A NOVEL TRAFFIC MANAGEMENT SYSTEM USING CANNY EDGE DETECTION

[1]Ankit Kumar Mishra, [2]Austin Emmanuel T, [3]Jayashree S, [4]Ms P Kokila
[1]Student, [2]Student, [3]Student, [4]Assistant Professors
[1,2,3,4] Information Science and Engineering
[1,2,3,4] The Oxford College of Engineering, Bangalore, India

Abstract: Currently the traffic control system in place in our country is non-flexible and non-adaptive to the ever-growing number of vehicles on the road. It does not take into account the changing traffic density during the different hours of the day. Consequently, the roads get congested frequently and intersections get blocked. Time and fuel, two highly important resources are wasted in this inefficient working of the present-day system. This system proposes a dynamic system that overcomes all these drawbacks. The Proposed system uses cameras installed at the red lights and intersections to monitor the traffic dynamically and then processes this information using image processing, computes the volume of the real time traffic, sets the timer of the signal accordingly. The system uses Canny Edge Detection algorithm to effectively calculate the traffic density and uses Arduino board and OpenCV to control traffic signals. The system also monitors if there is any scope of congestion at the intersection and adjusts the timer to prevent it. The entire system works autonomously and has a quick turnaround time, saving critical resources at every junction.

Keywords: Image Processing, Canny Edge Detection Algorithm, Traffic density, Traffic control system

I.INTRODUCTION

As the population of the modern cities is increasing day by day, vehicular travel is increasing which is leading to congestion problem. Traffic congestion has been causing many critical problems and challenges in the major and most populated cities. Due to this traffic congestion there is more wastage of time. The steady increase in the number of automobiles on the road has amplified the importance of managing traffic flow efficiently to optimize utilization of existing road capacity. High fuel cost and environmental concerns also provide important incentives for minimizing traffic delays. The system is intended to overcome the drawbacks, which are there in the existing systems implemented until now for the traffic management system. This system uses cameras installed at intersections to monitor traffic dynamically. It then processes the extracted information using an algorithm called Canny Edge Detection, computes the volume of traffic and sets the timer of the signal accordingly. Canny Edge Detection is the best algorithm to detect the vehicles because it uses multi-stage algorithm to detect the captured images. It also monitors the scope of congestion at the intersection and adjusts the timer to prevent it. The entire system works autonomously and has a quick turnaround time, saving critical resources at every junction.

Traffic congestion is a serious issue. In the existing system, signal times are fixed and it does not depend on the density of traffic. Large red light delays lead to traffic congestion. In this paper, a traffic control system is implemented in which signal timings are updated based on the traffic density. The system is using OpenCV and Arduino. Image processing of traffic video is done in OpenCV. The system uses Canny Edge Detection technique to compute the traffic density.

II.PROBLEM STATEMENT

With increase in the number of vehicles on the road today causes traffic congestion near junctions .The main effect of this matter is lot of time of the people is wasted on the road itself. At certain times in junctions, sometimes even if there is no traffic, people have to wait, because the traffic light remains red for the present time period, the road users should wait until the light turns to green. The present traffic control is not dynamic and predefined which does not relay on present traffic.

PROPOSED SYSTEM

The proposed system helps in changing the traffic lights dynamically, which helps in reducing the congestion of the traffic and more importantly, allows smooth functioning of the traffic. The proposed system changes RGB images to Gray-Scale images for further processing. Canny Edge Detection Algorithm is used for the edge detection. Images are smoothed by applying Gaussian filter. At last, with the help of white point count, the density of the traffic is calculated for various lanes, which helps in varying the time of the traffic signals.

Advantages:

- It reduces the manpower required to operate the traffic signals.
- It reduces the need for additional hardware that might incur extra cost.
- Use faster algorithms that will not delay the system when used in real time.
- Dynamic traffic signal times to regulate traffic based on traffic density.

Fig: Design Consideration of the Proposed System

III.RESEARCH METHODOLOGY

3.1 Modules Description

Pre-processing of Captured Image

Image pre-processing is performed to convert the raw images into more accessible form for edge detection. As Gray scale images have superior signal to noise ratio compared to RGB image, it is advantageous to convert RGB images into Gray scale for further processing. The following equation is used to convert each pixel in the image to its equivalent Gray scale form:

$$I = 0.3R + 0.59G + 0.11B$$

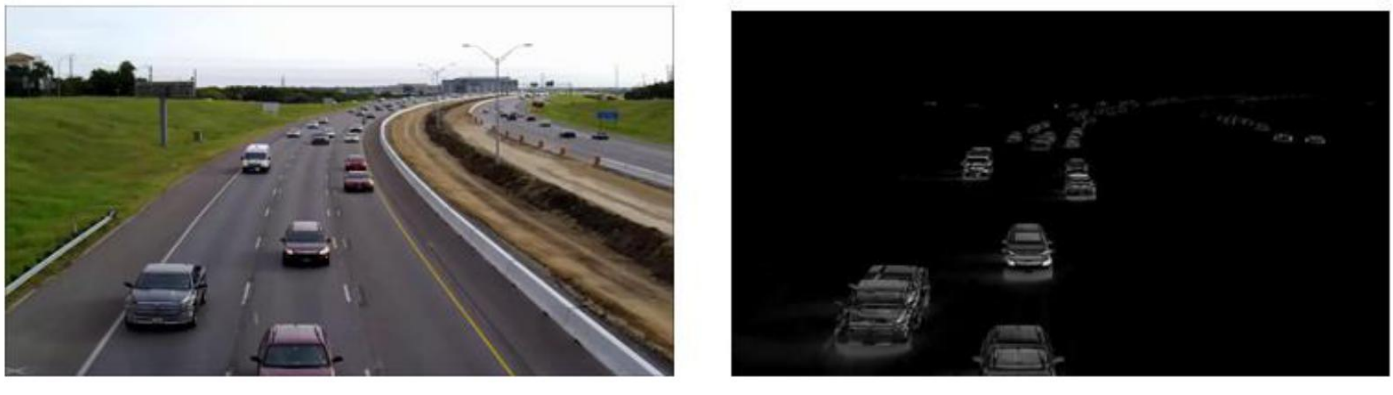

Fig: RGB to Gray Scale Image Conversion

Edge Detection

Edge detection is used to identify distinct shapes. It is used for isolating different shapes of the vehicles from rest of the image. After comparing different edge detectors, Canny Edge Detector is found to be most suitable for this application. Images are smoothed by applying Gaussian filter to reduce unwanted texture and details.

