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Traffic Light Control and Violation Detection Using Image Processing

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Abstract: Now a days as the population increases the transportation demands are increased. The total number of vehicles required to fulfil the transportation needs too are increased just as population have increased. Increase of the vehicle usage leads to heavy traffic in the road. It happens due to the current traffic control method and the road infrastructure. It will affect the human as well as fuel resources by wasting time in the road because of the heavy traffic. In order to reduce the wastage of time as well as the wastage of fuel in the road traffic an effective and a smart traffic control strategy is required. The traditional way of traffic control provides a time slot for each direction of road. Another advanced method is placing some proximity sensors on the road. This sensor gives the data about the traffic on the road. According to the sensor data the traffic signals are controlled. This project proposes a new way of traffic control. A digital camera installed with traffic signal light used to capture the live road images. Then the captured images are fed into digital image processor to find the traffic density on the road then the traffic signals are controlled. The proposed system helps to use the time and fuel resources efficiently by avoiding the time wasted on the empty road.

Keywords: Traffic Control, Image Processing, Support Vector Machine

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I. INTRODUCTION

As urbanization increases the transportation requirements are also increased. The requirements of high transportation cause traffic congestion in the urban areas. The fuel requirements and time requirements are increased due to the heavy traffic jam. [1]

The traffic jam not only depend the vehicles on the road but also depends the following factors such as weather, day, time, some unpredictable situations like accidents, road maintenance and some special events. One method to solve the traffic congestion is to construct new roads and flyovers. The main dis advantage of this method is that it requires more land resources. But the problem is the difficulties in acquiring land because of the commercial and the residential buildings are beside the road. It requires more time to evacuate them and construct the new one. So due to these reasons a traffic management system can be adopted with the available infrastructure rather than making new infrastructures.

A traffic control system with continuous monitoring of vehicle density on the traffic island can solve the traffic congestion problems by controlling the traffic signal duration according to the vehicle density in the traffic island. Advantages of this type of intelligent transportation systems are reduced capital cost as well as the maintenance cost. Traffic data can be stored and effectively used for transportation planning for future developments.

An intelligent traffic management system mainly uses the advantage of the digital image processing.

II. EXISTING SYSTEM

The following are the existing system used to control the traffic. And their drawbacks are discussed below:

In manual controlling of traffic, asthe name indicates man power is required to control the traffic. In manual controlling traffic police are required to control the traffic [2], The traffic police use sign board, sign light and whistle to control the traffic [3]. As the traffic density increases the manpower required to control the traffic too increases in manual controlling system. Since the strength of traffic police is poor compared to the traffic density in our country, it is not possible to control the traffic manually all the area of a city or town [2].[4].

Automatic traffic lights control system is a type of an embedded system, which is used to control the four sets of traffic lights at the traffic island [1]. But, this type of traffic control is not flexible, based on the traffic condition of the traffic island, rather, a particular time period is set apart for the red, green and orange

lights to function. These time periods are selected according to the peak traffic time, but the traffic density is varied as per time the day, the day of the week etc.

Another method to control the traffic light is Vehicle-Actuated Control [2]. This type of traffic control continuously attempts to adjust timing of the green light. A detector is located at some distance ahead from the stop line is the simplest type of vehicle-actuated traffic control method. The controller algorithm or the controller adjusts the green light time according the data send by the detector to the controller; the detector can be any type of proximity sensor. These types of simple vehicle actuated traffic controls too have the same accuracy problems just as the fixed-time type traffic control systems. The main disadvantage of this type of control is that the control algorithm gives the attention only to the vehicles on green light while not taking into account the number of vehicles waiting at red signal or not to compare the number of vehicles on the green signal with number of vehicles waiting in read signal at the traffic island. They will work accurately when the actual traffic flow happens. The traffic flow is assumed when the unit extension of green signal is selected.

Study Duration: November 2014 to November 2015.

III. PROPOSED SYSTEM

The proposed traffic management system tries to improve the accuracy of the transportation system with available infrastructure rather than making new roads. The proposed system controls the traffic signal according to the live road situations and also detects the traffic violations such as stop line violations and free left blocked vehicles. Figure1 shows the block diagram of proposed system.

The proposed system uses the advantages of digital image processing to control traffic on the roads. The conceptual idea of this system categories the vehicle and count the number of vehicles in each category then control the traffic signal based on the inferred traffic data.

