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Traffic Control System Using Image Analysis

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Abstract

This work is made to implement simulation model for the road traffic control system by image analysis. Now a days the major concern problems faced by all the metropolitan cities in all over the world is intense road traffic congestion. Due to traffic congestion there has been formation of several critical problems in densely populated towns. Because of this traffic congestion problems, many persons miss several opportunities, some may lose time and as such face a lot of Problems. To address above problem in the earlier methods, they adopted the constant traffic light duration which turns out to be a major drawback. In Traditional traffic control system the fixed time slot has been adopted to illuminate the light at each side of the junction which cannot be varied as per varying vehicles traffic density. In this work an attempt is made to address this vehicle traffic congestion problem at traffic signals. In the proposed method, above problem is overcome by estimating the density of vehicles on the road and computing the required duration of time for illuminating the signal lights and thus people can't wait for a fixed time period unnecessarily if traffic density is minimum.

Keywords: *Edge Detection, Image analysis, RGB to Greyscale, Traffic Control System*

1. Introduction

Traffic control system is the major issue in densely populated cities due to improper traffic control system administration and a lot of time is being wasted. Several vehicle detection technologies have been started due to increasing congestion on highways and problems related with existing detectors. The proposed method uses video image processing technique. In this approach vehicles are identified by the model with the help of images rather than using sensor devices implanted in the street. In this approach a high resolution camera will be positioned along with the traffic signal light. The Camera captures the image sequences of the traffic on the signal spots. Then Image analysis technique is applied to regulator the state of change of the traffic light by estimating the time required to illuminate the green signal dynamically based on the vehicle density. It shows that it can diminish the traffic jam and avoids the time being wasted by a green signal light on the vacant road. This kind of arrangement is very consistent in assessing the presence of vehicle as it makes use of real images of the traffic. This process visualizes the realism, hence it functions more better than those systems that depend on the finding of the vehicles' metal content.

2. Literature Survey

Abdul Kareem et.al [1] were able to design a traffic light monitoring system using adaptive associate memory. The purpose of the research was to minimize the needless longer waiting time at traffic signal lights using fixed cycle protocol. In this work authors proposed monitoring system was set to improve the configuration of traffic lights, by which it was easy to determine the street cases with the help of tiny associative memory. Good results were achieved when this method was applied. With the help of the program, street cases were

