Traffic Management Using Digital Image Processing

[1]Gundeep Kaur, [2]Sonia Sharma
[1,2]Dept. of CSE, Guru Nanak Dev University, Amritsar, Punjab, India

Abstract
Due to increase in population, the number of vehicles is increasing rapidly. Increase in vehicles leads to many traffic problems like traffic jams, accidents, money loss, wastage of time, pollution, health problems and many more. So it is necessary to manage and control traffic. Various traffic management techniques are used each having its own advantages and disadvantages. Currently used techniques are not so efficient in terms of performance, cost, maintenance etc. In this paper, we will discuss traffic management system based on Digital Image Processing. Use of digital image processing will help in better traffic management and also it is cost effective.

Keywords
Image Processing, Traffic management, Edge detection, Image Matching

I. Introduction

There are number of technologies used to detect the congestion of traffic and to manage it.

A. Manual Control

Nowadays, traffic is controlled manually. A traffic police is hired to control traffic on highways or roads and whistle is used to control traffic. But it becomes a difficult job for him if the traffic is huge.

B. Automatic Control

Another method used to control traffic is Traffic light System. A numerical value is loaded in timer for each phase. Depending on changes in timer, light is set at ON and OFF states on different lanes. Problem with this approach is that it is not good to have a green light on an empty lane.
Another method used to control traffic is by using sensors. Sensors will get the traffic information about a particular lane and accordingly traffic lights might be set. But the problem is traffic information provided by sensors is limited.

C. Image Processing Control

Much better approach is to use the concept of Digital Image Processing. In this methodology Cameras is placed on a long pillar from where the lane view can be taken clearly. Camera is used to take images or videos of lane to check out the traffic at any instant on that lane. It will take the real time values in concern. Vehicles can be detected under various challenging conditions. Images captured by camera will be processed using image processing techniques and number of vehicles on each lane is counted. Time is assigned to traffic light on each lane according to the count or density of vehicle on that road with priority given to ambulance. If there is any obstacle detected, a message will be shown on the LCD regarding that obstacle.

II. DIP Approach

Digital Image Processing deals with manipulation of digital images through a digital computer. A digital image is passed to a system as input, system process the image using algorithms and produces a valuable image as output.
Human eyes can easily detect traffic jam. Computers can only process binary data. The picture on the road is actually a binary data, which needs to be represented as a digital image. The image when captured is unformatted and raw. Programmers process the raw image and extract useful information from them.
For properly managing the traffic, it can be continuously monitored using cameras. Video recorded is extracted into frames which are then sent to the server. The server further processes the frame with different activities i.e. performs brightening, blurring, sharpening etc. Then the concurrent frames are compared and depending on their results and the count of vehicles in the frame, the server updates status as high or medium or low traffic.

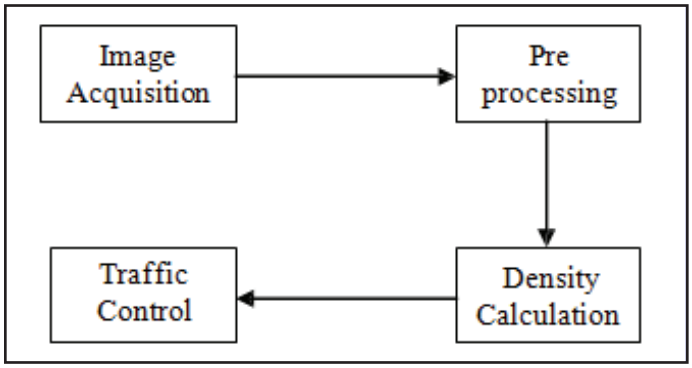

Fig. 1: Basic Architecture of Traffic Control System

First step is Image acquisition. Initially image is of the empty lane is captured for reference purpose. It is considered as a raw data. It is converted to grey scale and then converted to a binary image.

Image captured is then pre-processed i.e. enhanced so as to remove the noise and other environment effects on the image. Then edge detection is done to count the number of vehicles and vehicle density.

