Control of Real Time Traffic with the Help of Image Processing

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Abstract----- Fast transportation systems and rapid transit systems are nerves of economic developments for any nation. As the number of road users constantly increases, and resources provided by current infrastructures are limited, intelligent control of traffic will become a very important issue in the future.

Congestion results due to heavy traffic at a junction. Lot of man-hours are being wasted in travelling due to bad traffic management. To avoid congestion there are so many traffic management techniques available.

We have made an attempt to provide some traffic management technique using our Intelligent Traffic Control project so as to change real time traffic scenarios.

(I) Introduction

Conventional traffic control uses timing, which is inefficient due to varying vehicle density at different roads. There is a great need for the introduction of advanced technology and equipment to improve the existing ways of traffic control as the problem of urban traffic congestion spreads. The traffic problems are increasing nowadays due to the growing number of vehicles and the limited resources we are provided by the infrastructures.

To solve the problem of traffic congestion many techniques have been applied. Sensors based on closed loop control algorithms were designed based on emission of ultrasonic waves, magnetic loops etc. but they have problems of high cost of installation and maintenance and also poor accuracy in varying traffic conditions. Hence, sensors based on image processing were considered an attractive alternative.

But in the past they too suffered from issues such as complexity of image processing algorithms and also high cost of hardware needed for processing. But due to recent developments in field of computing, hardware costs have significantly reduced and special dedicated image processing softwares are available now. This has made image processing a clear winner for solving traffic congestion problems.

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Two main trends are noticeable in studies related with measurement of traffic flow. One aims to algorithms that use reduced parts of the image (Inigo, 1985; Inigo,1989; Michalopoulos, 1991) the other is concerned with algorithms that use the complete image (J3losseville and Lenoir, 1989; Hoose, 1991). According to the available literature, there does not exist a system that can overcome all the inconvenient distortions due perspective, changing weather conditions, shades and reflections, varied vehicles shapes, processing time and so on, seem still to be problems that each system have solved only partially. Therefore the problem is still open.

The main step in our system is to perform thresholding of the grayscale image. Thresholding should be appropriate so that counting of cars on the roads is accurate.

Hardware Module

Image sensors: In this project a USB based web camera has been used.

Computer: A general purpose PC as a central unit for various image processing tasks has been used.

Platform: consisting of a few toy vehicles and LEDs (prototype of the real world traffic light control system).

Software Module:

MATLAB version 7.8 as image processing software comprising of specialized modules that perform specific tasks has been used.

Interfacing: The interfacing between the hardware rototype

and software module is done using parallel port of the personal computer. Parallel port

(II) Steps in Image Processing

1. Image Representation

Image representation is concerned with characterization of the quantity that each picture-element (pixel) represents. The fundamentals requirement of digital processing is that images can be sampled and quantized. Image can be represented in analog or digital form. In digital representation, image can be represented in gray-scale or colour format. The gray-level images are represented as 8-bits which allow 256(0-255) possible gray colour combinations. The colour images are represented as 24-bits (32-bits including alpha transparency) in which each 8-bits represents red, green and blue colours.

2. Image Enhancement

In Image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display. Examples include contrast and edge enhancement is useful in feature extraction, image analysis, and visual information display. The enhancement process itself does not increase the inherent information content in the data. It simply emphasizes certain specified image characteristics.

Fig 1 Image Enhancement Sample

3. Image Restoration

Image restoration refers to removal or minimization of unknown degradations in an image. This includes deblurring of images degraded by the limitation of sensor or its environment, noise filtering, and correction of geometric distortion or non- linear ties due to sensors

4. Edge Detection

The image consists of objects of interest displayed on a contrasting background; an edge is a transition from background to object or vice versa. The total change in intensity from background to foreground is called the strength of the edge or edge

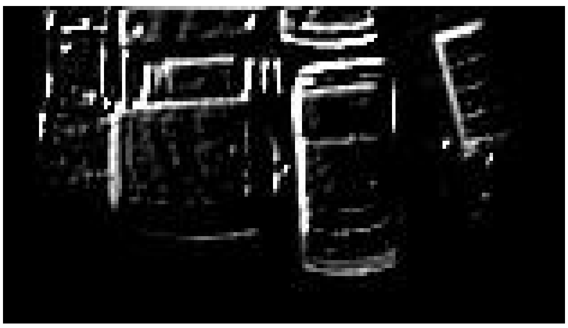

Fig 2 Edge Detection of Multiple Cars

5. Histogram Calculation

The histogram of an image represents the relative frequency of occurrence of the various gray levels in the image. The histogram of a digital image with gray levels in the range (0,l-1) is a discrete function.

$$P(r_k) = n_k / n$$

Where, r_k is the kth gray level n_k is the number of pixels in the image with that gray level n is the total number of pixels in the image k=0,1,2,...n-1.