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determined with variable weather situations on the basis of stream of images which were obtained from the street cameras. Findleret.al [2] proposed a knowledge-based system for distributed environments to check for traffic-adaptive control of traffic signals and real-time systems. The system had two processes for learning system. Here, firstly it optimizes the control for Constant traffic for a particular intersection on the streets networks and secondly, here stage was for the learning dispensed with control for the rapid changes in the patterns of the traffic. GiYoungEtalet.al [3]proposed that present traffic signal cycles were less efficient that the electro sensitive traffic lights since they were clever to be extended or reduce the signal cycle when the vehicle number increased or decreased abruptly. The work was centered on creating on ideal traffic signal by the help of fuzzy control system, Fuzzy relationship function values from 0 and 1 were utilized for the estimation of the indeterminate length of the vehicle, width of the road, speed of the vehicle and different conditions like type of car, starting time in delay and the volume of the vehicle in traffic were considered. A new method implemented for arrival time as well as departure time to simulate the arrival and exit of total number of vehicles on the road. The model is based on knowledge system and rules with RFID deployed to collect the traffic data on the road. This method is able to take decision on whatever was needed to control intersections in traffic based on the traffic light data acquired by RFID reader. A software was developed which simulated the status of any remote traffic junction depending on this technique. The system became extremely graphical in nature and used window system to permit simulation of different traffic situations at the junction. The results proved that the fuzzy logic controlling was better at performance and was cost effective too[4]. Different efforts in traffic engineering were made to yield the queue for traffic light model vehicles were arrived at an intersection which were Monitored by a traffic light then form queue. Here, the method developed uses different approaches towards the length of the traffic queue in every track on the street and expected vehicles with given time. Among all techniques based on the queue model, queue detection algorithm was proposed [5]. The algorithm consists of vehicle detection and motion detection operations, these two operations depend on obtaining the edges of the scenarios to decrease the effects of differences in various conditions of lighting. A de-centralized control module was defined by Jin and Ozguner. This method contains the both the blend of real time traffic light control and multiple endpoint routing based on a notion of cost-to-go to diverse end points [6]. Totrust that electronic traffic signal is predictable to expand conventional traffic light system in forthcoming intelligence transport situations as it has the benefit of being able to machines visible and was developed by Huang and Miller. They discussed about two of its products such as break sign signals and intersection of traffic signals consistent protocol for the electronic traffic signaling. These Procedures permitted vehicles to toughly distinguish the signal nominated directions in spite of possible threats caused by reflections. Here, authors validated how to make use of the protocols for constructing a model application. A red light alarm model and also put up the problem of possible irregularity threats caused by the uncertainty of location system being used [7].In 2004 Di Febbraro et al proposed that PN (Petri Net) models may applied to traffic control. They discussed about urban traffic systems and are modular representation of controlled by signalized intersections and considered such systems to be consisting with basic structural components; such as, intersections as well as road stretches, the movement of vehicles in the traffic network was defined with a microscopic pattern symbol and was comprehended through PNs. An excellent feature of this system is to representing the offsets from all traffic light cycles-as embedded in the structure in the model itself [8].Nagel and Schreckenberg in 1992 delineated a Cellular Automata model for traffic simulation. At each step, vehicles rise their speed until they reach their maximum velocity. With respect to slow movement vehicles, the speed will be reduced to avoid accident [9]. The development of a traffic signal controller using a easy predictor was developed by Tavladakis in 1999. The Measurements have been taken for current cycle and used to examine different settings for the next cycle, then resulting in the smallest amount of queued vehicles was executed. This method was very adaptive, as it uses only data for only one cycle and also it could not handle more variations in traffic flow[10].Chattarajet.al., in 2008 developed a new frame work for developing Intelligent Systems for monitoring road traffic. This is depend on the belief of RFID chip vehicle tracking. This Model is applicable in all the areas where RFID category of vehicles is made mandatory and the productivity of this system operates the traffic signals based on the present circumstances of density of vehicles in multiple positions of a road crossing and not on pre-assigned on times [11].

3. Problem Statement

Based on the rigorous literature survey, we could able to frame the problem statement.

Traffic control is based mainly on vehicle traffic density and we can improve the traffic control system by computing the vehicle density on the road and is achieved by acquiring Image from the traffic signals then converting that image to Greyscale Conversion then by applying the Image Enhancement and Edge Detection techniques to match the image from the existing image data store. Based on the image size finally, our proposed method calculates the time for illuminating the traffic signals.

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4. Methodology

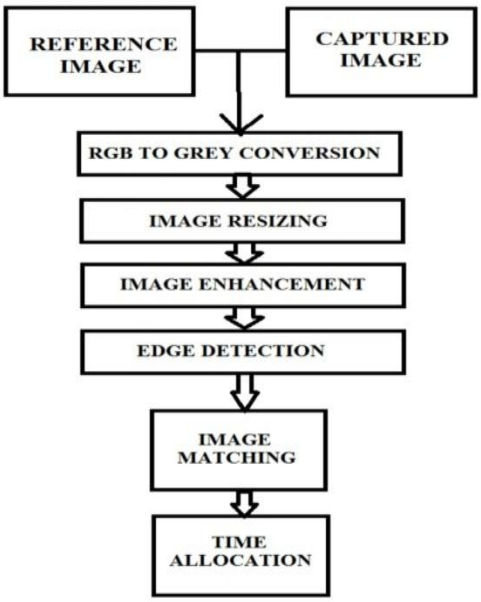

Figure 1: Time Allocation Process

Figure 1 shows the complete steps involved in the proposed methodology to capturing the image and applying basic image processing techniques to compare reference image and the acquired image to decide the allocation of time for illuminating the signal lights. The complete image analysis process is discussed below.

Image Analysis

The Block diagram represented in above Figure 1 provides an overview of traffic control system using image processing.

