JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DENSITY BASED TRAFFIC CONTROL SYSTEM USING IMAGE PROCESSING

VAIBHAV A. SURYAWANSHI, SARTHAK B. SHAH, SAGAR B. POKHARKAR
Department of Electronics and Telecommunication, Department of Electronics and Telecommunication
Assistant Professor, Department of Electronics and Telecommunication
AISSMS Institute of Information Technology, Pune, Savitribai Phule, Pune University, Maharashtra, India

ABSTRACT

In this project, a novel real-time traffic control system which can easily keep traffic in control using image processing techniques is presented. In this method, a webcam is used in each stage of the traffic light in order to take pictures of the roads where traffic is bound to occur. Count of vehicles in these images is calculated using image processing tools in "open cv" and different timings are allocated according to the count along with a green signal for vehicles to pass. The images capture by the camera is converted into the grey image and then it is given to the raspberry pie , where it analyze the image and decides whether the traffic density is high or not and according to this the timer of the signal is decided. In this project we have used the prototype like the green and red signals are represented using LEDs and the decrementing timer for the green sign.

1. INTRODUCTION

With the uncontrolled population growth, travelling has turned out to be a really hectic task in today's world. The increase in travelling people has caused a drastic growth in traffic at every nook and corner of the city. This, in turn, is contributing to the wastage of precious fuel and time which leads to impatience and frustration of the people. Traffic congestion is a common problem that has arisen due to the increased number of vehicles on the road. In order to deal with this problem, researchers have proposed many solutions. One of the currently used models is the timer model. Traffic can be controlled to a great extent by using timers at each phase of the traffic. Another model used is with the help of electronic sensors which detects the presence of vehicles, and produce appropriate signals. The cause of traffic is dependent on many factors like peak time, special days, season, bad weather, or unexpected events like accidents, special events or constructional activities. Once we get stuck in traffic, we may have to wait for hours to get out of it. We can solve this problem to a great extent by implementing this density based traffic control system using image processing which continuously manages the traffic lights based on traffic. This system uses image processing techniques such as background subtraction in order to find the count of vehicles present on the road (traffic density) which can be used to control the traffic signal light. The image processing tools which are present in Matlab can be used to program the code for finding the count of vehicles in a lane. This idea can be represented using a timer (Seven Segment Display) and LEDs instead of real traffic light.

2. LITERATURE SURVEY

[1] Prof. Vikram Deshmukh, Shruti Pantawane, Sonali Hajare, Anushree Kale proposed a system in which the conventional traffic light system has a fixed time pattern which doesn't vary as per the current traffic situation at the junction. This project helped sorting the problem by

capturing and converting the lanes images into greyscale images. Threshold value is calculated which will indicate the number of vehicles present at the particular lane. The project uses Image Processing using MATLAB software and microcontroller AT89S52. The advantages are the use of microcontroller preventing the error within machine and make things conditional and smart.

[2] Prakash, B. Sandhya Devi, R. Naveen Kumar, S.Thiyagarajan, P. Shabarinath proposed a system in which the number of vehicles was counted by the microcontroller. The microcontroller takes decision based on different vehicles count and updates the traffic light delays as a result. The processor used is the ARM architecture. The main advantage of the system is the information like number of vehicles on each lane will be known because of the sensors. The drawbacks that can be marked were the expensive sensors which incur lot of maintenance and the system is scalable.

[3] K. Vidhya, A. Bazila Banu proposed a system, in which the image captured in the traffic signal is processed and converted into greyscale followed by the calculation of threshold value indicating the number of vehicles present on that particular road. After this calculation, it came with the result to understand in which side the density is high. Raspberry Pi is used as a microcontroller for controlling the signals. The main advantages that are evident is firstly the use of OpenCV,secondly the usage of fast and low RAM usage. Also, the hardware level is feasible because use of Raspberry Pi. The disadvantages that can be figured out are that the OpenCV is not that flexible as compared to MATLAB. Also, the Raspberry Pi has a limited amount of memory.

[4] Prof. Durgesh shinde, Pallavi Shanbag, Sumitra mahajan, Dattray wagh proposed a system in which the conventional traffic light system has a fixed time pattern which doesn't vary as per the current traffic situation at the junction. This project helped sorting the problem by capturing and converting the lanes images into grayscale images. Threshold value is calculated which will indicate the number of vehicles present at the particular lane. The project uses Image Processing using MATLAB software and microcontroller AT89S52. The advantages are the use of microcontroller preventing the error within machine and make things conditional and smart.

3. METHODOLOGY

Existing Methods:-

There are numerous procedures proposed already for traffic monitoring to avoid the traffic jam on the road. The previously practiced traffic control system in most of the cities is based on fixed time control or manual control. However, the new implementations in a few cities focus on the implementation of the 'Adaptive Traffic Control System' (ATCS). In this system, with the help of traffic detectors, the traffic density is obtained from all approaches of 1 intersection of the road. The traffic light control time-dependent system has a fixed period to switch traffic between different directions. The traffic lights turn ON and OFF by itself based on the timer value. Consequently, the vehicles are made to wait for a longer period even on the empty road, or if the traffic density is very less. Using sensors is another way to control traffic by detecting the number of vehicles. Another most common strategy to control traffic is manual controlling. Manual controlling involves the need for traffic police. The traffic signals can be changed by the police manually based on the vehicles and traffic flow on the road by himself.

