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Real-Time Adaptive Traffic Light Management Using Image Recognition Technique

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Abstract— That the inadequate infrastructure cannot handle the issue of traffic is also a 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 vehicles. Instead of working on roads to accommodate the growing traffic various techniques have been devised to control the traffic on roads like embedded controllers that are installed at the junction. Adaptive signal control technologies are also kinder to the environment. Using adaptive traffic light controller can reduce emission of hydrocarbons and carbon monoxide due to improved traffic flow.

Many techniques have been developed in image processing during the last four to five decades. Most of the methods are developed for enhancing image obtained from unmanned space probes, spacecraft and military reconnaissance flights. Image processing system are becoming wide popular due to easy availability of powerful personnel computers, large memory devices, graphics software and many more. Real time management of traffic system is proven to work, yet these systems have been deployed on less than 1% of existing traffic signals. Federal highway administration is now working to bring these technologies to the rest of the country. For frustrated travelers, the optimal balance of red light/ green light is on the way. We have designed a new adaptive controller for the traffic.

Keywords— Real time management, image processing, Federal highway administration, red light/ green light etc.

I. Introduction

In modern life the people 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 scantly infrastructure and the irrational distribution of the development are main reasons for augmented traffic jam. The major cause leading to the traffic jam is the high number of vehicles was caused by the population and 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 is really efficient in fact. That the inadequate infrastructure cannot handle the issue of traffic is also a 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 vehicles. Instead of working on roads to accommodate the growing traffic various techniques have been devised to control the traffic on roads like embedded controllers that are installed at the junction. Adaptive signal control technologies are also kinder to the environment. Using adaptive traffic light controller can reduce emission of hydrocarbons and carbon monoxide due to improved traffic flow.

Real time management of traffic system is proven to work, yet these systems have been deployed on less than 1% of existing traffic signals. Federal highway administration is now working to bring these technologies to the rest of the country. For frustrated travelers, the optimal balance of red light/ green light is on the way.

A. PROBLEM STATEMENT:

In four way lanes, the traffic is not same in all the lanes. Sometimes the signal is green for the lane with no traffic, this will increase the traffic further more in busy lanes. To overcome the situation, adaptive traffic light controlling system is used.

B. OVERVIEW

Poor traffic signal timing contributes to traffic congestion and delay conventional signal systems use pre-programmed, daily signal timing schedules. Adaptive signal control technology adjusts the timing of red, yellow and green lights to accommodate changing traffic patterns and ease traffic congestion. The main benefits of adaptive signal control technology over conventional signal system are that it can.

- Continuously distribute green light time equitably for all traffic movements.
- Improve travel time reliability by progressively moving vehicles through green lights.
- Reduce congestion by creating smoother flow.
- Prolong the effectiveness of traffic signal timing.

The infrastructure creation by way of widening of roads, constructing flyovers, installing traffic signals and employing traffic signals at intersection and pedestrian crossing are giving only a temporary relief and increased vehicles are occupying the space created. The signals at traffic intersection and pedestrian crossing are termed as invisible speed breakers by the vehicular commuters.

II. LITERATURE SURVEY

H.S. Mohana developed a new approach in detecting and counting vehicles in day environment by using real time traffic flux through differential techniques. Counting object pixel and background pixel in a frame leads to the traffic flux estimation. The basic idea used is variation in the traffic flux density due to presence of vehicle in the scene. In this paper a simple differential algorithm is designed and tested with vehicle detection and counting application. Traffic flux estimation will play vital role in implementing vehicle detection and counting scheme. Real time dynamic scene analysis has become very important aspect as the increase in video analysis. The technique developed is having simple statistical background. Dynamic selection of images from the sequence is implemented successfully in order to reduce the computation time. The designed technique are evaluated such a 20 different video sequences and weighed thoroughly with simple confidence measures. To make the design illumination invariant, a section of the background is taken as reference, which will not be affected by the traffic flow. Threshold is fixed and used to discriminate the low, medium and high traffic flux. There is a plot for traffic flux density; it's basically 1% flux density versus number of frames. Basically vehicle detection is carried out by using this plot. Suppose if there is vehicle in the scene, then there is a flux change according to vehicle size. Obviously if there is big vehicle (or object), there is maximum or if there is small vehicle (or object), there is minimum amount of flux (white pixels).