Image Acquisition: An image acquired by a camera is a 2D function *f(p,q)*here,*p,q* representing plane coordinates. The intensity of the image is an amplitude at any point *f*. This is also referred by the gray level of an image at that point. We can change thep & q values to finite discrete values for forming a digital image. Digital images are consisting with finite elements, every finite element is referred as pixel.

Image Formation:
There are several circumstances for developing an image *f(p,q)* values of an image is comparative to energy emitted by a physical source. So *f(p, q)* should be nonzero and finite. i***e: 0<f(p)<*** ∞

Resizing the image: The scaling of an image happens in all digital image or photos at some phaselet it be in Bayer de-mosaicking or in image enlargement whenever we required to upsurge the pixels of an image it is essential to resize the image.

GREY Conversion: The Color images are kept in three matrices in RGB format. One for Red pixel(R), for Green *pixel(G)* and for Blue pixel*(B).* In gray scale images, it is difficult to differentiate how much we release the different colors, we release the similar amount in every channel. However, we can differentiate the total emitted light for every pixel.

Image Enhancement: It is the process of manipulating digital images using the software tools like filters editors so that we can change the properties of the image for further analysis.

Image Matching: It is the process of comparing two images in order to get measure of their similarity.We used a different method for image matching. Comparing reference image with the real time image pixel by pixel.

*Percentage of match= (MP/TP)*100*
MP: Matched Pixels
TP: Total No. of Pixel

Edge Detection: It is the process of identifying points in an given image by applying various mathematical methods. It aims to identify the set of points in a given digital image where in image brightness can change suddenly. Edges are those at which image brightness modifies suddenly and these points are organized into a set of curved line segments named as edges. Figure 2 shows the Canny's edge detection process.

Figure 2: Canny's Edge Detection

5. Experimental Results

The Figures 3, 4,5 and 6 shows the Raspberry PI 3, Block Diagram of Proposed Model , Circuit Diagram and Traffic Waiting Time Graph respectively. The following various components have been used to implement the proposed system.

Raspberry Pi: It is a tiny single-board computer system with an open-source platform that has a flourishing community of its own like audio. This is used in several types of projects from trainees learning to know how to code for home automation systems. We can have few versions of the Raspberry Pi, but the modern version has improved upon its ancestor in terms of its functionality.

Webcam: In our project it is required to use the webcam to capture the steam of images from the traffic signal. It is a special video camera that performs the streaming of its images into the network. The captured video stream may be kept, observed or may sent to any other networks using internet. The webcam can be connected by a USB cable or it can be built into computer hardware.

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Python: Python provides many libraries for image manipulation tasks. These libraries deliver an easy and intuitive way to alter images and make sense of the underlying data. Python supports open source package Scikit –image that works with NumPyarrays. Here we used the few modules like PIL/Pillow, and SciPy Python core scientific module for image manipulation and processing task. It is one of the best option to develop image processing softwares. For edge detection and image matching softwares it's a perfect option. Python consists of large collection of libraries, it speeds up the development process.

OpenCV: OpenCV supports many algorithms which are more relevant to image processing, computer vision and Machine Learning. It supports variety of programming languages like C++,Python and Java also provisions diverse operating systems like Windows, Linux, Mac OS, iOS and Android.

Table1 shows the pseudo code of our proposed model involving 7 major steps for estimating the time for Illuminating the Traffic signal.

Table1:Time Allocation Pseudo Code

Input: **Images captured by a camera**

Output: **Allocates time for the signal**

Step 1:*Saving a reference image*

- Image of an empty traffic captured by a camera
- The conversion of RGB to Grayscale is done on this reference image

Step 2: *Acquiring the traffic image*

- Image is captured through a camera

Step 3: Conversion of *RGB to grayscale of the image*

- The acquired traffic image is converted to grayscale

Step 4:*Image Enhancement*

- Enhancing the grayscale image for increasing the sharpness

Step 5: *Edge detection*

- Canny's Edge detection is done on the enhanced grayscale image

$$Edge\_Gradient\,(G) = \sqrt{G_x^2 + G_y^2}$$

$$Angle(\theta) = \tan^{-1}\left(\frac{G_x}{G_y}\right)$$

Step 6:*Image matching*

- Comparing the reference image and the acquired traffic image for the differences

Step 7:*Time Allocation*

Depending on the percentage of match between reference image and acquired image, computes the time for illuminating the Trafic signal

Figure 3: Raspberry PI 3

Table2 Shows the results obtained from our experimental setup. It clearly indicates that based on the percentage of match between the reference image and the acquired image dynamically our proposed model computes the time for illuminating the Traffic signal. Figure 6 shows traffic Waiting Time Graph. It shows that as the Vehicle density increases waiting time increases. When density of vehicle reaches to certain peak point then our model starts decreasing the waiting time.

