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Research on Traffic Signal Controller

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Abstract*: With the world moving towards smart cities, one of the major problems faced by almost all of cities is that of vehicular road traffic congestions. This paper attempts to address the problem of traffic congestions caused at traffic signals. Timings allotted are fixed. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. In this paper we show how image processing can be used for managing this. The image captured in the traffic signal is processed and converted into grayscale image then its threshold is calculated based on which the contour has been drawn in order to calculate the number of vehicles present in the image. The traffic is analyses through data collected from cameras and depending upon the volume of traffic, the traffic light durations are set. It also demonstrates how the durations can be changed dynamically. Raspberry pi is used as a microcontroller which provides the signal timing based on the traffic density.*

Keywords: *Raspberry pi; intelligent traffic management; image processing; Vehicles count smart cities; smart traffic signal*

I. INTRODUCTION

In modern life we have to face Traffic management. It is one of the most critical issues faced by big cities with many problems one of which is traffic congestion becoming more serious day after day. It is said that the high volume of vehicles, the inadequate infrastructure and the irrational distribution of the development are main reasons for increasing traffic jam. The major cause leading to traffic congestion is the high number of vehicle which was caused by the population and the development of economy. With growing purchasing capacity of citizens and for the luxury that it offers, the number of vehicles is increasing exponentially. What adds to this ever increasing number of individually owned vehicles is the poor infrastructure and management of public transport available. The Indian government records [1] reflect this situation perfectly. The number of vehicles newly registered in the year 1951 was 306, in the year 1975 it was 2472, in the year 2000 it was 48857, while in the year 2011 it rose to a whooping number of 141866. Thus, it can be seen that the increase in the number of vehicles has been exponential. However, the systems devised to control this traffic have gone through up gradation at a much slower pace compared to this. The traffic signals used today are more or the less same those were used in the 1990s decade. They might have undergone aesthetic changes, but technologically they have hardly changed. The conditions can get even worse if this traffic management is done by a human, traffic cop. Thus, the traffic problem needs a state-of-art technology based solution.

Due to the massive growth in urbanization and traffic congestion, intelligent vision based traffic light controller is needed to reduce the traffic delay and travel time especially in developing countries as the current automatic time based control is not realistic while sensor based traffic light controller is not reliable in developing countries. The time durations for which a traffic signal turns red, yellow and green have been fixed for that particular signal traditionally. However, the traffic flow is very dynamic and never uniform. As a result many times, a lot of 'green' duration of a traffic signal gets wasted. That is, the signal has turned green but there are no vehicles coming in from that particular side. This leads to unnecessary delay and also increases in congestions on the remaining sides of the road crossings.

Instead of acting as a flow controlling mechanism sometimes they, in fact, lead to biased traffic flow leading to congestions on certain sides. If these timings are well managed, it will lead to a smoother flow of traffic and result in time saving too. Thus, the relative traffic volumes on all sides of the roads need to be analyses. Whichever side has more flow should get longer duration of 'green' signal time. Image processing is a powerful tool that can serve this purpose. Digital image processing is basically analysis and manipulations done on an input image from getting various attributes of image to detecting objects in it. It is used widely across various disciplines of sciences and engineering such as biomedical analysis, astronomy, surveillance, robotics, weather monitoring among many others. The analysis can be done in real time as well as post processing. However, real time analysis needs equally capable software and hardware platforms as well very optimized programming practices. Also, image processing can be done on images captured indoor as well as outdoors. While the indoor images have the benefits of controlled lighting conditions outdoor images pose a challenge due to variance in lighting. Especially during the night time it is very hard to capture images without using flash. The widely used solution for this is inclusion of infrared (IR) lights to illuminate the scenes in absence of sufficient natural light. The real time images taken from cameras can be used to monitor traffic volumes.

The idea of controlling the traffic light efficiently in real time has attracted many researchers to work in this field with the goal of creating automatic tool that can estimate the traffic congestion and based on this Variable, the traffic sign time interval is forecasted. Thus a vision based system seems to be a good solution to address this problem. In a vision based system the main steps to be carried out would be – acquisition of images in real time, analysis of images, estimation of traffic flow on all sides on the traffic signal and setting appropriate timing intervals.