The Canny Edge Detection algorithm can be broken down into the five following steps:

- Apply Gaussian filter to smoothen the image in order to remove the noise
- Find the intensity gradients of the image
- Apply non-maximum suppression to get rid of spurious response to edge detection
- Apply double threshold to determine potential edges

- Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges

The Canny algorithm contains a number of adjustable parameters, which can affect the computation time and effectiveness of the algorithm.

- The size of the Gaussian filter: the smoothing filter used in the first stage directly affects the results of the Canny algorithm. Smaller filters cause less blurring, and allow detection of small, sharp lines. A larger filter causes more blurring, smearing out the value of a given pixel over a larger area of the image. Larger blurring radii are more useful for detecting larger, smoother edges – for instance, the edge of a rainbow.
- Thresholds: the use of two thresholds with hysteresis allows more flexibility than in a single-threshold approach, but general problems of thresholding approaches still apply. A threshold set too high can miss important information. On the other hand, a threshold set too low will falsely identify irrelevant information (such as noise) as important. It is difficult to give a generic threshold that works well on all images. No tried and tested approach to this problem yet exists.

White Point Count

A white point is a set of values or that serve to define the color "white" in image capture, encoding, or reproduction. It is used to calculate the traffic density by comparing the number of white pixels to the number of black pixels. This gives an estimation of the traffic density in the lane.

White point count: 61659 pixels

White point count: 13302 pixels

Time allocation

Time allocation is done based upon the white point count of the traffic on the road at that particular time. The number of white pixels of the edge detected image and total number of pixels gives the density percentage.

$$\%density = \frac{\text{No. of white pixels}}{\text{Total no. of pixels}}$$

- If the density is between 0 to 10% - green light is on for 10 seconds.
- If the density is between 10 to 50% - green light is on for 30 seconds.
- If the density is between 50 to 70% - green light is on for 40 seconds.
- If the density is between 70 to 90% - green light is on for 60 seconds.
- If the density is between 90 to 100% - green light is on for 90 seconds.

Arduino-Python Interfacing

The system is based on OpenCV and Arduino. Camera captures the video. It is send to PC and opencv is used for image processing. It also consists of Arduino which controls the signal timings to which LED's are connected. The entire algorithm for image processing is implemented in OpenCV. The hardware interface of Arduino is interfaced to OpenCV is through pyserial Software. After interfacing, density calculated is used to allocate time for the lanes. LEDs of each lane connected to Arduino glow based on time allocated.

Configuring LED

LED's is used to represent the traffic signal of each traffic lane . Two arrays of LEDs with each array encompassing a red and a green LED for two lanes. Python programming language is used for image processing and Arduino development board is used to control the LEDs. The inputs of these LEDs are connected to the digital I/O pins of the Arduino. All of the pins have common ground connected to the ground of Arduino. LEDs are controlled by the output pins of the Arduino, which are controlled by the time, allocated to each consecutive lane.

3.2 Result Analysis

In this section, the performance of the system is checked with respect to White Point Count, calculation of the Traffic Density and glowing of LEDs with respect to Arduino-Python interfacing after the Time Allocation. The Time Allocation for various lanes is accurate and it helps in performing the traffic control smoothly suggests the proposed system to be an efficient solution. The proposed system helps in reducing manpower required to operate the traffic signals. It reduces the need for additional hardware that might incur extra cost. The following table suggests the calculation of white point count, calculation of traffic density related to the white point count and time allocation for the respective LEDs for two lanes.

Lanes	White Point Count	Traffic Density	Time Allocation
Lane 1	30720	10%	20 Seconds
Lane 2	156600	50.97%	30 Seconds
Lane 1	195643	63.68%	40 Seconds
Lane 2	222278	72.35%	50 Seconds
Lane 1	276940	90.1%	60 Seconds

Table: Time Allocation for Signals based upon the calculated traffic density

So, the table shows the variation and an improvement which indicates an efficient processing of the proposed system.

3.3 Future Work

In future work Raspberry pi microcontroller can be used which will directly integrate the opencv software there is no need to install the opencv in the system. With the help of raspberry pi we can provide the view of the traffic to the traffic controller room so that the green signal will be provided for the longer time in the required area during the signal in order to avoid the unnecessary waiting time during the signal.

IV. CONCLUSION

The system presents a novel approach, based on Canny Edge Detection (CED) algorithm to construct a traffic management system, with the aim of improving the traffic conditions. In this proposed system, the images are captured at intersections, and then they are processed using CED algorithm. After that, the calculation of the density of the traffic is done using the white point count, and dynamically the signal times are changed depending on the intensity of traffic. Therefore, the system autonomously controls the traffic, involving lower human power with virtually no new installation cost. This model is an attempt to detect the density of vehicles on road in real time. The implementation of the proposed system will help in attaining great accuracy. The increase in accuracy for the tested dataset will help a lot by avoiding the traditional edge detection methodology, which are not so effective in achieving the proper traffic management. Moreover, this will also contribute in a much faster overall computing process.

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