For online learning, incremental algorithm of the SVM was previously proposed in and the approach was adapted to other variants of kernel machines. When a single data point is added and/or removed, these algorithms can efficiently update the trained model without re-training it from scratch. Although these algorithms were developed in different context, they can be considered as instances of parametric programming or path-following.

Laura Munoz proposed a system to estimate traffic density with the cell transmission model. This uses cell densities as state variables instead of cell occupancies, and also accepts non uniform cell lengths, and allows congested condition to be maintained at the downstream boundary of a modeled freeway section. Using cell densities instead of cell occupancies permits to include uneven cell lengths, which leads to greater flexibility in partitioning the highway.

Tomas Rodriguez proposed a system on real-time traffic monitoring; the system is self-adaptive and is able to operate autonomously for long periods of time, i.e. no hidden parameters to be adjusted. It performs in all weather condition and automatically selects the appropriate algorithm for day, night and transition periods. The system is robust against fast and slow illumination changes and is able to cope with long broken shadows, and shadows from parallel roadways. Ordinary camera movements (i.e. wind vibrations) hardly affect its performance because the system is tolerant against temporal tracking errors and strict constraints are used to identify the vehicles. Here the system segments the video by extracting the moving objects of the scene and performing a preliminary classification (i.e. it will not attempt to identify shadows). Once the work image has been created the image is segmented by extracting the moving objects using an adaption of well- known back-ground suppression techniques. The system uses detection and tracing steps to make an abstraction of physical objects implicit in the segmentation mask for every incoming image and then track those objects in the sequence until all vehicles and shadows present in the scene is identified.

A. Standard Traffic Control Systems:

1) Manual Controlling:

Manual controlling the name instance it requires man power to control the traffic. Depending on the countries and the states the traffic police are allocated 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 traffic.

2) Automatic Controlling:

Automatic traffic light is controlled by timers and electrical sensors. In traffic light each phase a constant numerical value loaded in 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 vehicles and signals on each phase, depending on the signal the lights automatically switch ON and OFF.

3) Drawbacks:

The manual controlling system need more man power. Due to poor strength of traffic police it is difficult to control traffic manually in all area of a city or town. So it is better to control timer for each 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 a 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.

B. Image Processing in Traffic Light Control:

The proposed 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 vehicles presence because it uses actual traffic images. It visualizes the practicality, so it functions much better than those system that rely on the detection of vehicles metal content.

C. 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.

III. DETAILED DESCRIPTION OF PROJECT

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 operation such as sharpening, blurring, 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. It is better to choose image processing for calculation of traffic density as camera are very much cheaper than other devices 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.

A. Methodology:

There are many methods of detecting vehicles on road such as motion detection, installing lasers on both side of the road etc., which is tedious and involve large number of hardware. This method uses image processing techniques to count the number of vehicles on road and estimate the density. The number of vehicles found can be used for surveying or controlling the traffic signal. Our methodology is based on vehicle detection using image processing.

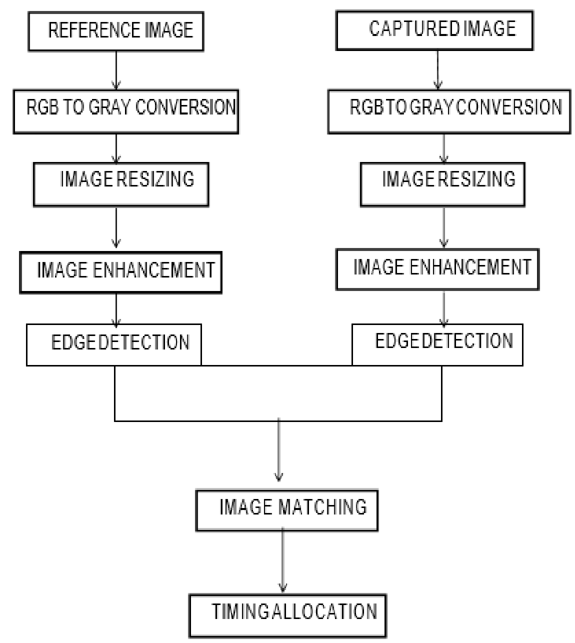
B. Block Diagram

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 an image. It is also called the gray level of image at that point. Convert these x and y values to finite discrete values to form a digital image. The image of retina is taken for processing and to check the condition of the person. 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.

