL TIME TRAFFIC LIGHT CONTROL USING IMAGE PROCESSING

Submitted By : Aishwarya Kamble (15102005)
Prakhar Mittal (15102040)
Name of the Supervisor : Mrs. Juhi Gupta
Name of Examiner : Mrs. Shruti Sabharwal

Submitted in the fulfilment of the degree
Of
Bachelor in Technology
In
Electronics and Communication Engineering

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY,

NOIDA

TABLE OF CONTENTS

DECLARATION

We hereby declare that the Report of the Project work titled "**Real Time Traffic Light Control Using Image Processing**" which is being submitted to Jaypee Institute of Information Technology, Noida in the partial fulfilment of the requirements for the award of Degree of B. tech in the Department of Electronics and Communication Engineering, is a bonafide report of the work carried out by us. The material contained in this Report has not been submitted to any University or Institution for the award of any degree.

Aishwarya Kamble …….

Prakhar Mittal …….

CERTIFICATE

This is to certify that the project titled "**Real Time Traffic Light Control Using Image Processing**" submitted by **AISHWARYA KAMBLE** and **PRAKHAR MITTAL** in fulfilment for the reward of degree of B. Tech in Electronics and Communication of Jaypee Institute of Information technology, Noida has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Signature of the Supervisor …….

Mrs. Juhi Gupta

Assistant Professor, ECE Department,

JIIT, Noida, Sector-62.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude towards my project mentor Mrs. Juhi Gupta (Assistant Professor, ECE department, JIIT, Noida) for her invaluable support and guidance. I am sincerely indebted for her continuous feedback and expert guidance.

I express my heartfelt thanks for her valuable guidance, keen interest, constructive critism, constant support and inspiration up to the final shaping of the first part of dissertation.

Signature of the Students …….

……..

Name of the Students - Aishwarya Kamble

Prakhar Mittal

Date - …….

ABSTRACT

As the problem of urban traffic congestion spreads, there is a pressing need for the introduction of advanced technology and equipment to improve the state-of-the-art of traffic control. Traffic problems nowadays are increasing because of the growing number of vehicles and the limited resources provided by current infrastructures. We propose a system for controlling the traffic light by image processing. The system will detect vehicles through images instead of using electronic sensors embedded in the pavement. A camera will be installed alongside the traffic light. It will capture image sequences. The image sequence will then be analysed using digital image processing for vehicle detection, and according to traffic conditions on the road traffic light will be controlled.

It is well recognized that vision-based camera system is more versatile for traffic parameter estimation. Moreover, quantitative traffic parameters can give us complete traffic flow information, which fulfils the requirement of traffic management theory. Image tracking of moving vehicles can give us quantitative description of traffic flow.

In the present work the designed system aims to achieve the following.

- Distinguish the presence and absence of vehicles in road images;
- Signal the traffic light to go green if the road is empty;
- Signal the traffic light to go red if the maximum time for the green light has elapsed even if there are still vehicles present on the road.

CHAPTER 1

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 development 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 Vietnam, the local authorities passed law limiting to the number of vehicles for each family. The methods mentioned above are really efficient in fact. That the inadequate infrastructure cannot handle the issue of traffic is also a decisive reason. These techniques are briefly described in next section [1].

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].

1.1.2 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].

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. All these drawbacks are supposed to be eliminated by using image processing [1].

1.3 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 [2].

1.4 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. An Image is rectangular graphical object. Image processing involves issues related to image representation, compression techniques and various complex operations, which can be carried out on the image data. The operations that come under image processing are image enhancement operations such as sharpening, blurring, brightening, edge enhancement etc. Image processing is any form of signal processing for which the input is an image, such as photographs or frames of video; the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing are also possible [2].

CHAPTER 2

DETAILED DESCRIPTION OF OUR PROJECT

Image Processing Process

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

Image processing involves issues related to image representation, compression techniques and various complex operations, which can be carried out on the image data. The operations that come under image processing are image enhancement operations such as sharpening, blurring, and brightening, edge enhancement. Traffic density of lanes is calculated using image processing which is done of images of lanes that are captured using digital camera. We have chosen image processing for calculation of traffic density as cameras are very much cheaper than other devises such as sensors.

Making use of the above-mentioned virtues of image processing we propose a technique that can be used for traffic control. The block diagram of the proposed algorithm is given on next page [3].