Issues in Existing Methods:-

A time-based traffic control system is one of the common methodologies or techniques to control traffic. But this methodology is contingent on time rather than on density. On account of this, the vehicles have to encounter an erratic delay in waiting time. The vehicles are made to wait even on the empty road in a time-based traffic control system which can again contribute congestion or traffic jam. Sensors can be used to detect vehicles and control traffic accordingly. But even in this method, the time is wasted by the green light on an empty road. Manual controlling engages the need for traffic police to change the traffic signals accordingly. This method also requires manpower. Although abundant methods are present already to control traffic, these methods can still bring on congestion due to disparate reasons. A traffic light control system based on the image processing technique can handle the problem of traffic congestion more effectively.

Proposed Method:-

The proposed system is implemented in Matlab with an objective to reduce the traffic based on density. Four main steps are considered for the system: a) image

acquisition b) RGB to grayscale transformation c) image enhancement and d) morphological operations. A camera is installed and used to capture video of the highway. The video is recorded continuously in consecutive frames and each frame is compared to the initial captured image. The total number of cars present in the video is found out using image processing algorithms. If the total number of cars exceeds a predefined threshold, heavy traffic status is displayed as a message. The block diagram of our proposed model is shown in Fig. 1.

A. Image Acquisition:

The first step in the process of image processing is the acquisition of the image. Generally, an image is considered to be a two-dimensional function ($\boldsymbol{a}$, $\boldsymbol{b}$) where a and b are spatial coordinates [6]. The value of the function at any point is known as the intensity, also known as the grey level of the image at that point. These and b values must be converted to finite discrete values in order to form a digital image which is necessary to process through a digital computer. Each digital image is composed of pixels which are finite elements. A webcam is used for capturing video and frames are extracted to obtain images. The intensity values are proportional to the radiated energy by a physical source. Hence pixel values must be nonzero and finite. $0 < (\boldsymbol{a}, \boldsymbol{b}) < \infty$ (1)

B. RGB to Gray Conversion:

The colour images are in RGB format. In grayscale images, each pixel is represented using 8 bits and pixel values are represented using 256 levels varying from 0 to 255. The greyscale values are obtained as a weighted average of the individual R, G and B components as in (2). .0.3R + 0.59G + 0.11B (2) Fig. 1 Block Diagram of Density Based Traffic Control System Using Image Processing

C. Image Enhancement:

Image enhancement is the process of adjusting the pixel values of an image either in the spatial domain or in the frequency domain to improve the visual perception of the captured image. Image enhancement tools in Matlab are used to obtain the grayscale version of the captured image with proper contrast and better quality. Image enhancement techniques used in the proposed method include noise removal using Wiener filter, Blob analysis and dilation.

D. Thresholding:

Image thresholding is a simple and effective method to differentiate an image into foreground and background. It's a segmentation process used to isolate objects from the background. If the histogram of the image is bimodal [7], a single global threshold can be used for segmentation. Automatic determination of the threshold value for each captured traffic image is done using Otsu's algorithm as discussed below. 1. Select an initial estimate for the global threshold value T. 2. Segment the image using threshold T. This will produce two groups of pixels, P1 consisting of all pixels with intensity values > T, and P2 consisting of all pixels with values ≤ T. 3. Compute the average (mean) intensity values a1 and a2 for the pixels in P1 and P2 respectively. 4. Compute a new threshold value: Tnew = 1 2 ($a1 + a2$) (3) 5. Repeat steps 2 to 4 until the difference between the two values of threshold in successive iterations is smaller than a predefined parameter ΔT.

E. Foreground Detection:

The aim of foreground detection is to detect changes occurring in the image sequences. Foreground detection is done to separate these changes taking place in the foreground from the background. All detection techniques are based on setting a reference background image and detecting changes which occur in the other images with respect to the reference image. Defining the background becomes challenging when the image contains shapes, shadows, and moving objects. A good foreground detection system must be able to develop a good background model and be robust to changes in lighting, repetitive movements (leaves, waves, shadows), and long-term changes. Here the foreground is detected using the automatically generated threshold value found out using Otsu's principle.

1. Vehicle Counting:

There are many methods presently in use to detect vehicles on road such as motion detectors, installation of lasers on both sides of the road, etc., which increases the hardware requirements. Our proposed system makes use of Otsu's Principle with image processing techniques to count the number of vehicles on road and hence estimate the density. The count of vehicles found can be used for controlling the traffic signal. To count the numbers of vehicles, two input images are given, one of the blank road and the other with the vehicles on the road. The input image is then converted from RGB to grayscale.

Now the two images are compared and the difference is taken using background subtraction and the difference image is converted into binary form. The blobs in the binary image are opened only when the blob area is greater than 2000. Using Matlab, the exact number of vehicles, are determined and the count is displayed using a seven segment display.

