Thesis Report on

Traffic Density Estimation and Flow Control for Video Surveillance System

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DECLARATION

This is to certify that this thesis report entitled “Traffic density estimation and flow control for video surveillance system” submitted by ParthoSharothi Paul (ID:09101014) for the degree of Bachelor of Science in Computer Science and Engineering to the Department of Computer Science and Engineering, School of Engineering and Computer Science ,BRAC University. The contents of this thesis have not been submitted to any other Institute or University for the award of any degree or Diploma. I hereby declare that this thesis is based on the results found by myself and materials of work found by other researcher mentioned by reference.

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Abstract

Video monitoring and surveillance have been widely used in traffic surveillance system. It is important to know the road traffic density in predefined traffic videos especially in mega cities like Dhaka for signal control and effective traffic management .In this paper, I researched on vehicle density estimation and flow control for outdoor traffic surveillance is presented. A common approach is to perform background subtraction, which identifies moving objects from the portion of a video frame that differ significantly from a background model. For Background modeling I used Frame differencing method as for density estimation as our background is static. My experiments shows static background subtraction algorithms with adaptive thresholding, post-processing with morphological image processing can produce good results with much lower computational complexity. Depending on the number of vehicle my embedded system will generate signal effectively to Control the flow of traffic in the road.

Keywords:

Background Segmentation , Image processing , Density estimation , embedded system ,Traffic signal system .

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CHAPTER 1
INTRODUCTION

1.1 Motivation:

With the increasing buying power of common man today the number of vehicles on the road is creating heavy traffic that is difficult to control and maintain safety. This problem is much serious and unsafe for pedestrian, especially in large cities like Dhaka. Growth of traffic here is nonlinear as compared to the development of infrastructure like roads, intersections and bridges. It is difficult for most of the time and sometimes impossible to modify or broaden them in existing cities. New construction takes its own time with all constraint. To smoothen flow of traffic at intersection, options available with traffic control department are to impose one way or use traditional traffic monitoring and controlling system. Traditional system is notso effective but and limited by the time human can work. Human intervention is there to take clever, critical decision . Traffic policemen decide time for traffic signal control depending on the density at particular lanes. Existing automatic system uses preset signal timings to control traffic at intersection. Time to be Preset time is again decided by the traffic officer depending upon his/her survey about traffic condition for a particular intersection. Most of the time, these methods are ineffective, because of sudden fluctuation in flow of traffic apart from peak hours. Unnecessary waiting; people will lose time, miss opportunities and get frustrated. Traffic congestion problems create a deep impact on production and transportation of goods. Need is for automatic adjustment of the signal timing with changing traffic conditions for better control over traffic .

1.1.1Definitions and Problem Description:

The problems of conventional traffic Flow control system are mentioned below:

Heavy Traffic Jams:

With increasing number of vehicles on road, heavy traffic congestion has substantially increased in major cities. This happened usually at the main junctions commonly in the morning, before office hour and in the evening, after office hours. The main effect of this matter is increased time wasting of the people on the road. The solution for this problem is developing a embedded system which will generate signal depending on the number of traffic in the road for different junctions. The delay for junctions that have high volume of traffic should be setting longer than the delay for the junction that has low of traffic.

No traffic, but still need to wait:

At certain junctions, sometimes even if there is no traffic, people have to wait. Because the traffic light remains red for the preset time period, the road users should wait until the light turn to green. The solution of this problem is by developing a system which detects traffic flow on each road and set timings of signals accordingly.

1.1.2Proposed System (Density Estimation and flow Control):

Objective of proposed system is to improve efficiency of existing automatic traffic signaling system. The system will be image processing, measuring traffic load and adaptive signal controlling. The timing will be calculated each time change automatically depending upon the traffic load. Proposed system will be functioning based on the intelligent decision along with automated signaling. System will have artificial vision with the help of digital camera. 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 traffic load every time and operate in a cyclic clockwise signal lights control. Controls of the signal will be routed through the Arduino. MATLAB programming environment will be used for simulating and developing the proposed system.