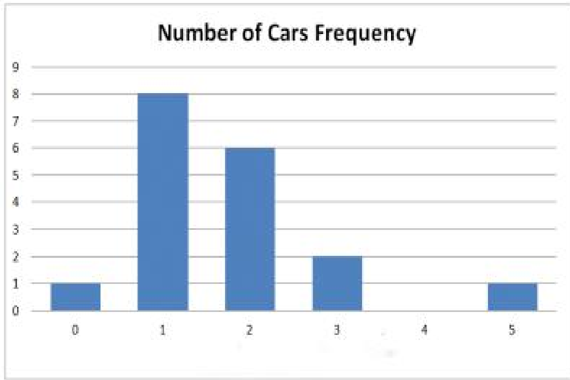

Fig 3 Histogram Analysis

(III) **Types of image features**

- **Edges:**

Edges are points where there is a boundary (or an edge) between two image regions. In general, an edge can be of almost arbitrary shape, and may include junctions. In practice, edges are usually defined as sets of points in the image which have a strong gradient magnitude. Furthermore, some common algorithms will then chain high gradient points together to form a more complete description of an edge. These algorithms usually place some constraints on the properties of an edge, such as shape, smoothness, and gradient value.

Locally, edges have a one dimensional structure.

- **Corners**

The terms corners and interest points are used somewhat interchangeably and refer to point-like features in an image, which have a local two dimensional structure. The name "Corner" arose since early algorithms first performed edge detection, and then analysed the edges to find rapid changes in direction (corners). It was then noticed that the so-called corners were also being detected on parts of the image which were not corners in the traditional sense (for instance a small bright spot on a dark background may be detected). These points are frequently known as interest points, but the term "corner" is used by tradition.

- **Blobs**

Blobs provide a complementary description of image structures in terms of regions, as opposed to corners that are more point-like. Nevertheless, blob descriptors often contain a preferred point (a local maximum of an operator response or a center of gravity) which means that many blob detectors may also be regarded as interest point operators. Blob detectors can detect areas in an image which are too smooth to be detected by a corner detector.

Consider shrinking an image and then performing corner detection. The detector will respond to points which are sharp in the shrunk image, but may be smooth in the original image. It is at this point that the difference between a corner detector and a blob detector becomes somewhat vague. To a large extent, this distinction can be remedied by including an appropriate notion of scale. There are several motivations for studying and developing blob detectors. One main reason is to provide complementary information about regions, which is not obtained from edge detectors or corner detectors. In early work in the area, blob detection was used to obtain regions of interest for further processing. These regions could signal the presence of objects or parts of objects in the image domain with application to object recognition and/or object tracking. In other domains, such as histogram analysis, blob descriptors can also be used for peak detection with application to segmentation.

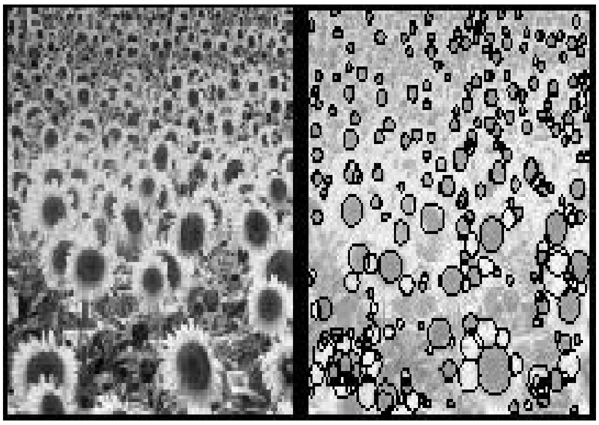

Fig 4 Blob Detection

- **Ridges**:

For elongated objects, the notion of *ridges* is a natural tool. A ridge descriptor computed from a grey-level image can be seen as a generalization of a medial axis. From a practical viewpoint, a ridge can be thought of as a one-dimensional curve that represents an axis of symmetry, and in addition has an attribute of local ridge width associated with each ridge point. Unfortunately, however, it is algorithmically harder to extract ridge features from general classes of grey-level images than edge-, corner- or blob features. Nevertheless, ridge descriptors are frequently used for road extraction in aerial images and for extracting blood vessels in medical images—see ridge detection.

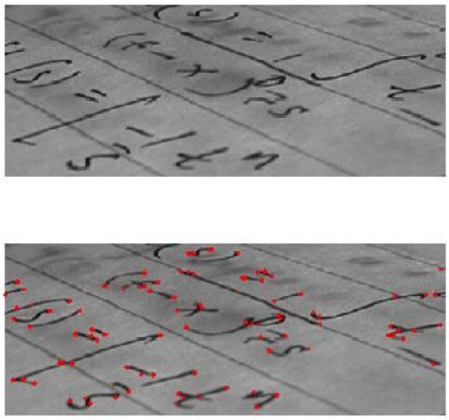

Fig 5 Ridge Detection

Overview of the system

- Capture Image
- Convert to gray scale
- Gray to Binary scale
- Calculate Traffic density
- Led will glow
- Current traffic on road will be uploaded and message will be sent to the control room accordingly.