2. Time Allocation:

Once the number of vehicles is found out, then time allocation is done based on the count. Time allocation is indicated using LEDs which are connected to our circuit. Also, a Seven Segment Display screen is attached to display the time allotted. When the count of cars is greater than 1 and less than 5, the timer shows 5 seconds and LED blinks for 5 seconds. When the count of cars is greater than 5 and less than 10, then the timer shows 10 seconds and LED blinks for 10 seconds.

4. IMPLEMENTATION

The main parts required for this system are hardware, interfacing and software module [8].

Hardware Module:

A USB based web camera to capture images of the traffic on road. The hardware module consists of an Arduino board used to control LEDs representing the red and green lights. A timer module is used to display the remaining time.

Software Module:

MATLAB version R2016a is used as the image processing software which comprises specialized modules that perform specific tasks. Matlab coding is completed using the reference and captured images.

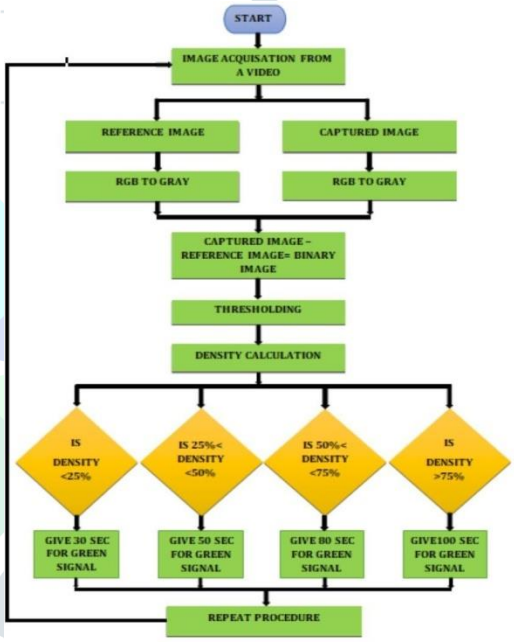
Interfacing:

A webcam is interfaced to the system and Arduino is interfaced to Matlab using serial communication.

The algorithm behind the block diagram consists of the following steps.

1. Start program
2. Capture image of the blank road by the connected camera module for reference
3. Capture image with vehicles
4. The images are converted from RGB to grey
5. A threshold value is found using Otsu's principle
6. Find the difference between frames using threshold
7. Add Gaussian noise to the difference output
8. Apply Weiner filter to it to filter the blobs
9. Convert to binary image
10. Fill holes to the blobs
11. Open all blobs having an area greater than 2000
12. Determine the number of cars
13. Display the output image
14. The count of vehicles is found and displayed.
15. According to the number of vehicles, green light is allotted for different timings for each count displayed by a seven segment

5. FLOW CHART OF THE WORKING METHOD



6. EXPECTED RESULTS

LANE NO 1

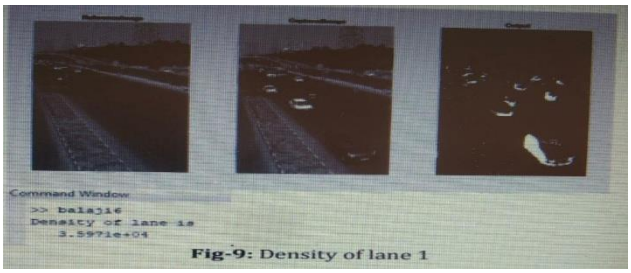


Fig-9: Density of lane 1

LANE NO 2

LANE NO 3

LANE NO 4

As discussed above we need a reference image to calculate density of the captured image. But it was hard to get a blank road such that lane without vehicle. We took some videos of different lanes having different traffic densities. From these videos we took a frame having low number of vehicles and considered it as reference image. Now a frame from a video is captured at any desired time, named Captured Image. This image is then compared with reference image and we got output as shown in following images. In the output images background is not completelydark this is because camera wasn't steady while taking videos. In above case of match boxes we got a steady image, that's why background was completely removed.

Now we got densities of all four lanes. These densities are compared with each other and each lane got timing for green signal according to its density. This output was seen on prototype of LEDs representing signal system. The timings for each signal were different according to density of vehicles present on that lane. Timings of green signalfor each lane were seen on two seven segment displays.

7. CONCLUSION

Density Based Traffic Signaling System provides a more efficient replacement to the current conventional traffic system. The system uses Image processing to compute the densities and accordingly provide the green light signal to the lanes. The system is an advantage to the denser traffic lanes providing ease of movement, avoiding congestion, also the pedestrians can safely cross the roads and the system is available 24/7. The system is a standalone design and meant to maintain its computation as long as it is connected to the power supply. Also, the design of the system considers the cost factor so as to provide efficient system in way less cost. Using this method at each crossway could help in a continuous journey of the people. This project focuses on making the standard traffic signal density based. This will make the traffic signal more feasible by giving green light time to the lane which has more density.

8. REFERENCES

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