2.1 BLOCK DIAGRAM

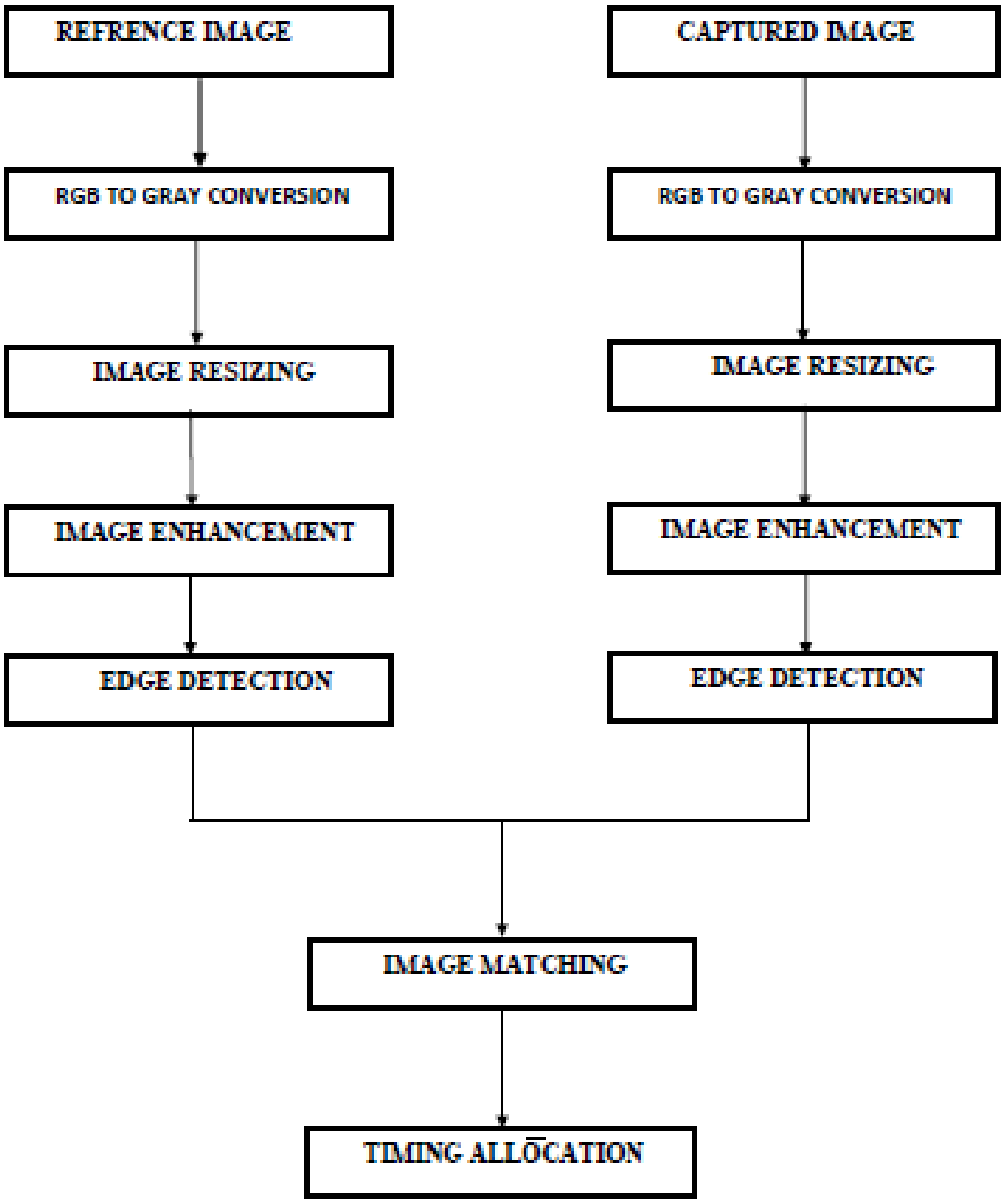

Fig 2.1a) Algorithm to implement Image Processing [3]

2.1.1 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 element and each finite element is called a pixel [3].

2.1.2 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. **$0< f(x,y) < \infty$.**

2.1.3 Image Pre-Processing:

2.1.3.1 Image Resizing/Scaling:

Image scaling occurs in all digital photos at some stage whether this be in Bayer demosaicing or in photo enlargement. It happens anytime you resize your image from one-pixel grid to another. Image resizing is necessary when you need to increase or decrease the total number of pixels. Even if the same image resize is performed, the result can vary significantly depending on the algorithm.