(IV) DESCRIPTION OF PROJECT

Two traffic control techniques, cyclic and acyclic, are widely used. In ATCS, time is distributed cyclically to each road of the intersection. The roads on each intersection are assigned names as Road A, Road B, Road C and Road D as shown in Fig. 1. Each road has a standard set of signals namely red, yellow and green. During initialization the camera is rotated by 90 degrees after every 2 seconds to take the pictures of all roads on intersection. All the signals on intersection are turned red at this moment. After the images have been processed, time is assigned to each road according to its traffic density as Time A, Time B, Time C and Time D. The green signals are turned on in sequence starting from Road C to Road D to Road A to Road B and back to Road C. Camera position is adjusted in such a way so that it is always two steps ahead from the road signal which has been turned green. For example, if green signal of Road C is turned on, then camera will be pointing towards Road A. The camera will capture Road A conditions after the time "Time C-Snap Time" is elapsed and moved to next position, Road B. Snap Time is fixed at 3 seconds. After the calculated time for Road C is passed, its green signal is turned off and green signal of Road D is turned on. The state of the signal is changed with a delay of 1 second in between. The complete sequence of signals for ATCS is shown in the Table.

SIGNALING SCHEME AND SEQUENCE FOR ADAPTIVE TRAFFIC CONTROL SYSTEM

Camera Pos	Camera Pics	Road A			Road B			Road C			Road D			Signals Duration
		R	Y	G	R	Y	G	R	Y	G	R	Y	G	
D	Take Pics of All Roads with 2s in b/w	1	0	0	1	0	0	1	0	0	1	0	0	8 sec
A		1	0	0	1	0	0	0	1	0	1	0	0	1 sec
A		1	0	0	1	0	0	0	0	1	1	0	0	Time C-Snap Time
A	Take Pic of A	1	0	0	1	0	0	0	0	1	1	0	0	Snap Time
B		1	0	0	1	0	0	1	0	0	0	1	0	1 sec
B		1	0	0	1	0	0	1	0	0	0	0	1	Time D-Snap Time
B	Take Pic of B	1	0	0	1	0	0	1	0	0	0	0	1	Snap Time
C		0	1	0	1	0	0	1	0	0	1	0	0	1 sec
C		0	0	1	1	0	0	1	0	0	1	0	0	Time A-Snap Time
C	Take Pic of C	0	0	1	1	0	0	1	0	0	1	0	0	Snap Time
D		1	0	0	0	1	0	1	0	0	1	0	0	1 sec
D		1	0	0	0	0	1	1	0	0	1	0	0	Time B-Snap Time
D	Take Pic of D	1	0	0	0	0	1	1	0	0	1	0	0	Snap Time

Table 1 Working of the System

Fig 6 Experimental Setup

Image Analysis

The acquired image from the camera is processed to calculate the total covered area of vehicles on the road. The greater the number of vehicles in region of interest on the road, the greater will be the covered area and more will be the time assigned to that road. The main steps of image processing are described below:

1) ***Region of Interest (ROI) Selection***: The main objective for selecting a region of interest (ROI) is to filter out undesired information present on roads. First of all, pictures of all empty roads of intersection are captured and saved. Since the image is a matrix, so some desired rows and columns are deleted from these images and these are then saved as region of interest images. This process of selecting a portion of the original image is also known as cropping of image.

2) ***Conversion to Grayscale***: The acquired image of actual road condition is converted into grayscale image with histogram equalization process for improving the image contrast.

3) ***Conversion to Binary***: The grayscale image is converted into binary format

4) ***Applying ROI***: The converted binary image is anded with ROI image on pixel by pixel basis to remove the undesired area.

5) ***Edge Detection***: The edges are then found in the resulting image using the sobel edge detection method. It returns edges at those points where the gradient of image is maximum.

6) ***Morphological Operations***: The resulting image with edges is first eroded using disk as structuring element to remove noise. It is then dilated with line as structuring element to remove the discontinuities in object edges making the boundaries continuous.

7) ***Road Time Calculation***: White pixels in image are then counted for allocating the time to signals of all roads at intersection. More white pixels will correspond to denser road and hence more time will be assigned.

