

Density based Traffic Control System using Image Processing

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Abstract - We all know that world population is increasing day by day, so the need of transportation is also rising. This constant need leads to increase in number of vehicles. Most of the countries use traditional traffic signal system which has timer at its core to control the traffic lights in each lane. This system causes major time delays, slower speeds and longer journeys because of time wasted on lanes with lower densities or sometimes no density at all. This proposed system uses image processing and microcontroller to calculate the density of traffic on each lane. A camera is placed in each lane that will capture images of road. Different timings are assigned to each lane by microcontroller according to density of respective lane.

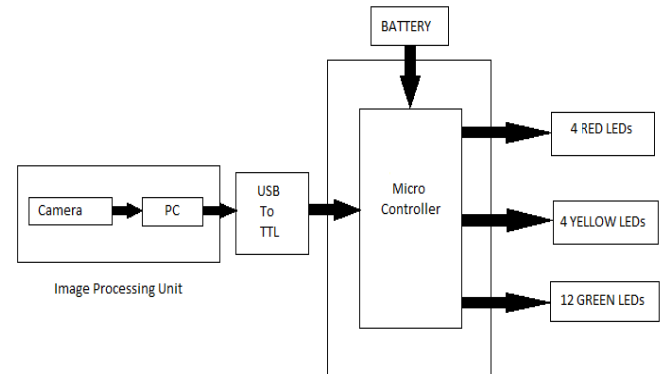


Fig-1: Block Diagram of Proposed System

Key Words: MATLAB, Image Processing, ARDUINO, Grayscale image, Thresholding, RGB image, LED, Seven Segment Display.

1. INTRODUCTION

A metropolitan city like Mumbai has car density of around 510 vehicles every kilometre, followed by Pune and Kolkata which has 359 and 319 vehicles per kilometre. Now controlling this kind of heavy traffic is a tedious task. So we need some advanced traffic management system to control this traffic. Imagine a system which uses images of a lane, calculates its density and decides timing of each lane accordingly. Here we propose a system which uses a webcam to capture images of each lane and these images are given to the MATLAB for image processing. After using various MATLAB algorithms density of each lane is calculated. A microcontroller is used to compare all the densities, prioritize them and show the output on signal system.

1.1 Procedure Adopted

In our system camera is dynamically capturing entire top view of the four lanes and sending it to the PC. PC will process the received images using MATLAB software and gives the information about the traffic density present in each lane. PC will send this information from processed image to the microcontroller using USB to TTL cable. USB to TTL is used for serial communication between PC and microcontroller. The information taken from PC is converted into Binary form followed by calculation of Density. Microcontroller will control the Traffic signal lights.

2. Working of Proposed System

To find out how density is calculated we have created our own database where we have considered matchboxes representing vehicles.



Fig-2: Reference Image



Fig-3: Lane 1



Fig-4: Lane 2

Let us consider above three images where an image with no vehicles is a reference image and following two images are two lanes with different densities of vehicles. MATLAB software is used to compare these two lanes with reference image. By comparing the two images such that reference image and captured image we get difference between two images. As we can see background of reference and captured image is same but number of moving objects which are vehicles is changing. This change is nothing but a difference between two images. A new image is formed after calculating the difference which is known as binary image. This binary image is then used to calculate density of vehicles in an image.

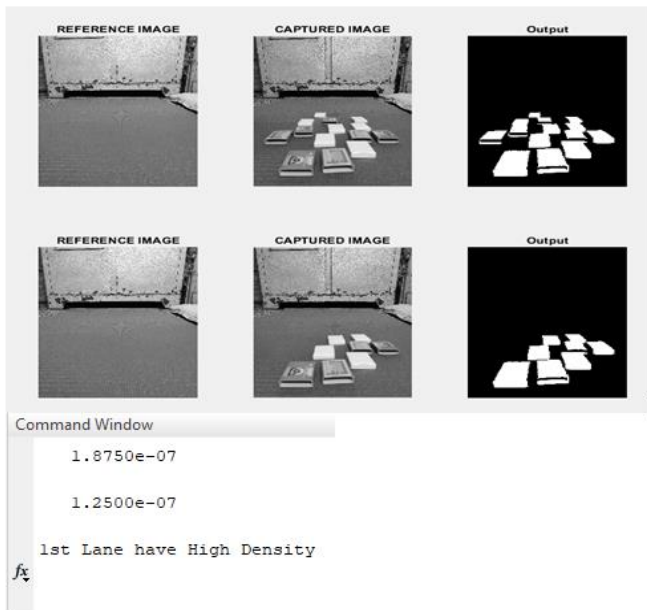


Fig-5: Output on MATLAB window

As we can see in the output image of MATLAB, after using various image processing algorithms density of both the lanes is calculated. This density is compared and the lane with highest density is shown.