1.2 Report Overview:

Chapter 2

In this chapter we have undergone several researches related to Background Segmentation and we also review several papers for Pre-process And post process frames for noise reduction and blob analysis for traffic detection .

Chapter 3

This chapter reviews the methodology all the procedures that I choose to develop our embedded traffic flow control system .

Chapter 4

In this chapter explains various experiments and observe the results and the limitations.

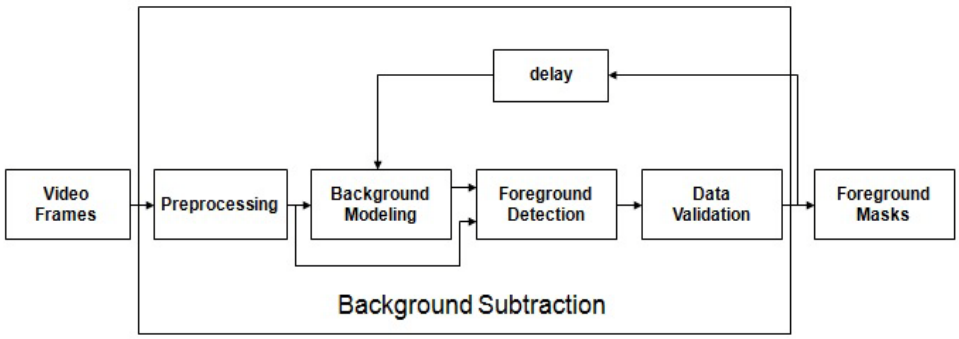
Chapter 5

A summary of our thesis work and gives an idea about our future work.

CHAPTER 3
LITERATURE REVIEW

2.1 Background Subtraction :

Basic Principle of background subtraction, compare a static background frame with the current frame of a video scene, pixel by pixel. Background subtraction techniques involves the comparison of an observed image with an estimated image that does not contain any object of interest; this is referred to as the background model. This comparison process called foreground, detection divides the observed image into two complementary sets of pixels that cover the entire image. The four major steps in a background subtraction are preprocessing, background modeling, foreground detection, and data validation. Preprocessing consists of a collection of simple image processing tasks that change the raw input video into a format that can be processed by subsequent steps. Background modeling uses the new video frame to calculate and update a background model. Foreground detection then identifies pixels in the video frame that cannot be adequately explained by the background model, and outputs them as a binary candidate foreground mask. Finally, data validation examines the candidate mask, eliminates those pixels that do not correspond to actual moving objects, and outputs the foreground mask Many different approaches have been proposed for each of the four processing steps.



There are a several approaches in background subtraction for static and dynamic background. Based on requirement researcher used those algorithm among them Frame difference , Adaptive background Subtraction ,Gaussian Mixture , kernel density estimation are well known . Every algorithm has positive and negative impacts , some takes much computation time others are good for less noise and dynamic model.

Choosing the process actually depends on these process:

1. Evaluate how better sophisticated methods are compared to other background sub -Traction methods

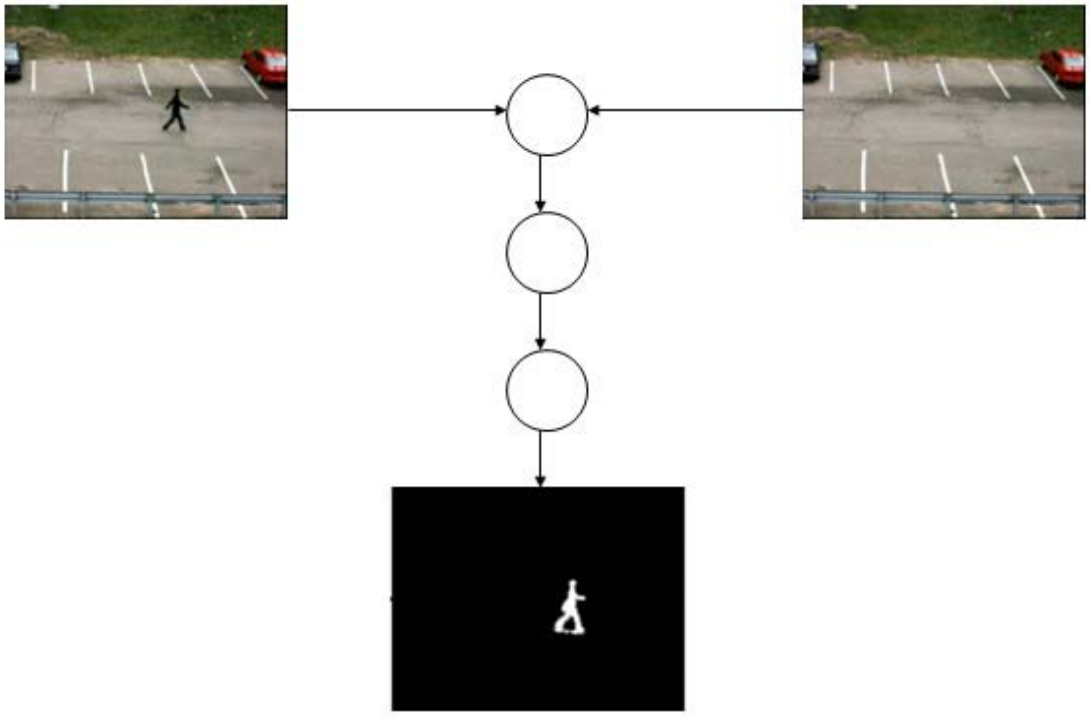
2. Compare the processing power and the amount of memory required by each method
at runtime

3. Determine to which type of video each method suits best.

Frame Differencing **Algorithm** :

Frame differencing is a particularly efficient and sensitive method for detecting changes between images. It is widely used in density estimation, motion detection, traffic flow control where a fixed camera is used to observe dynamic events in a scene. The frame differencing algorithm may be sub-divided into three parts : firstly the generation of a suitable reference or background , secondly, the arithmetic subtraction operation and thirdly, the selection and

$$B(x, y, t) = I(x, y, t - 1)$$
$$(I(x, y, t) - I(x, y, t - 1)) > Th$$

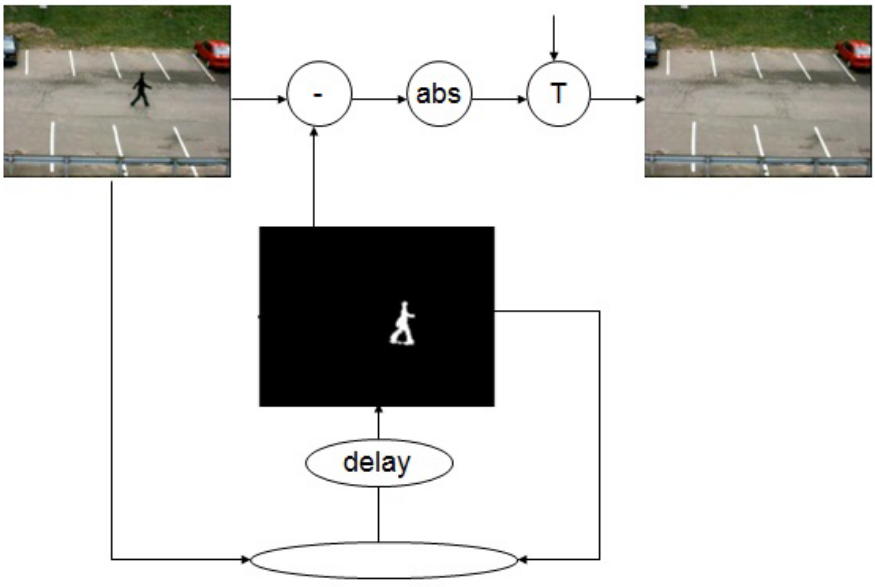


application of a suitable threshold. Reference images can be generated

by a variety of methods. Frame differencing uses the video frame at time t 1 as the background model for the frame at time t. But this works very efficiently for static image . Background is estimated to be the previous frame. In this process For background image is subtracted from foreground frame pixel by pixel. As this is very much effective for static frame its effectiveness depends on the background frame that will be subtracted from foreground. Frame difference has very low computational time and memory requirement is very less than other processes.