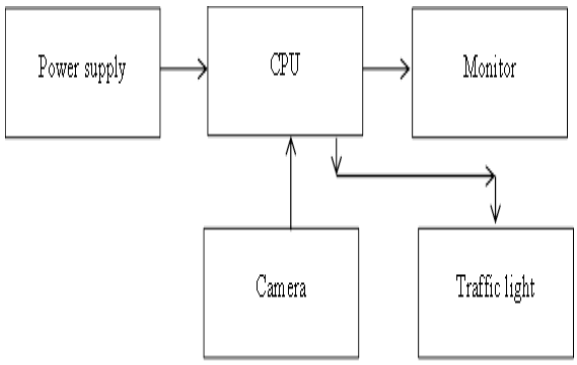

Figure1: block diagram of proposed traffic management system.

This system use open cv platform to implement the software section which includes acquiring the live road video streams, image enhancements, support vector machine to identifying and categorize the vehicles [5].

The main components of the system are power supply, laptop or desktop computer, camera, traffic lights.

The power supply unit is one of the essential components of the system which provides the required operating voltage to the each component with their required form and magnitude. The required form means AC or DC and magnitude means the voltage and current levels. Camera act as sensor to acquire the live road image in digital form and then forward, the acquired video signal to the CPU. The CPU receives the live road traffic data through the camera and perform some operations like image enhancement, identifying and categorize the vehicles, and finally generate the traffic signal based on the vehicle density on the traffic island and also store the images of traffic violated vehicles. The monitor provides an interface with system and the operator. Traffic signal lights control the vehicle flow through the traffic island.

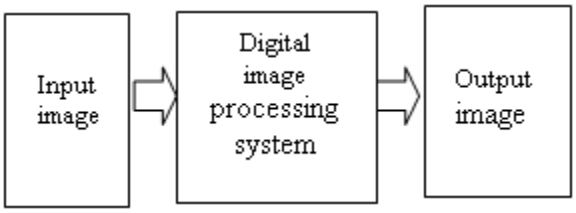

Figure2: Block diagram of fundamental steps for digital image processing

Digital images are represented by a matrix array and each element in the matrix contains the intensity values of the digital image. By performing the following image enhancement operations such as colour space conversion, Gama correction, thresholding and edge detection. These operations help to extract the adequate information from the acquired image [6]. Figure2 shows the basic fundamental block diagram of an image processing system.

Image processing includes the following operations, they are [6]

- Image acquisition
- Image enhancement
- Image restoration

A support vector machine (SVM) is a type of classifier used in order to categorize the objects from an image or a video stream [7]. Supervised learning is used to train the support vector machine, which means thousands of images from different perspective of the object to be identified is used to make a classification table. After the training, the system will identify the object from an image which is taken from any perspective of the object. The images are subjected to some image processing operations such as Gama correction, cropping, intensity conversation, etc. [7]

Open CV (Open Source Computer Vision Library: http://opencv.org) is an open-source BSD-licensed library [8] which contains large collection of software algorithms used for computer vision application. Some computer vision applications are object detection, human features identification, motion detection etc. Modular structure is used in the Open CV library; that means the computer vision algorithms has static or shared libraries. Some of the commonly used Open CV algorithms are mentioned below [8]

Core:-In Open CV core is a basic data structure module, which includes different types of array, mat function and basic functions for modules in Open CV.

Imgproc: - This module library is used to perform all image processing operations in Open CV such as edge detection image cropping, Gama correction and basic filtering etc.

Video: - Open CV use this module to analyse videos. It supported video analysis operations are objet tracking, motion detection, background and foreground identifications.

Calib3d:- This library includes the fundamental elements required to perform multidimensional geometrical operations and stereo operations.

Features2d:-This library uses some sub modules to detect salient features, descriptors and descriptor matchers. The following are the sub library used in this module; Object, Highui, Gpu.

FLANN, Google test wrappers, and python etc. are the some other libraries used in Open CV.

Methodology

In the technology advanced century digital image processing provides wide range of opportunities to the automation and control fields.