II. SENSORS

The most common approach to vehicle detection is using active sensors such as radar-based (i.e., millimeter-wave) [9], laser-based (i.e., LIDAR) [10-11], and acoustic-based. In radar, radio waves are transmitted into the atmosphere, which scatters some of the power back to the radar's receiver. A Lidar (i.e., "Light Detection and Ranging") also transmits and receives electromagnetic radiation, but at a higher frequency; it operates in the ultraviolet, visible, and infrared region of the electromagnetic spectrum. The reason that these sensors are called active is because they detect the distance of objects by measuring the travel time of a signal emitted by the sensors and reflected by the objects. Their main advantage is that they can measure certain quantities (e.g., distance) directly without requiring powerful computing resources.

Radar-based systems can "see" at least 150 meters ahead in fog or rain, where average drivers can see through only 10 meters or less. Lidar is less expensive to produce and easier to package than radar; however, with the exception of more recent systems, Lidar does not perform as well as radar in rain and snow. Laser-based systems are more accurate than radars; however, their applications are limited by their relatively higher costs. Prototype vehicles employing active sensors have shown promising results. However, when a large number of vehicles move simultaneously in the same direction, interference among sensors of the same type poses a big problem. Moreover, active sensors have, in general, several drawbacks, such as low spatial resolution and slow scanning speed. This is not the case with more recent laser scanners, such as SICK [9], which can gather high spatial resolution data at high scanning speeds.

III. VEHICLE DETECTION

On-board vehicle detection systems have high computational requirements as they need to process the acquired images at real-time or close to real-time to save time for driver reaction. Searching the whole image to locate potential vehicle locations is prohibitive for real-time applications. The majority of methods reported in the literature follow two basic steps:

1) the locations of possible vehicles in an image and
2) where tests are performed to verify the presence of vehicles in an image.

Although there is some overlap in the methods employed for each step, this taxonomy provides a good framework for discussion throughout this survey.

IV. NEED

As can be seen from the discussion above, a need of real time system is needed to control the traffic signs. The system should be able to collect visual data using cameras mounted at appropriate positions. The data should then be processed immediately so as to estimate the traffic sign durations that need to be set at a particular traffic signal for a particular direction. The cameras should also centrally connected to a computer so that the traffic signals work in synchronization.

V. PROBLEM DEFINITION AND LIMITATION

Real-time traffic congestion estimation tool as it is the most significant factor on which intelligent transportation systems are based. Some of the researchers have focused in their work on traffic flow estimation. It is measured as the rate at which vehicles pass a fixed point (e.g. vehicles per minute). They used spot sensors such as loop detectors and pneumatic sensors to quantify the traffic flow However; the sensors are very expensive and need a lot of maintenance especially in developing countries because of the road ground de-formations. In addition, metal barriers near the road might prevent effective detection using radar sensors. It is also found that traffic congestion also occurred while using the electronic sensors for controlling the traffic. In contrast, video based systems are much better compared to all other techniques as they provide more traffic information and they are much more scalable with the progress in image progressing techniques. This is the main reason for the motivation to develop vision based tool for traffic light control in this work.

VI. ARCHITECHTURE FOR THE CONTROL SYSTEM

Figures 1 highlights the flow chart as well as model of the traffic flow control system at various intersections. The system designed here will be integrated into the existing video surveillance system as a plug in so that the security system is improved much more than the traditional surveillance system in order to accomplish a number of surveillance activities.

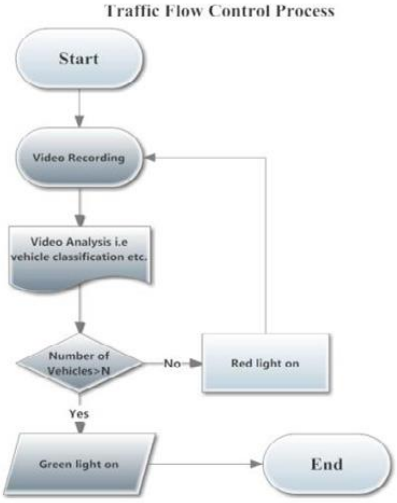

Fig. 1. Proposed flow chart

Both the wireless camera and wired cameras are applicable for the system. Green light indicates the vehicle to move and red light indicate the vehicle to stop in this proposed system. The numbers of vehicles are calculated per road lane and similarly count the total number of vehicles in all directions in order to decide which direction the vehicles can move. Thus, control traffic signal lights accordingly.