Adaptive Background Subtraction Algorithm :

Background B is a single grayscale/color image void of moving objects. This image can be a picture taken in absence of motion or estimated via a temporal median filter . In order to cope with illumination changes and background modifications, it can be iteratively updated as follows:



Adaptive Background subtraction is very adaptive with illumination change , adaptive with the background change. Background frame is updated over time so it has more computational time but respond is good with changes.
Background frame is subtracted from foreground frame , foreground frame is updated at rate @ over time .Adaptive BS work very good for Static background except it has quite more memory requirement and computational time than other static ground algorithms.

Comparative Study of Algorithms :

	Frame Difference	Adaptive BS	GMM	Kernel Density
Static Background	***	***	**	**
Multimodel	*	**	***	***
Noisy Background	**	**	***	***
Computation Time	***	**	**	*
Memory Requirements	***	***	*	*

Frame difference is best for static background . It consumes less memory and require less computational time than other .Adaptive Background Subtraction is also good for static background it consumes Much computational time than other .GMM , Kernel density estimation

Algorithm requires much computational time and memory but very good for multimodal background.
Thus frame difference does not work very good on multimodal background but it's very efficient on static background. Our project Is based on static background so frame difference is best solution For our project.

2.2 Adaptive Thresholding:

Adaptive Thresholding compares the input video frame with the background model, and identifies candidate foreground pixels from the input frame. The most commonly used approach for foreground detection is to check whether the input pixel is significantly different from the corresponding background estimate:

(I(x, y,t) - I (x, y, t -1)) >Th

Another popular foreground detection scheme is to threshold based on the normalized statistics:

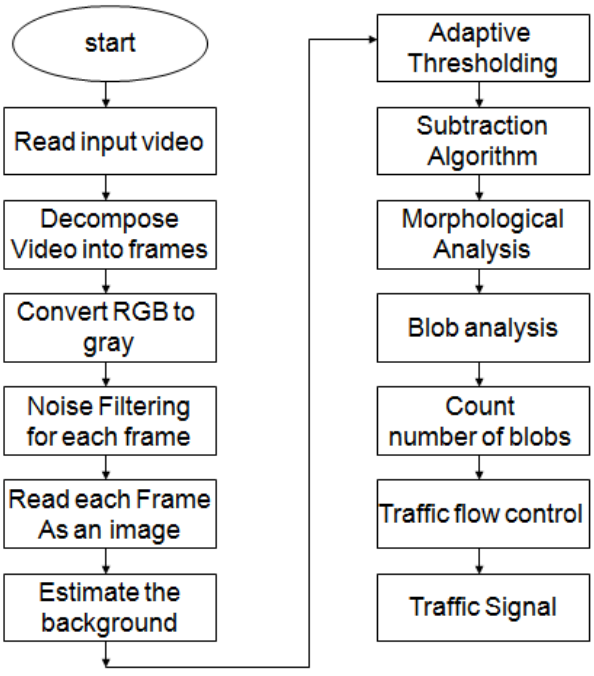
$$\frac{|I_t(x,y) - B_t(x,y) - \mu_d|}{\sigma_d} > T_s,|$$

wheresigma d and @ _d are the mean and the standard deviation of It(x; y) Bt(x; y) for all spatial locations (x; y).