Images are resized because of number of reasons but one of them is very important in our project. Every camera has its resolution, so when a system is designed for some camera specifications it will not run correctly for any other camera depending on specification similarities. so it is necessary to make the resolution constant for the application and hence perform image resizing [4].

2.1.3.2 RGB to GRAY Conversion:

Humans perceive colour 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 colours (red, green and blue), and hence stimulate the three types of cones at will, we are able to generate almost any detectable colour [4].

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 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. When converting an RGB image to grayscale, we have to consider the RGB values for each pixel and make as output a single value reflecting the brightness of that pixel [4].

2.1.4 Image Enhancement

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

In poor contrast images, the adjacent characters merge during binarization. We have to reduce the spread of the characters before applying a threshold to the word image. Hence, we introduce "**POWER- LAW TRANSFORMATION**" which increases the contrast of the characters and helps in better segmentation. The basic form of power-law transformation is

$$s = cr^{\gamma}$$

where r and s are the input and output intensities, respectively; c and γ are positive constants. A variety of devices used for image capture, printing, and display respond according to a power-law. By convention, the exponent in the power-law equation is referred to as gamma.

Hence, the process used to correct these power-law response phenomena is called gamma correction. Gamma correction is important, if displaying an image accurately on a computer screen is of concern. In our experimentation, γ is varied in the range of 1 to 5. If c is not equal to '1', then the dynamic range of the pixel values will be significantly affected by scaling. Thus, to avoid another stage of rescaling after power-law transformation, we fix the value of c = 1.With γ = 1, if the power-law transformed image is passed through binarization, there will be no change in the result compared to simple binarization. When γ > 1, there will be a change in the histogram plot, since there is an increase of samples in the bins towards the gray value of zero. Gamma correction is important if displaying an image accurately on computer screen is of concern [5].

Fig2.1.5a) Gamma 0.2[5]

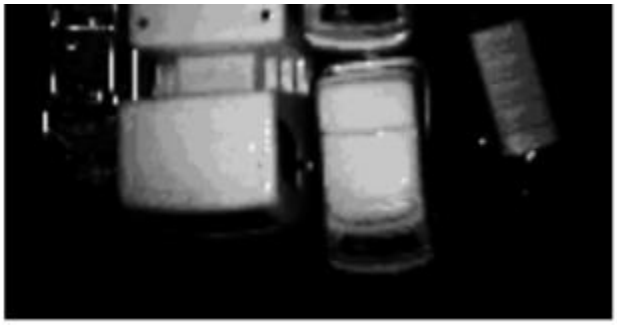

Fig2.1.5b) Gamma 4[5]

2.1.5 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 [5].

2.1.5.1 Edge detection techniques

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

Following are list of various edge-detection methods: -

- Sobel Edge Detection Technique
- Perwitt Edge Detection
- Roberts Edge Detection Technique
- Zero cross Threshold Edge Detection Technique
- Canny Edge Detection Technique

In our project we use “CANNY EDGE DETECTION TECHNIQUE” because of its various advantages over other edge detection techniques.

2.1.5.2 Canny Edge Detection

The Canny Edge Detector is one of the most commonly used image processing tools detecting edges in a very robust manner. It is a multi-step process, which can be implemented on the GPU as a sequence of filters. Canny edge detection technique is based on three basic objectives.

- Low error rate: -

All edges should be found, and there should be no spurious responses. That is, the edges must be as close as possible to the true edges.

- Edge point should be well localized: -

The edges located must be as close as possible to the true edges. That is , the distance between a point marked as an edge by the detector and the center of the true edge should be minimum.

- Single edge point response: -

The detector should return only one point for each true edge point. That is, the number of locae edge should be minimum. This means that the detector should not identify multiple edge pixels where only a single edge point exists [6].

2.1.6 IMAGE MATCHING

Recognition techniques based on matching represent each class by a prototype pattern vector. An unknown pattern is assigned to the class to which is closest in terms of predefined metric. The simplest approach is the minimum distance classifier, which, as its name implies, computes the (Euclidean) distance between the unknown and each of the prototype vectors. It chooses the smallest distance to make decision. There is another approach based on correlation, which can be formulated directly in terms of images and is quite intuitive.

We have used a totally different approach for image matching. Comparing a reference image with the real time image pixel by pixel. Though there are some disadvantages related to pixel-based matching but it is one of the best techniques for the algorithm which is used in the project for decision making.