Table2: Results obtained

Percentage of Match between reference Images and acquired traffic image	**Time of Illuminating the Trafic Signal**
Brtween 0 to 9 %	Green light Upto 90 Seconds
Brtween 10 to 49 %	Green light Upto 50 Seconds
Brtween 50 to 69 %	Green light Upto 30 Seconds
Brtween 70 to 89 %	Green light Upto 20 Seconds
Brtween 90 to 100 %	Red light Upto 60 Seconds

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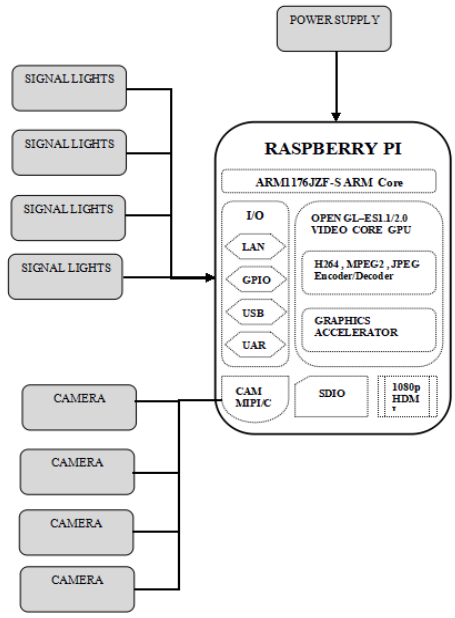

Figure 4: Block Diagramof Proposed Model

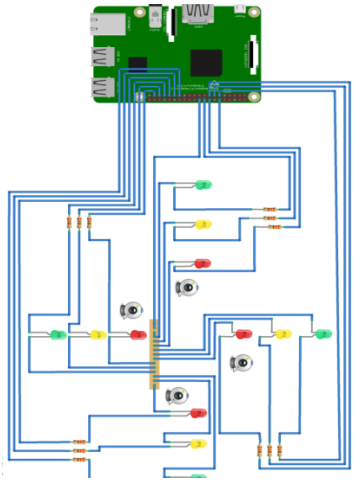

Figure 5: Circuit Diagram

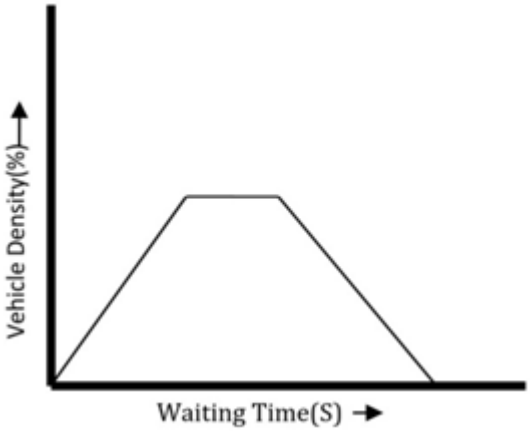

Figure 6: Traffic Waiting Time Graph

6. Conclusion

In the proposed model we use Traffic control with image analysis technic that overcomes limitations of the existing methods to control traffic. In existing approaches, we can find an error in the use of the timer's automatic traffic control, wasting time using green light if there is no traffic also. Proposed method avoids this problem. The Canyon Edge Detector technique is considered the most effective when comparing different edge detection algorithms. This project shows that image processing approach is an effective approach for traffic control system in comparison with the traditional technologies. Proposed system eradicates the need for additional hardware like sound sensors etc. The main advantage is the difference in signal timing that controls optimal traffic density using image matching and analysis. Because of the single moving camera, the accuracy of predicting the time depends on the registration position. Our results shows the optimal use of Traffic signals to the society.

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