CHAPTER 3
PROPOSED SYSTEM IMPLEMENTATION

3.1 System Architecture :

The overall System Architecture is shown below it defines the system in a sequential manner. In this work the background segmentation algorithm , noise reduction through morphological analysis , blob detection and signal system based on number of blobs or density on the road architecture as well as module have been developed .Process starts with reading a input Frame , we convert this RGB into gray images .



Applying background subtraction algorithm with noise Reduction process we find the the number of vehicles in the road .Number of blobs is the actual density of vehicle .Number of blobs is a int value and for number of vehicle on road Traffic light and signal changes. I implemented my project on hardware with arduino. Traffic lights Red, Green and Yellow changes for traffic density to control the flow of traffic On road.

3.2 Software Implementation :

Background Segmentation :

In the first step, the background is subtracted from the current frame. The difference matrix is applied to a threshold. The gray levels greater and lower than the threshold is updated as 1 and 0, respectively, which leads moving objects to be represented as white pixels

$$D(I,j) = C(I,j) - B(I,j)$$

D : Difference matrix with n rows and m columns
C : Current frame matrix with n rows and m columns
B : Background matrix with n rows and m columns

D(I,j) = 1 if D(I,j)>th
0 if D(I,j)<th

0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	1	1	1	0	0	0	0	0	0	0
0	1	1	1	1	0	0	0	0	0	0
0	1	0	0	1	0	0	0	0	1	0
0	1	1	1	1	0	1	0	0	1	1
0	1	1	1	1	0	1	0	0	1	1
0	0	0	0	0	0	1	1	0	1	1
0	0	0	0	0	0	1	0	0	1	1

Once the binary matrix showing the difference between current frame and background is obtained, this matrix is analyzed in order to detect the vehicle.

Morphological Image Processing :

Morphological Image processing is mainly used to reduce the noise of An image. Series of steps by eroting , dilating reduce the extra thin part that is compared as noise.
Morphological image processing has 4 differeent process to reduce the noise.

- Erosion
- Dilation
- Opening
- Closing

Erosions and dilations are the most elementary operators of mathematical morphology. I will only use this two process erosion and dilation to reduce the noise. Erosion is a process by which a number of pixel is removed from the frame . if there is small dot or negligible pixel in a frame we can avoid this pixels by erosion frames. Dilation is a process it uses to bridging the gap. After the Background subtraction

There could be gap in between congested pixel , that could hamper in counting vehicle. For smooth counting and perfect blobbing dilation is mandatory. Erosion and dilation both process comes in a series . From diagram after erosion in fig 2 contains less noise then fig 1. After Erosion for perfect blobbing we do dilation , blobs is more accurate and well shaped for counting .

Blob Detection and Counting :

After the Morphological Image Processing it gives a contour of objects that represent the density and amount of traffic on the road . Blob analysis can be used to detect any kind of 2 dimensional shape of an image. The detection is based on spatial characteristics with certain criteria. In many applications where computation is time consuming, blob analysis to eliminate blobs that are of no interest based on their spatial characteristics and keep only the relevant blobs for further analysis. White portion of frame are counter as blob , the number of Blob NOB represents the traffic density on the road.

3.3 Hardware Implementation :

Hardware Selection :

The hardware components required for traffic signal system is shown below

Hardware Components

1. Arduino Uno
2. Led and wire
3. Breadboard

Software selection :

The minimum software requirements for this project are:

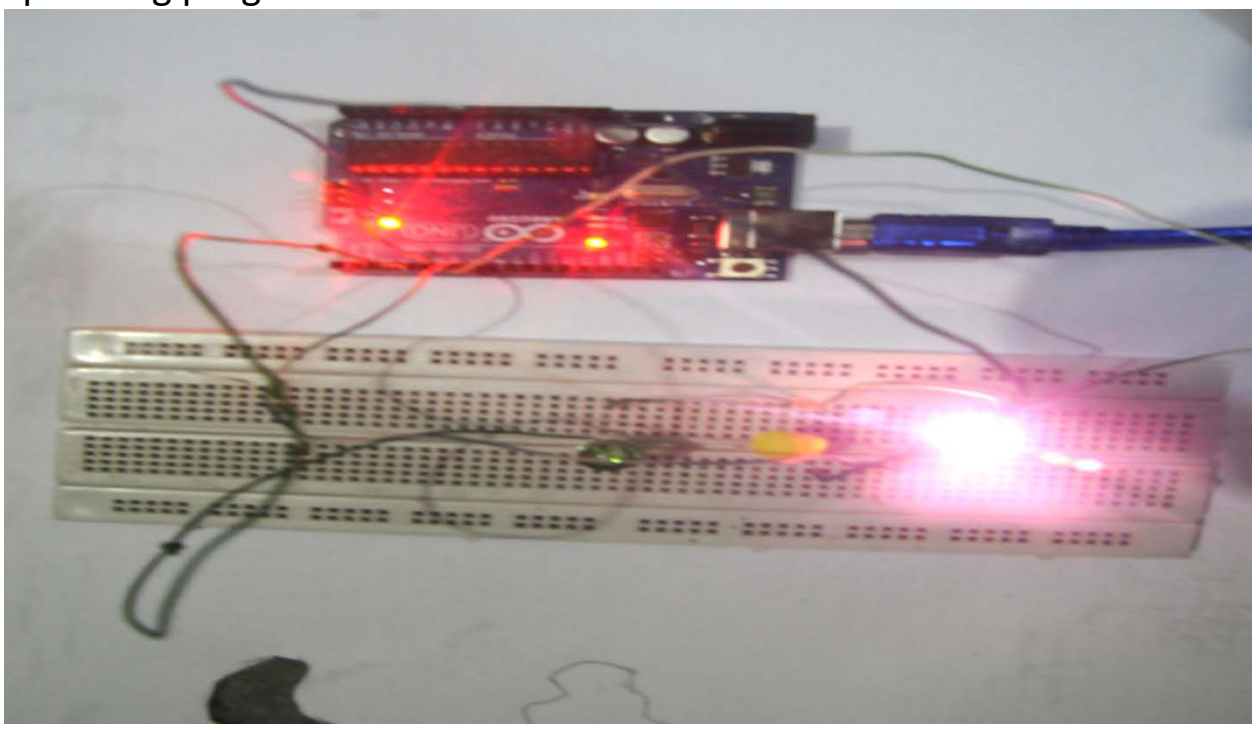
- Windows XP
- Arudino IO
- Mat lab Programming Language

Camera positioning :

The test camera view angles parameters are selected based on our software optimization requirements . Selecting appropriate camera parameter is one of most important factors for successfully implementing the developed system .

Implementation :

Arudino is a single-board microcontroller, intended to make the application of interactive objects or environments more accessible. The hardware consists of an open-source hardware . Pre-programmed into the on-board microcontroller chip is a boot loader that allows uploading programs into the microcontroller



memory without needing a chip programmer.We will send data serially to the microcontroller and based on the data it will show the output on pin 4,5,6.The red light will be on port 4 ,yellow on port 5 and port 6 green . Based on the NOB
(Number of blobs) serial data transferred in microncontroller will show the signal .

CHAPTER 5
EXPERIMENTAL RESULTS

I detected the running as well as stopped vehicle for various different conditions for various data input. Based on data input my project runs successfully and show the exact number of vehicle on the road.