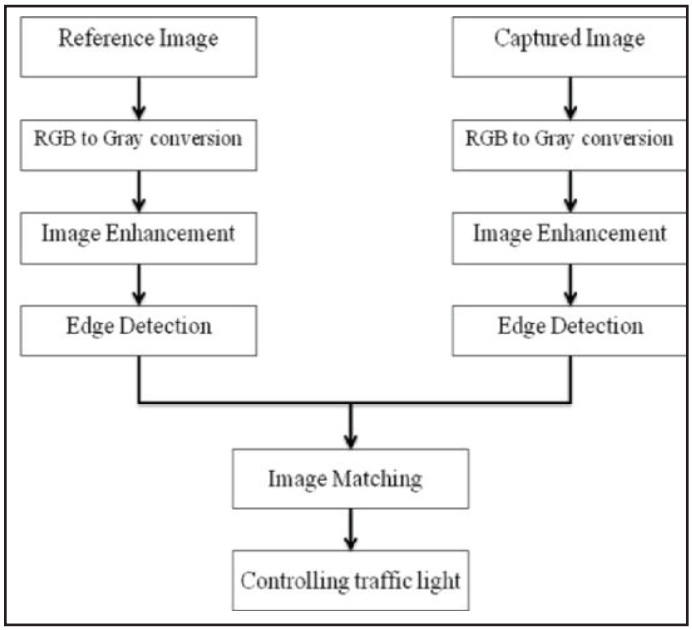

Fig. 2: Block Diagram

Preprocessing is done to get a clear image. Since the images are extracted from real time video frames they can be distorted, blurred or dark. Images can be blurred when the weather is foggy or rainy. Similarly, images can be darker when captured at night time conditions or can be too bright when it's very sunny (like in afternoon).Therefore different pre-processing methods are applied on the images to improve the quality of the image, according to the need of the user.

RGB to Gray conversion: Real time image of lane is captured, and converted into grey scale. This conversion is important. In RGB format there are three separate image matrices storing amount of red, amount of green, amount of blue in each pixel, whereas in gray scale we do not differentiate how much we emit of different colours, we emit the same amount in every channel.

Fig. 3: Gray Scale Conversion

Image enhancement highlights certain features of interest in image and involves operations like blurring, brightening, edge enhancement etc. to improve the information content. Sometimes image captured is blurred. As the moment of image capturing can't be recalled, deblurring of image is performed to enhance the image quality.

Edge Detection: In the Canny edge detection method an adaptive background subtraction is used. After that, canny edge detector will detect all the edges of the vehicles present in the image. Canny edge detector may prove to be effective as it considers all neighbourhood pixels while detecting edges.

Fig. 4: Edge Detected Picture

Traffic Control

The edge detected reference and real time images are matched and accordingly the traffic light durations can be set.

Fig. 5: Reference Image

Fig. 6: Captured Image

- If the matching is between 0 to 10% - green light is on for 90 seconds.
- If the matching is between 10 to 50% green light is on for 60 seconds.
- If the matching is between 50 to 70% green light is on for 30 seconds.
- If the matching is between 70 to 90% green light is on for 20 seconds.
- If the matching is between 90 to 100% - red light is on for 60 seconds.

In other methodology, the number of vehicles on each lane is detected and accordingly the traffic light timers are set to control traffic. The vehicle count can also be used to develop an android app that will give the user details about the traffic jam conditions at any particular location. Counting number of vehicles may be a problem when image has different types of vehicles, like car, bicycle etc. It is better to calculate the density of vehicle traffic rather than calculating the count of vehicles. Vehicle density can be calculated with the help of various algorithms. The density calculation can help in automatic traffic lights switching for better traffic management.

III. Emergency Vehicle Detection

In case any emergency vehicle is detected the traffic light timer is set to green till the ambulance is not crossing. Emergency vehicle is detected by density of their flashing red lights. Once detected it will be given priority over other vehicles.

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Fig. 7: Image of Vehicle in Day Time

Fig. 8: Detection of all Lights

Fig. 9: Detection of Emergency Vehicle

IV. Safety Message Display on LCD

Safety messages are shown on LCD like 'Wear Helmets' to avoid any accident and hence traffic congestion.

In case of any obstacle is located at a distant ahead the lane, the LCD attached along with camera will display a message and warn the drivers about the obstacle. If number of vehicles in that lane is more than the threshold then "Lane is blocked" message is displayed on LCD.

V. Conclusion

The study infers that image processing overcomes the limitations of all traditional methods of traffic control. It removes the need for extra hardware such as sound sensors. The use of multiple sequential cameras will help to increase the analysis of traffic jam at the local region. The use of image processing is good for traffic management but it still requires much improvement. The use of image processing may help to identify vehicles as they pass and priority can be given to emergency vehicles and help in supervision on a reasonably large scale.

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