Real image is stored in matric in memory and the real time image is also converted in the desired matric. For images to be same their pixel values in matrix must be same. This is the simplest fact used in pixel matching. If there is any mismatch in pixel value it adds on to the counter used to calculate number of pixel mismatches. Finally percentage of matching is expressed as

$$\%\text{match} = \frac{\text{No.of pixels matched sucessfully}}{\text{total no.of pixels}}$$

The block diagram of the proposed algorithm discussed above is implemented in MATLAB R2016a. So it is necessary to gain an insight of MATLAB [6].

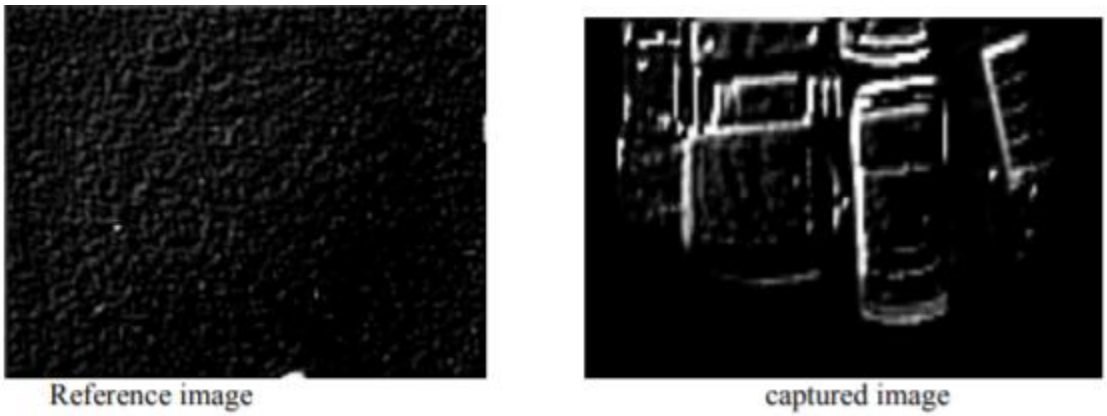

Fig 2.1.6a) Edge detection [6]

Required Software

2.2 Introduction to MATLAB

The name MATLAB stands for MATrix LABoratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects.

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research.

MATLAB has many advantages compared to conventional computer languages (e.g., C, FORTRAN) for solving technical problems. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. The software package has been commercially available since 1984 and is now considered as a standard tool at most universities and industries worldwide.

Therefore, the software part of our project which includes Image Processing is been implemented in MATLAB [7].

Required Hardware

2.3 ARDUINO

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (*shields*) and other circuits.

The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers.

In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project [7].

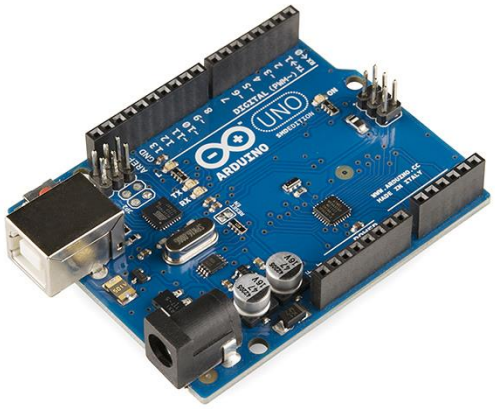

Fig 2.3a) Arduino UNO R3 [7

2.3.1 PARTS OF ARDUINO

- Analog Reference pin
- Digital Ground
- Digital Pins 2-13
- Digital Pins 0-1/Serial In/Out - TX/RX - These pins cannot be used for digital i/o if you are also using serial communication.
- Reset Button - S1
- Analog In Pins 0-5
- Power and Ground Pins
- External Power Supply In (9-12VDC) - X1
- USB

2.4 IMAGE SENSORS

An **image sensor** or **imaging sensor** is a sensor that detects and conveys the information that constitutes an image. It does so by converting the variable attenuation of light waves (as they pass through or reflect off objects) into signals, small bursts of current that convey the information. As technology changes, digital imaging tends to replace analog imaging.

We are using Webcam as a Image Sensor in our Project [8].

2.4.1 WEBCAM

A **webcam** is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and emailed as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. Unlike an IP camera a webcam is generally connected by a USB cable, or similar cable, or built into computer hardware, such as laptops. The term "webcam" may also be used in its original sense of a video camera connected to the Web continuously for an indefinite time, rather than for a particular session, generally supplying a view for anyone who visits its web page over the Internet. Some of them, example those used as online traffic cameras, are expensive, rugged professional video cameras[8].