Traffic Density Estimation

<table>
<tr>
<td>  </td>
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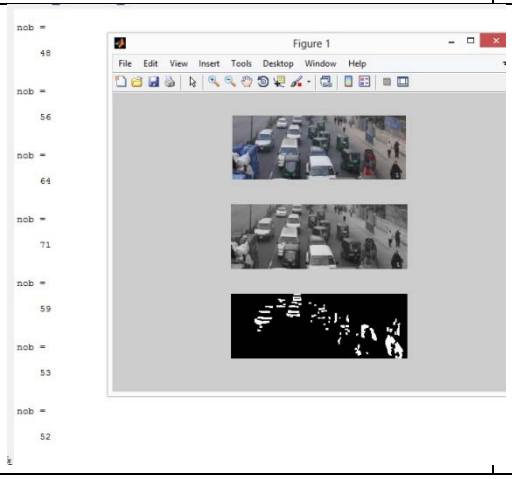
</tr>
<tr>
<td>Number Of vehicles

= 10</td>
<td colspan="2"> 
</td>
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</table>

Our program can count the running vehicle here number of vehicle in this frame shown is 10 which is traffic density for a particular time.

Traffic Flow control

<table>
<tr>
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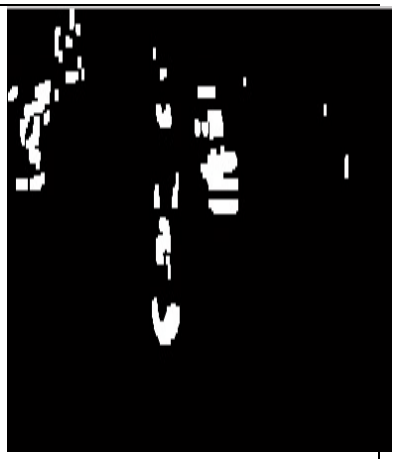
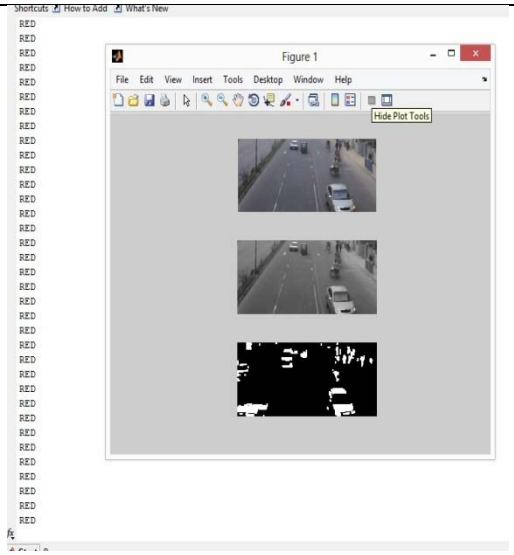
<td>  </td>
<td>  </td>
</tr>
<tr>
<td>Signal

RED
RED
RED
RED
YELLOW
GREEN
GREEN</td>
<td> 
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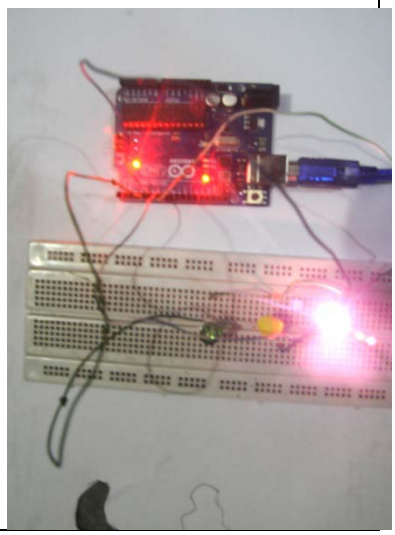
<td>  </td>
</tr>
</table>

Depending on the density of traffic on road either stopped or running its shows the traffic signal and controls the flow .

CHAPTER 6

CONCLUSION And FUTURE WORK

I have demonstrated my thesis on traffic density estimation and flow control based on image processing technique and I have successfully calculated the traffic and also implanted a signal sytem which shows the vehicle the direction on road. In A metro city like in Dhaka it was never implemented before which is less memory consuming , faster than other process and accurate.

I developed this application using many open source tools and software Arduino Io , Matlab and in future I will generate a android based system *to give traffic update to* general for that they can avoid the traffic jam . I faced some trouble to take input video , with a proper input data my project would be more better.

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