Formation of Image:

There are some conditions for forming an image f(x,y) as values of images are proportional to energy radiated by a physical source. So f(x,y) must be nonzero and finite.



The block diagram above gives an overview of how traffic will be conducted using image processing.

C. Image Pre-Processing:

1) Image Resizing/Scaling:

Image scaling occurs in all digital photos at some stage whether this be in photo enlargement. It happens anytime you resize 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 cameras has its resolution, so when a system is designed for some camera specification 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.

2) RGB to GRAY Conversion:

An RGB image can be viewed as three images (a red scale image, green scale image and blue scale image) stacked on top of each other. In MATLAB, an RGB image is basically a M*N*3 array of color pixel, where each color pixel is a triplet which corresponds to red, blue and green color component of RGB image at a specified spatial location.

Similarly, a gray scale image can be viewed as a single layered image. In MATLAB, a grayscale image is basically M*N array whose values have been scaled to represent intensity.

In MATLAB, there is a function called rgb2gray() is available to convert RGB image to gray scale image. Here there is a need to convert an RGB image to grayscale image without using rgb2gray() function.

The key idea is to convert an RGB image picture which is a triplet value corresponding to red, blue and green color component of an image of a specified spatial location to a single value by calculating a weighted sum of all three color components.

Algorithm for conversion:

1. Read RGB color image into MATLAB environment.
2. Extract red, blue and green color components from RGB image into three different 2D matrices.
3. Create a new matrix with the same number of rows and columns as RGB image, containing all zeros.
4. Convert each RGB pixel values at location (i,j) to gray scale values by forming a weighted sum of red, green and blue color component and assign it to corresponding location(i,j) in new matrix.

D.IMAGE ENHANCEMENT:

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

In poor contrast images, the adjacent characters merge during binarization. The spread of the characters have to be reduced before applying the threshold to the word image. Introduce 'power law transformation' which increases the contrast of the characters and helps in better segmentation.

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.

E. EDGE DETECTION:

Edge detection is a name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes shortly 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 discontinuities over time is known as change detection. Edge detection is a basic tool in a image processing, machine vision and computer envisage, particularly in the areas of feature reveal and feature extraction.

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.

Following are list of various edge detection methods:

1. Sobel edge detection technique.
2. Perwitt edge detection technique.
3. Roberts edge detection technique.
4. Zero cross threshold edge detection technique.
5. Canny edge detection technique.

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

2) Canny edge detection technique:

Canny proposed a filter determined analytically from three criteria:

1. Ensure a proper detection: a strong response even at low contours.
2. Guarantee a good location.
3. Ensure that for a contour, there will be only one detection(avoid the effects of rebounds due, for example, truncation filters).

These three criteria’s are expressed in the joint optimization of three functional that define the optimal linear filter for the vehicle detection in an image.

The canny edge detection algorithm consist of following basic steps;

1. Smooth the input image with Gaussian filter.
2. Compute the gradient magnitude and angle images.
3. Apply non maxima suppression to the gradient magnitude image.
4. Use double thresholding and connectivity analysis to detect and link edges.

F. 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. Further more, 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(example: C,FORTAN) 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 world wide.

It has powerful built in routines that enable a very wide variety of computation. It also has easy to use graphics commands that make the visualization of results immediately available. Specific application are collected in packages referred to has toolbox. There are toolboxes for signal processing, symbolic computation, control theory, simulation, optimization and several other fields of applied science and engineering.

There are various tools in MATLAB that can be utilized for image processing, such as Simulink, GUI, etc.. Simulink contains various toolboxes and image processing tool box is one such example. Simulink is used for simulation of various projects. GUI is an another important tool in MATLAB. It can be designed either by manual programming which is tedious task or by using guide. GUI is explained in next section.