Consider a signal system which uses image processing to control the traffic. Now consider a camera taking videos of each lane continuously, so at what time a frame should be captured and given to the software for further processing. By using some MATLAB functions we took a video from hardware of computer. We set the time for which a frame is to be captured. This captured image goes through various image processing techniques which are briefly discussed below.

2.1 Image Processing

First step is an image acquisition where an image frame is captured from video present on hardware of the computer. This image can also be called as RGB image, RGB image is nothing but a true color image. This RGB image is then converted into grayscale image.

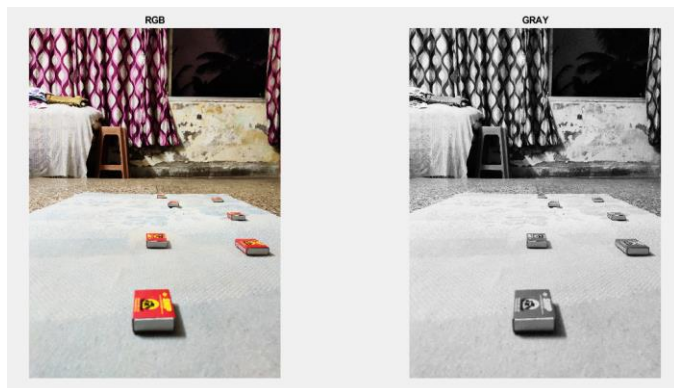


Fig-6: Grayscale of an image

A grayscale is a range of monochromatic shades from black to white. Therefore a grayscale image contains only shades of gray and no color. Image enhancement algorithm is used to simplify further image processing.

The next step is thresholding, main purpose of thresholding is to reduce the information in order to simplify further processing.

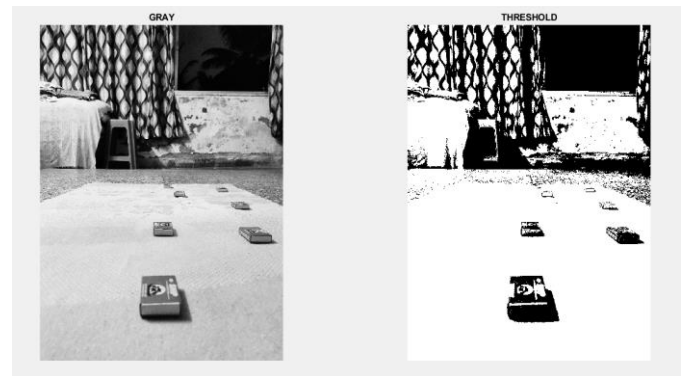


Fig-7: Thresholding of an image

In this method we will assign thresholding boundary where, pixels with luminosity greater than thresholding level are assigned with white color and others with black.

Now we find binary image, as already discussed binary image is nothing but subtraction of reference image from captured image. Binary image will show density of vehicles by white portion and the rest of the background will be dark. By using MATLAB functions we calculated density of traffic by calculating area occupied by white portion in an image.

2.2 Controlling Section

To establish a communication between MATLAB and external hardware such as microcontroller and web-cam interfacing has to be done. Support packages like ARDUINO support package and Web-cam support package are installed to interface the MATLAB with these external devices.

Then code for ARDUINO is executed in MATLAB. MATLAB compared and matched the density of lanes with reference image and calculated the percentage matching which is then given to the ARDUINO.

By using if-else loop statements the required seconds for which green signal will remain on was given. The duration of green signal of the lane with the highest traffic is more as compared to others, so that the traffic in that lane can pass and reduce the congestion.

To see the output we made a prototype having 4 Red, 4 Green and 4 Yellow LEDs representing signal system of four lanes. MATLAB gives calculated density values to ARDUINO and ARDUINO decides timing logic which should be given to the signal system. This system of LEDs is connected to ARDUINO. Final output which is timings for green signal of each lane can be seen on this prototype of LEDs.

A timer circuit is used to display timings of all the green signals. We used two seven segment displays which are connected to ARDUINO.

Calculated density will be shown in form of density. Let's say reference image has zero percent density so after comparing it with density of captured image, we will get new percentage value of density. This value of density is used to calculate timing for green signal. The logic behind this is shown in the flowchart shown below.

