TRAFFIC DENSITY ANALYSIS USING BACKGROUND SUBTRACTION ALGORITHM

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Abstract — Traffic monitoring and controlling has always been a challenge. The exponentially increasing vehicular traffic has led to many issues ranging from traffic congestion to increased road accidents. Improved traffic density estimation would help to curb the traffic before it becomes critical problem. The proposed image processing based traffic density analysis system reads a video captured by web cam and background subtraction would be applied on the converted frames. This process would lead us to get a binary image which would be processed for vehicle detection and further analysis. The software required is OpenCV. The hardware required is Arduino, USB web camera, traffic light module, etc. The existing system is inefficient for the humongous traffic currently present on the roads and the non-linear behaviour of the traffic cannot be completely analysed. In the proposed system the moving objects or vehicles are distinguished and hence vehicles would be detected easily. It can also reduce the traffic congestion rate.

Index Terms — Image processing, background subtraction, traffic density estimation, reduced traffic rate.

I. INTRODUCTION

Traffic-jam is a very big problem in developing cities. In fact it's ever increasing day-by-day nature makes it difficult to find where the traffic density is more in real time, so that to schedule a better traffic signal control and effective traffic routing. The root cause of this can be of different situations like congestion in traffic like insufficient Road width, Road conditions due to weather, unrestrained demand large delay of Red Light etc. While insufficient capacity and unrestrained demand are somewhere interrelated, the delay of respective light is hard coded and not dependent on traffic. Indeed, manual control is must, Therefore, in order to reduce man's power, the need for simulating and optimizing traffic control to satisfy the increasing demand arises. Technology in the recent past using image processing for surveillance and safety, is widely used in vehicle and traffic management for traveller information. The traffic density estimation can also be achieved using Image Processing. The solution we provide for Traffic management by having a special intelligence which the images of road feed from the cameras (webcam or IP camera) at traffic junctions for real time traffic density calculation using image processing. It also focuses on the algorithm for switching the traffic lights according to vehicle density on the road, thereby aiming at reducing the traffic congestion on roads which will help lower the number of accidents. In turn, it will provide safe transit for people and reduce fuel consumption and waiting time.

The rest of the paper is organised as follows. The next section discusses the Literature survey on the existing traffic density algorithms. Section III presents the Proposed Architecture for the traffic density analysis algorithms. Section IV discusses working principle proposed system architecture. Section V deals with the methodology followed. Section V shows the experimental setup and results. Finally conclusions are drawn in section VI.

II. LITERATURE SURVEY

A lot of techniques are proposed to detect traffic density to control traffic signal. Image processing is one of the most popular techniques. Many methods are used to detect traffic density using image processing. Canny edge detection has been proposed to measure traffic density. Perwitt edge detection and fuzzy logic has been used to control traffic signals. we have proposed a background subtraction based traffic density estimation method which will provide an intelligent traffic control system to control traffic light according to traffic density.

Taqi Tahmid, Eklas Hussain[1] have presented a pressing need for the introduction of advanced technology and equipment to improve the state-of-the-art of traffic control. The current methods used such as timers or human control are proved to be inferior to alleviate this crisis. In this paper, a system to control the traffic by measuring the real-time vehicle density using canny edge detection with digital image processing is proposed. This imposing traffic control system offers significant improvement in response time, vehicle management, automation, reliability and overall efficiency over the existing systems. Besides that, the complete technique from image acquisition to edge detection and finally green signal allotment using four sample images of different traffic conditions is illustrated with proper schematics and the final results are verified by hardware implementation.

Mohammad Shahab Uddin, Ayon Kumar Das, Md. Abu Taleb[2] describes a method of real time area based traffic density estimation using image processing for intelligent traffic control system. Area occupied by the edges of vehicles will be considered to estimate vehicles density. Calculating the areas of different live roads, the system will automatically estimate the traffic density of each road which will help to...
determine the duration of each traffic light. An intelligent traffic signal control system with the proposed traffic density estimation technique will be far better than the conventional timer based system. The main contribution of this research lies in the development of a new technique that detects traffic density according to the area of the edges of vehicles for controlling traffic congestion. Specialized algorithm, morphology and images captured with cameras will be used for the detection of traffic density for the intelligent traffic control system.

Anil Atvar, Yusuf Ozguzhan Artan, Şafak Ozturk[3] have done video analytics on low/high resolution security camera images. Traffic density estimation from traffic camera images can be considered as one of these subjects. Traditionally GPS data from commercial vehicle fleets have been utilized to estimate traffic density on roads. Traffic density estimation has been implemented using image processing and classification algorithms on traffic camera images. In this study, we propose a simple method that does not require high computational processing power to estimate traffic density on roads, unlike other studies in the literature.