G.GUI:

A graphical user interface(GUI) is a graphical display in one or more windows containing controls ,called components, which enable a user to perform interactive tasks. The user of the GUI does not have to create a script or type commands at the command line to accomplish the tasks. Unlike coding programsto accomplish tasks, the user of a GUI need not understand the details of how the tasks are performed. GUI components can include menus,toolbars,push buttons, radiobuttons,listboxesand sliders just to name a few. GUIs created using MATLAB tools can also performed any type of computation,read and write data files, communicate with other GUIs, and display data as tables or as plots.

The GUI contains

1. An access components

2.A pop-up menu listing three data sets that correspond to MATLAB Functions: peaks, membrane, and sinc

3. Astatic text componentto label the pop-up menu

4. Three buttons that provide different kinds of plots: surface, mesh and contour When you click a push buttons, the axes component displays the selected

datasets using the specified type 3D plot.

Typically,GUIs wait for an end user to manipulate a control and then respond to each user action in turn. Each control, and the GUI itself, has one or more callbacks, named for the fact that they “call back” to MATLAB to ask it to do things. A particular user action, such as pressing a screen button, or passing the cursor over a component, triggers the execution of each callback. The GUI then response to these events.You as the GUI creator, write call backs that define what the components do to handle events. This kind of programming is often referred to as event-driven programming. In event-driven programming,callback execution is asynchronous, that is event external to the software trigger call back execution. In the case of MATLAB GUIs, most events are user interactions with the GUI, but the GUI can respond to other kinds of events as well, for example, the creation of a file or connecting a device to the computer.

You can code call-backs in two distinct ways: As MATLAB language functions stored in files

As strings containing MATLAB expressions or commands (such as c=sqrt(a*a+b*b))using functions stored in code files as call-backs is preferable to using strings, because functions have access to arguments and are more powerful and flexible. MATLAB scripts cannot be used as call-backs. Although it can provide a call-back with certain data and make it do anything you want, you cannot control when call-backs execute. That is, when GUI is being used, it no control over the sequence of events that trigger particular call-backs or what other call- backs might still be running at those times. This distinguishes event-driven programming from other types of control flow, for example processing sequential data files.

A MATLAB GUI is a figure window to which the add user operated components. These components can be selected ,sized and positioned as like using call-backs and can make the components do what it want when the user clicks or manipulates the components with keystrokes.

Two ways to build MATLAB GUIs :

1. Use GUIDE(GUI development environment), an interactive GUI construction kit.

This approach starts with a figure that you populate with components from within a graphic layout editor.

GUIDE creates an associated code file containing call-backs for the GUI and its components. GUIDE saves both the figure and the code files. Opening either one also opens the other to run the GUI.

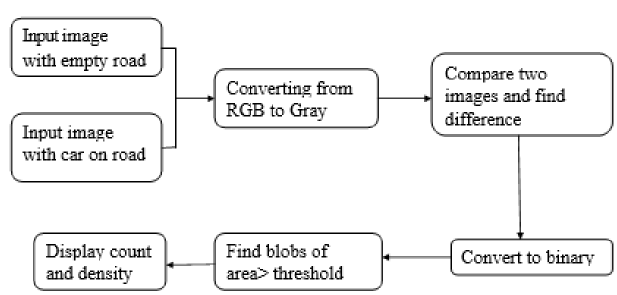
2. Create code files that generates GUIs as function or scripts.

Using this approach, create a code file that defines all component properties and behaviours. When a user executes the file, It creates a figure is not saved between sessions because the code in the file creates a new one each time it runs.

The code files of the two approaches look different. Programming GUI files are generally longer, because they explicitly define every property of the figure and its controls, as well as the call-backs. GUIDE GUIs define most of the properties within the figure itself. They store the definitions in its FIG-file rather than in its code files. The code files contains call-backs and other functions that initialize the GUI when its opens.

Create a GUI with GUIDE and then modified it programmatically. However it cannot create a GUI programmatically and then modify it with GUIDE. The GUI-building technique chosen depends on the experience, preferences, and the kind of applications the GUI need to operate.