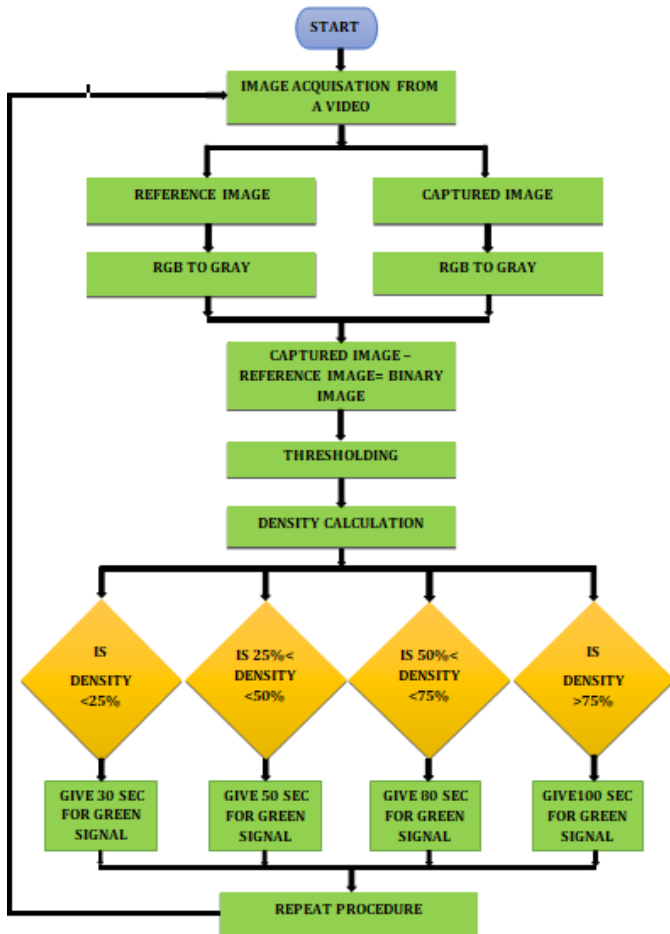


Fig-8: Flowchart of proposed system

3. Results

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 CapturedImage. This image is then compared with reference image and we got output as shown in following images. In the output images background is not completely dark 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. A video

from steady camera can completely remove background and we will only get density of vehicles. Now we can see the output of MATLAB in its command window. The output is nothing but density of that particular lane.



Fig-9: Density of lane 1

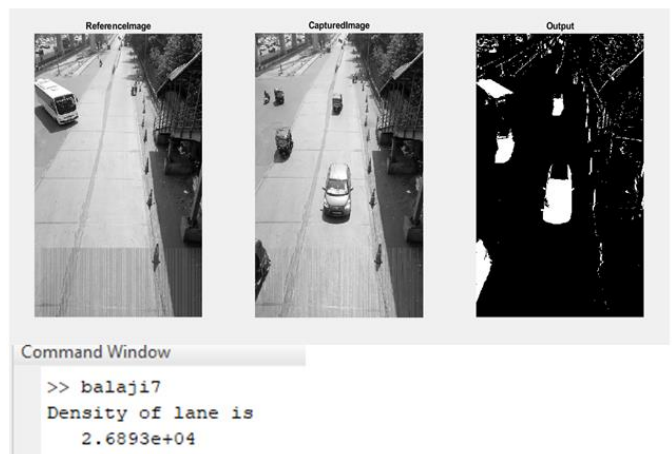


Fig-10: Density of lane 2



Fig-11: Density of lane 3

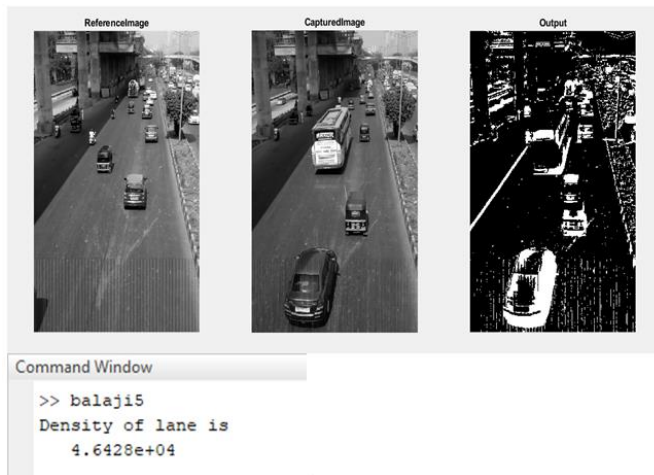


Fig-12: Density of lane 4

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 signal for each lane were seen on two seven segment displays.

4. CONCLUSIONS

Thus the system of Density based Traffic Control System using Image Processing has been successfully implemented. A microcontroller, ARDUINO MEGA was used to control the traffic signal system and two seven segment displays. Production costs are low while achieving high speed and accuracy. This density based image processing technique removes limitations of traditional signal controlling systems.

5. Future Scope

Image processing technology extracts information from images and integrates it for wide range of applications. Here we have outlined one of the most prominent fields where image processing could bring significant benefits. A density based image processing system will remove all the barriers which were placed by traditional timer or sensor based systems.

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