Md. Fahim Chowdhury, Md. Ryad Ahmed Biplob, Jia Uddin[4] have proposed a dynamic traffic control system by measuring the traffic density at the intersections by real time video feeds and image processing. A video sample was collected and then Mixture of Gaussian algorithm was used for background subtraction method and for foreground detection to keep the count of the cars in each lane. The vehicles are detected by their line of centroid. A movement in centroid confirms a vehicle. The traffic lights at the intersections will change dynamically according to the conditions of traffic that will be detected from the video feeds. In between two intersections, there will be multiple cameras installed to count the number of vehicles entering and leaving each intersection. Furthermore, we restrict the vehicles to take right turns in the intersections. To validate our work, density measurement algorithm, images of live feeds and logics for traffic control are shown in this paper.

III. PROPOSED ARCHITECTURE

In this paper, a system is proposed for image processing based traffic density analysis system. Here we use web cameras which provide frames at fixed rate. It is the input given to the system. Background subtraction algorithm is applied on these frames. The output from background subtraction process is processed to estimate the traffic density. Based on the density estimation it sends control signals to traffic control module. The advantages are reduced congestion rate, minimized road accidents, provide safe transit time for people, reduced fuel consumption and wait time for the people. The required flow of the entire proposed system is as shown in the Fig.1.

Fig. 1: Block diagram of proposed architecture

IV. WORKING PRINCIPLE

The web camera is placed on the either side of the roads. During camera setup process the static frame of interested area is fixed. These cameras provide frames at fixed rates. These frames are then processed using background subtraction algorithm. Background subtraction algorithm results in a binary image which shows the objects on each frame. The output obtained from background subtraction process may contain broken edges. These edges are joined with the help of dilation process. It also enhances the edges of the object. The dilated image is then processed by applying contours to estimate the objects on each frame. Based on the estimation the control signals are sent to the traffic light control module.

V. METHODOLOGY

The Web camera provides frames at fixed rate which is fed as input to the system. These frames are then processed using background subtraction algorithm. The output obtained from the background subtraction process is dilated and applied contours to estimate the traffic density on specific frame. Based on the estimation the interrupts are sent to the Arduino. Arduino is interfaced with traffic light control module. Based on the interrupts sent to the Arduino the control signals are sent to the traffic light control module.

PREPROCESSING

Pre-processing is a common name for operations with images at the lowest level of abstraction -- both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some image features important for further processing.

1. CAMERA SETUP

The cameras produce frames at a fixed frame rate which are the input data for the system. In the initialisation step, interesting points in the static scene should be manually marked once. Interesting points could be areas where new vehicles can appear or disappear. Another possibility is to mark only the roads themselves as interesting areas if you are only interested in vehicles on the road.
2. BACKGROUND SUBTRACTION

In this step we generate a background model and a binary mask that displays all foreground objects in the current frame. This technique also results in elimination of shadows.

3. DILATION

Dilation means enhancing the pixels across the boundary of the object in the frames. The detected frames from the above step may contain broken edges. These broken edges do not dilate the outline of the vehicles clearly. We have used dilation operation to fill in the gaps between the edges.

4. APPLYING CONTOURS AND DENSITY ESTIMATION

This step leads to density estimation. Contour which is a rectangular box is applied across all the dilated frames. These contours will cover all the dilated objects on the frames. This will result in the number of objects in a specific frame.

5. DECISION MAKING

In this step we will make a decision based on the above steps. If the estimation for cam 1(in case of two cam system) is greater than estimation for cam2, the control signal to traffic control module is changed according to the estimation and vice versa.

VI. EXPERIMENTAL SET-UP

CASE 1: Traffic Density in Camera 2 is greater than Camera 1

In the result below, camera 1 is focusing on any one of the directions (here we have taken it as east) and camera 1 is focusing on opposite direction (say west) with respect camera 1. It is found that camera 1 is with low density when compared to camera 2. Fig 2 depicts the above scenario.

So the signal favoring to traffic on west direction is made green and that of the east is made red.

Based on the given delay it checks alternatively. In this north and south direction are made always red as we didn’t take into account for density estimation. Fig. 3 shows the above traffic condition.

CASE 2: Traffic Density in Camera 1 is greater than Camera 2

In the result below, camera 1 is focusing on any one of the directions (here we have taken it has east) and camera 1 is focusing on opposite direction (say west) with respect camera 1. It is found that camera 2 is with low density when compared to camera 1. Fig. 4 depicts the above scenario.

So the signal favoring to traffic on east direction is made green and that of the east is made red. Based on the given delay it checks alternatively. In this north and south direction are made always red as we didn’t take into account for density estimation. Fig. 5 shows the above traffic condition.
VII. CONCLUSION

The proposed system is tested with the toy cars and the snapshots of the result where shown above section. The results were more accurate than the existing system. Even at equal heavy traffics on both sides it minimizes the traffic rate by releasing the signal at regular intervals. Therefore it minimizes the traffic congestion rate, minimizes the wait time of the people, reduces the road accidents, etc. the system is bit slow when compared to the existing system due to processing of images which can be resolved using high end image processing processor. Position of camera is much more important because wrong position may lead to improper results. As a future scope we can also add ambulance detection along with this system. When an ambulance is detected and the traffic density of that is less when compared to other side then the side with the ambulance is given more priority than the other side.

REFERENCES