H.BLOCK DIAGRAM:



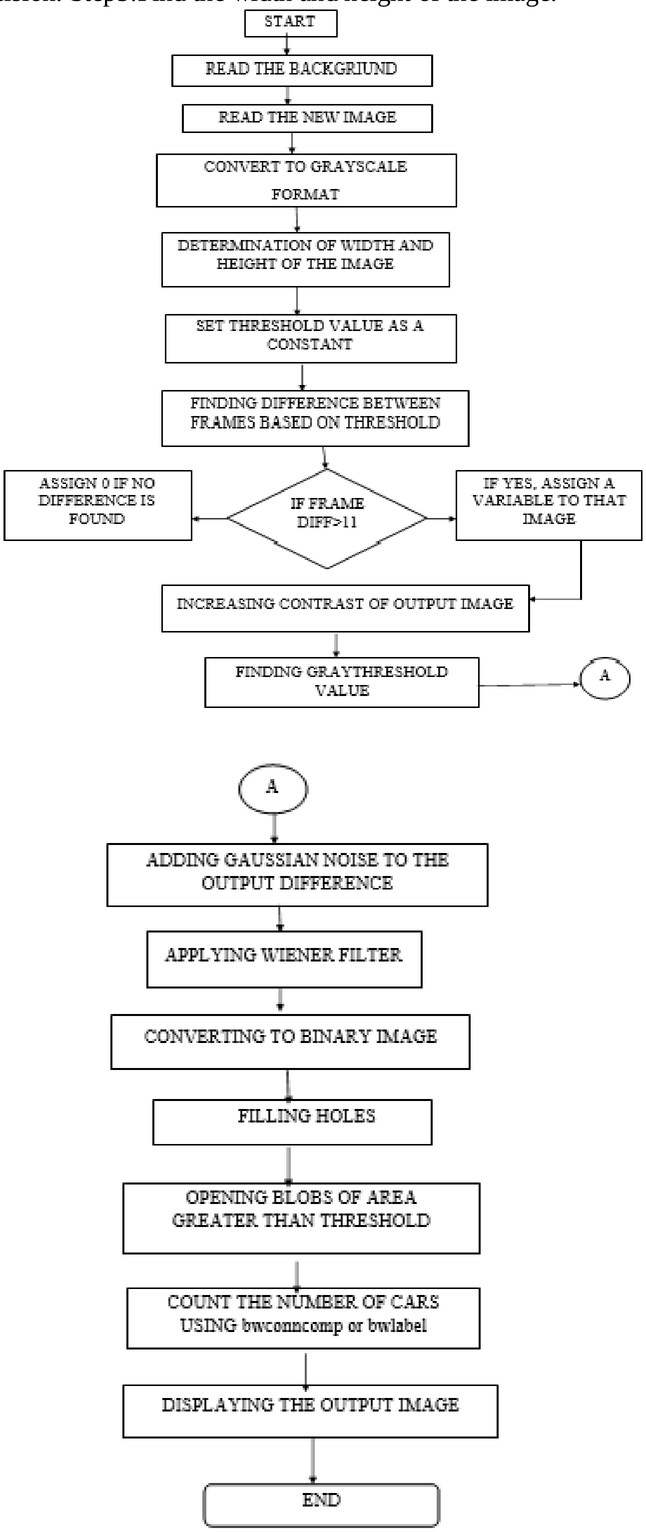
In vehicle counting two input images are given, one without cars and the other with cars in it. The input image is then converted from RGB to gray. Now compare the two images and find the difference. Then the image is converted to binary. The blobs in the image are taken when the blob area is between the area of smallest and largest vehicle in that particular image and in some cases the blob area above some threshold is removed. Finally the count of vehicles and density of traffic are displayed.

I. ALGORITHM:

Vehicle count: Step1: Start the program

Step2: Read the input background image of the empty road. Step3:Read the new image with vehicles on road.

Step4:Convert the images to grayscale format using double precision. Step5:Find the width and height of the image.



Step6:Set threshold value equal to 11.

Step7: Find the difference between frames based on the threshold,

Step8:If frame diff> than 11 then assigning the image to a variable else"0" if no difference is found.

Step9: Increase the contrast of the output image using imadjust() Step10: Find a gray threshold value using graythresh() command. Step11: Add Gaussian noise to the output difference.