The proposed system first collects the live status on the traffic island from the installed cameras. Captured videos are first converted to grey scale then thresholding applying. In the next step the video frames are converted to images, again small frames created from each images. The support vector machine algorithm search small image frames to identify and categorize the vehicles. It also collects the number of vehicles in each category. Finally the system controls the traffic signal according to the traffic density. If anyone of route in the traffic island is empty the intelligent control system gives the empty road time slot to the high density route.

Image acquisition is the very first step in this system. A 5MB USB web cam with 50 frames per second is used to capture the videos in order to reduce the production cost of prototype. In actual system a high resolution camera with night vision capability can be used. Figure3 shows the image capturing process.

Figure3: Image acquisition.

The captured image is colour image so it requires to converts the image into grey scale for further processing. Figure4 illustrate the colour space conversion.

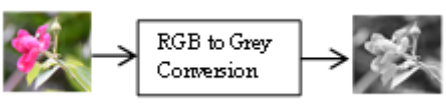

Figure4: RGB to Grey scale conversion.

The grey scale image is then threshold. The thresholing produce a background eliminated intensity image. This method logy can also help to identify the vehicles. Figure 5 represent the thresholding process.

Trained SVM will compare threshold image. Then it will categorise and identified the vehicles. The data acquired from the SVM helps to control the traffic signal lights.

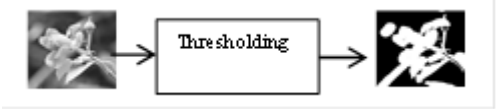

Figure 5: Image Thresholding.

This system also identifies traffic violations. The captured image compared with an empty road image and store the image of stop line violated vehicles.

IV. RESULTAND DISCUSSIONS

The fundamental objective of this paper is to make an intelligent transportation management system without constructing new infrastructures to fulfill the transportation demand. To demonstrate and justify the proposed idea for an intelligent transportation system, a prototype of a typical T junction was created; which includes a USB camera, Intel i3 processor laptop with Ubuntu 16.04 OS, and OpenCV programming language; for the cost reduction in this system used a single camera and segment its video frame into 3 sections. Different types of toy cars were used to represent different category of vehicles and the vehicle density. This proposed system classifies the vehicles based on their size and count. The number of vehicles in each category, based on these data vehicle density is calculated. According to the vehicle density on each route in the traffic island, traffic signals were controlled. The system not only controls the traffic signal but also detects the stop line violation and stores the images of traffic violated vehicles. The acquired image for identify the traffic density is shown in figure 6. Figure7-10 represents the state of intermediate stages. Figure11-13 illustrates the result obtained with different traffic conditions.

Figure6 Acquired image.

The image is acquired using a 5MP USB webcam to identify the traffic density. In figure6 shows the entire view of the typical T junction.

Figure7 Segmented image.

Acquired image was segmented into 3sections for distinguish the traffic conditions in the T junctions. In the figure7 shows the segmented image of left side of the T junction.

Figure8 Intensity Image.

The acquired image is colour image so it requires converting it into grey scale image for further processing. Figure8 shows the intensity image of left side traffic. Figure 9 shows the threshold image of left side traffic.

Figure9 Threshold Image.

Figure10 Traffic detected image

Figure 10 shows the left side image with information about the traffic density.

Figure11high traffic density in left side of T junction

From the figure 6 it is clear that the vehicle density in left side is higher than right side and the T junction. There are 2 cars, 1bus, and a truck in the left side and single bus in each other side. So the control system gives green signal to left side and red signal to all other sides.

Figure12: high traffic density in right side of T junction

From the figure 7 it is clear that the vehicle density in right side higher than left side and the T junction. There are 2 cars, and bus in the right side; one bus in left side and one truck in T junction. So the control system gives green signal to right side and red signal to all other sides.

Figure13 High traffic density in T junction

From the figure8 it is clear that the vehicle density in T junction is higher than the other sides. There are 1 car, 1 bus and 1 truck in the T junction; one bus in left side and one car in right side. So the control system gives green signal to T junction and red signal to all other sides.

V. CONCLUSION

The proposed traffic control strategy collect the live status of traffic island by using a camera. The control algorithm uses the advantages of image processing and support vector machine to identify and categorize the vehicle. Beside on the traffic density traffic lights are controlled and it also save the data of traffic violated vehicles. In future traffic points in cities can be connected through networking which helps to make an efficient traffic management system. It is possible to add a special control strategy for emergency vehicles like ambulance, fire engines etc. in future.

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