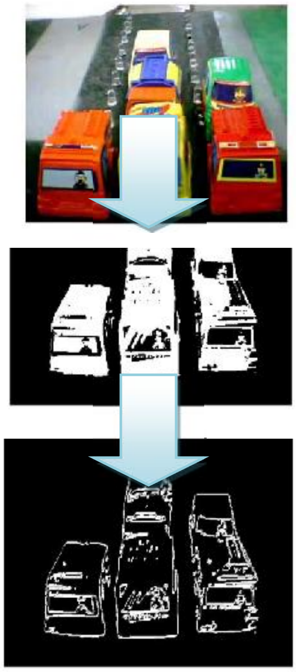

Fig 7 Complete Process of Image Conversion

OUTPUT/SCREENSHOTS

OUTPUT :

Sizeblob 1 = 5 671

The number of cars on 1st road detected are 1

Sizeblob 2 = 1 663 483

The number of cars on 2nd road detected are 2

Sizeblob 3 = 632 652 671

The number of cars on 3rd road detected are 3

The number of cars on 4th road detected are Absence of cars

SCREENSHOTS

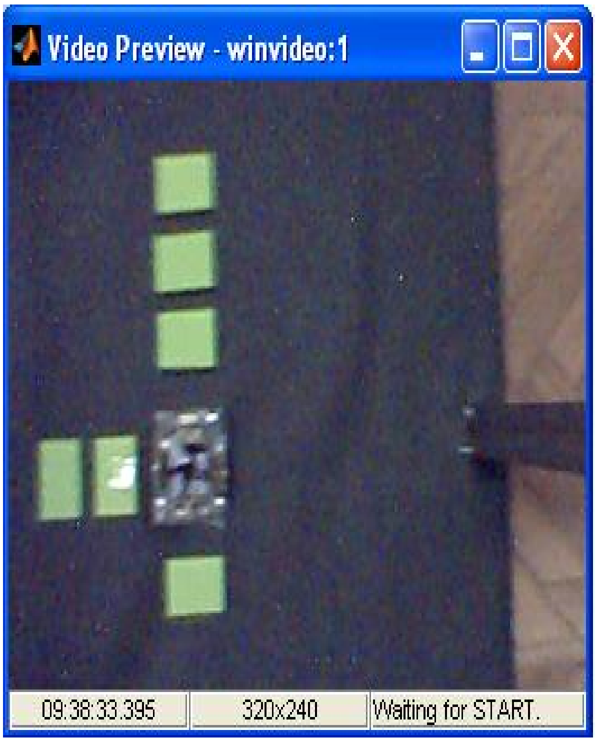

Fig 8 Video Feed from Camera

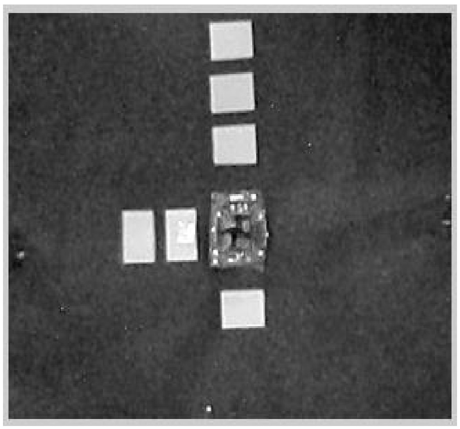

Fig 9 Grayscale Image of Traffic Signal

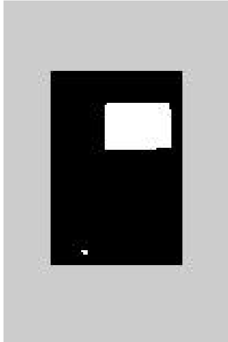

Fig 10 Image of Road 1

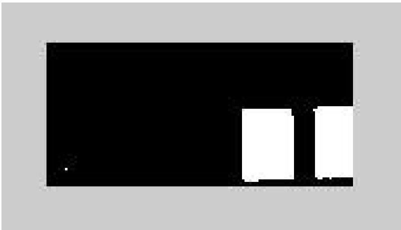

Fig 11 Image of Road 2

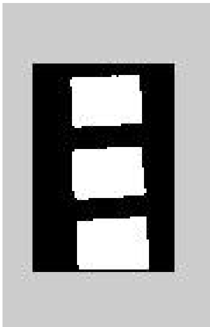

Fig 12 Image of Road 3

Fig 13 Image of Road 4

Future Enhancements

- The present system has a single camera mounted for a particular junction. In future, a separate camera for each road at an intersection will allow the system to use video processing which can improve the system efficiency further.

- The vehicle objects can also be categorized into various classes depending upon the geometrical shape of vehicle for blocking the passage of large vehicles e.g., trucks during day times. This will further help our cause in managing the traffic.

- Also, the entire system can be collaborated with a GSM Interface enabling the signals to be controlled via Mobile phones in case of an emergency. This might be beneficial in case of ambulance, police or fire brigade.

Summary and Conclusions

The study 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 voids the time being wasted by a green light on an empty road. 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.

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