Step12: Apply Weiner filter to filter the blobs. Step13: Fill holes to the blobs.

Step14: Open all blobs having area>than threshold. Step15: Count the number of cars using bwconncomp. Step16: Display the output image.

Step17:Stop the program.

J. FLOW CHART:

K. MODULE DESCRIPTION:

Getting the input image:

imread() reads a grayscale or color image from the file specified by the string file name. If the file is not in the current folder or in a folder on the MATLAB path,specified the full pathname.

In this module we get two input image one is the image with vehicles and the other image is a background image without vehicles in it.

Converting color image into gray:

Rgb2gray() converts both the images to gray images. Convert both image into gray level by using double precision.

In MATLAB, there is a function called rgb2gray() is available to convert RGB image to gray scale image. Here there is a need to convert an RGB image to grayscale image without using rgb2gray() function.

The key idea is to convert an RGB image picture which is a triplet value corresponding to red, blue and green color component of an image of a specified spatial location to a single value by calculating a weighted sum of all three color components.

Foreground detection:

Set threshold value=11, find the difference between two images by using abs() [absolute], abs can help find the absolute between the two images. If the difference between the two images is greater than the threshold value of 11 than those will be displayed as blobs at the output.

Morphological operation:

imageadjust(imadjust()) used to adjust the image intensity vale to the color map. graythresh() used to set a suitable gray threshold value for the output image.

Add Gaussian noise to the output image and filter it using Weiner filter.Convert image to binary and fill holes if necessary. Open blobs of area greater than threshold, this will help detect vehicles.

Counting and density calculation:

Count the number of blobs by using bwconncomp, the number of blobs gives the number of vehicles present in the

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image. From the count the density of traffic can be estimated.

It has powerful built in routines that enable a very wide variety of computation. It also has easy to use graphics commands that make the visualization of results immediately available. Specific application are collected in packages referred to has toolbox. There are toolboxes for signal processing, symbolic computation, control theory, simulation, optimization and several other fields of applied science and engineering.

IV. IMPLEMENTATION AND RESULTS

A. IMPLEMENTATION:

An image with car and an image without car is taken and convert it into grayscale images. Then the absolute difference between the two images is found and foreground image is detected. By using that image, the number of vehicles is counted.

1) INPUT IMAGES:

Lane 1:

FIGURE 4.1

FIGURE 4.2

Lane 2:

FIGURE 4.3

FIGURE 4.4

Lane 3:

FIGURE 4.5

FIGURE 4.6

Lane 4:

FIGURE 4.7

FIGURE 4.8

Lane 1:

FIGURE 4.9

FIGURE 4.10

Lane 2:

FIGURE 4.11

FIGURE 4.12

Lane 3:

FIGURE 4.13

FIGURE 4.14

Lane 4:

Lane 1:

FIGURE 4.17

Lane 2:

FIGURE 4.18

Lane 3:

FIGURE 4.19

Lane 4:

FIGURE 4.20

Lane 1:

FIGURE 4.21

Lane 2:

FIGURE 4.22

FIGURE 4.23

Lane 4:

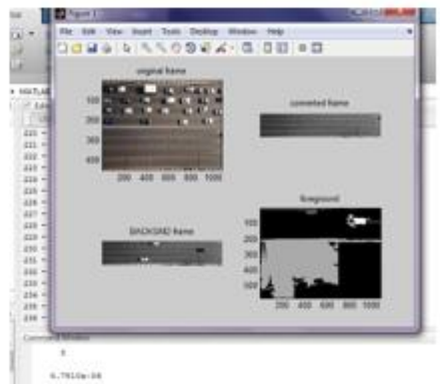

FIGURE 4.24

V.CONCLUSION AND FUTURE ENHANCEMENT

A. CONCLUSION:

"Traffic control using image processing" technique that we propose overcomes all the limitations of the earlier techniques used for controlling the traffic. Earlier in automatic traffic light 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 has compared to traditional techniques. 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 count of vehicles. The accuracies in calculation of time due to single moving camera depends on the registration position while facing road every time.

B. FUTURE ENHANCEMENT:

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.

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