Fig 2.4 Webcam [8]

CHAPTER 3

IMPLEMENTATION AND RESULTS

3.1 Implementation Algorithm

The block diagram of the project was discussed in previous chapter. The algorithm behind the block diagram consists of following steps

- We have a reference image and the image to be matched is continuously captured using a camera that is installed at the junction.
- The images are pre-processed in two steps as follows
    1. Images are rescaled to 300x300 pixels.
    2. Then the above rescaled images are converted from RGB to gray.
- Edge detection of pre-processed images is carried out using Canny edge detection technique.
- The output images of previous step are matched using pixel to pixel matching technique.
- After matching the timing allocation is done depending on the percentage of matching as
    - If the matching is between 0 to 30% - green light is on for **20** seconds.
    - If the matching is between 30 to 50% - green light is on for **15** seconds
    - If the matching is between 50 to 70% - green light is on for **10** seconds.
    - If the matching is between 70 to 90% - green light is on for **5** seconds.
    - If the matching is between 90 to 100% - red light is on for **10** seconds.

CHAPTER 4

CONCLUSION

4.1 Conclusion

"Traffic control using image processing" technique that we propose overcomes all the limitations of the earlier (in use) techniques used for controlling the traffic. 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. Upon comparison of various edge detection algorithms, it was inferred that Canny Edge Detector technique is the most efficient one. The project demonstrates that image processing is a far more efficient method of traffic control as compared to traditional techniques. The use of our technique removes the need for extra hardware such as sound sensors. The increased response time for these vehicles is crucial for the prevention of loss of life. Major advantage is the variation in signal time which control appropriate traffic density using Image matching. The accuracy in calculation of time due to single moving camera depends on the registration position while facing road every time. Output of GUI clearly indicated some expected results. It showed matching in almost every interval that were decided as boundaries like 10%, 35%, 68% etc.

4.2 Future Work

The focus shall be to implement the controller using DSP as it can avoid heavy investment in industrial control computer while obtaining improved computational power and optimized system structure. The hardware implementation would enable the project to be used in real-time practical conditions. In addition, we propose a system to identify the vehicles as they pass by, giving preference to emergency vehicles and assisting in surveillance on a large scale.

REFERENCES

[1] A. S. Salama, B. K. Saleh, M. M. Eassa," Intelligent Cross Road Traffic Management System (ICRTMS)," 2nd Int. Conf. on Computer Technology and Development, Cairo, Nov 2010, vol. 1, pp. 27-31.

[2] B. Fazenda, H. Atmoko, F.Gu, L. Guan1 and A. Ball" Acoustic Based Safety Emergency Vehicle Detection for Intelligent Transport Systems" ICCAS-SICE, Fukuoka, Aug 2009, vol. 4, pp.4250-4255.

[3] Z. Jinglei, L. Zhengguang, and T. Univ, "A vision-based road surveillance system using improved background subtraction and region growing approach," Eighth ACIS Int. Conf. on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing, Qingdao, August 2007, vol. 11 pp. 819-822.

[4] M. Siyal, and J. Ahmed, "A novel morphological edge detection and window-based approach for real-time road data control and management," Fifth IEEE Int. Conf. on Information, Communications and Signal Processing, Bangkok, July 2005, vol. 21, pp. 324-328.

[5] Y. Wu, F. Lian, and T. Chang, "Traffic monitoring and vehicle tracking using roadside camera," IEEE Int. Conf. on Robotics and Automation, Taipei, Oct 2006, vol. 1, pp. 4631– 4636.

[6] R.S. Bauer, T. D'oring, F. Meysel, "Traffic surveillance using multi-camera detection and multi-target tracking", Proceedings of Image and Vision Computing New Zealand Dec 2007, vol. 13 pp. 175–180.

[7] D. Beymer, P. Lauchlan, B. Coifman, and J. Malik, "A real-time computer vision system for measuring traffic parameters," IEEE Conf. on Computer Vision and Pattern Recognition, Sept 1997, vol. 7, pp 495 -501.

[8] M. Fathy and M. Y. Siyal, "An image detection technique based on morphological edge detection and background differencing for real-time traffic analysis," Pattern Recognition Letters, Dec 1995, vol. 16, pp 1321-1330.