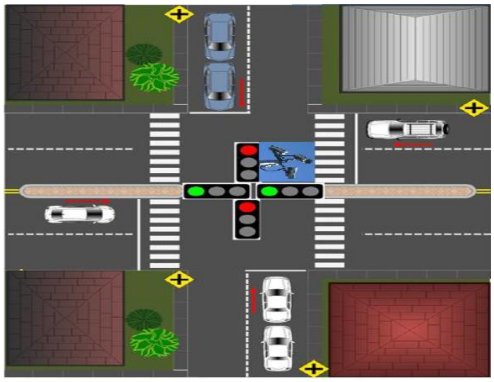

Fig. 2 Traffic flow control system at an intersection

In this architecture camera is placed on the top of the signal to get the clear view of traffic on the particular side of the signal so that it will capture the image and analyze the traffic in that particular side and get the count of the number of vehicle. With this count the density of that particular side will be determined and corresponding signal will be provided. Fig 2.

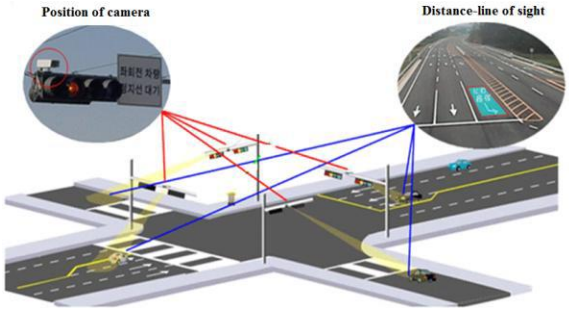

Fig. 3. Control system Architecture

VII. DENSITY MEASUREMENT

A. Source Image

In this system the source image is the RGB image which can be given by the users for getting the contour image and the vehicle count in output screen. The following code can be used to auto size of the output screen .Fig 2

Fig. 3 Source image

Fig 4 Gray Scale Image

B. Grayscale Image

The grayscale image can be used to display the objects in the format of black and white. In this system the output will be display the grayscale image after getting the source image only, because source image only converted into the grayscale image.

C. Digital Image Processing

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subfield of digital signal processing, digital image processing has many advantages over analog image processing; it allows a much wider range of algorithms to be applied to the input data, and can avoid problems such as the build-up of noise and signal distortion during processing. The different levels at which one may want to interact with the System.

***1) User interface*:** Running the GUI, Creation of batch jobs for applications using mat lab batch, Batch management, batch execution, including use of MATLAB scripts to run batch jobs on multiple datasets with very little user interaction.

2) ***Application development:*** Requirements on code structure of application

VIII. PROPOSED DESIGN

On studying all of the previous works cited above, I propose a holistic approach to have an intelligent traffic management system. There will be cameras at all traffic signals which will monitor the traffic incoming from various sides. The image data sequences collected from the cameras will be processed in real time to quantify the volume of traffic in a particular direction. The timings of the traffic signals will be dynamically set depending upon the incoming volume from that direction. The side having more traffic volume will be allotted longer duration of 'green time' compared to others. This will avoid wastage of 'green signal time'. Four cameras will be set on each cross road which will be connected to a single computer that will perform all the processing.

IX. CONCLUSION

Thus we have proposed a novel system for intelligent traffic signal control. We have successfully demonstrated traffic volume quantification using image processing techniques. Also, we have parameterized the traffic signal timings and shown how they can be set autonomously. In future we would like to have a network of all such cameras in the whole city. This would facilitate better control and co-ordination among different traffic signals in the city. Also, we plan to add neural networks to this system so as to detect and read the license plates of vehicles not following the rules.

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