Real Time Traffic Density Count using Image Processing

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ABSTRACT
Due to the increase in the number of vehicles day by day, traffic congestions and traffic jams are very common. One method to overcome the traffic problem is to develop an intelligent traffic control system which is based on the measurement of traffic density on the road using real time video and image processing techniques. The theme is to control the traffic by determining the traffic density on each side of the road and control the traffic signal intelligently by using the density information. This paper presents the algorithm to determine the number of vehicles on the road. The density counting algorithm works by comparing the real time frame of live video by the reference image and by searching vehicles only in the region of interest (i.e., road area). The computed vehicle density can be compared with other direction of the traffic in order to control the traffic signal smartly.

Keywords
Traffic density count, image processing, intelligent controlling of traffic.

1. INTRODUCTION
The number of vehicles on the road increases day by day therefore for the best utilization of existing road capacity, it is important to manage the traffic flow efficiently. Traffic congestion has become a serious issue especially in the modern cities. The main reason is the increase in the population of the large cities that subsequently raise vehicular travel, which creates congestion problem [1-5]. Due to traffic congestions there is also an increasing cost of transportation because of wastage of time and extra fuel consumption [2]. Traffic jams also create many other critical issues and problems which directly affect the human routine lives and some time reason for life loss [6-8]. For example if there is an emergency vehicle like ambulance on the road with the critical patient on board. In that situation if an ambulance gets stuck in a heavy traffic jam then there are high chances that the patient cannot reach the hospital on time. So it is very important to design an intelligent traffic system which controls traffic intelligently to avoid accidents, collisions and traffic jams [7-8]. The most common reason of traffic congestion in third world countries is an inefficient traffic signal controlling which affects the traffic flow. For example if one lane has less traffic and the other lane with huge traffic but the duration of green light for both lanes is same then this is the waste of available resources and is inefficient. By considering the above example if the lane with higher traffic density should switch on the green signal light for a longer period than the lane with lesser density.

There are lots of techniques proposed to design an intelligent traffic system, for example, fuzzy based controller and morphological edge detection technique are proposed in [1]. This technique is based on the measurement of the traffic density by correlating the live traffic image with a reference image. The higher the difference is, higher traffic density is detected. In [9] another technique is proposed to design an intelligent traffic system, which is based on four lane system in which time is allocated according to the number of vehicles on the lane. This paper also proposes an emergency vehicle detection, within a limited scenario. In [10] another technique is proposed which is based on neural networks, which identify the vehicles and traffic density by processing the traffic videos. The technique proposed in [11] is based on computing the traffic load by comparing two images, the reference image and the live traffic image. They improved object detection using image segmentation and noise removal operations.

In [2] another technique is proposed to control the traffic signal by using image processing, in which they first selected the reference image which is the image with no vehicles or less vehicles and every time matching real time images with that reference image. On the basis of the percentage of matching traffic lights controlled. But in this technique image matching is performed by the edge detection.

The reference subtraction is a complex technique, with limited outcomes. This paper presents a density analyzer scheme based on counting the number of vehicles in the present image, which provides us more accurate information for signal decision making.

The paper is organized as follows: section II explains the design of the system. Section III discusses the working of the system. Finally section IV concludes the paper followed by the key references used in the work results followed by the key references used in this work.

2. SYSTEM MODEL
The work is divided into 4 parts. The first part is to process the video signal and image acquisition from fixed camera using MATLAB. The second part is to select the target area where the vehicles could be present by using image cropping technique. The third part is the object detection which is performed by enhancing features of the image. Finally, the last part is the density counting, where the number of vehicles are being counted. The overall block diagram of the proposed system is illustrated below.

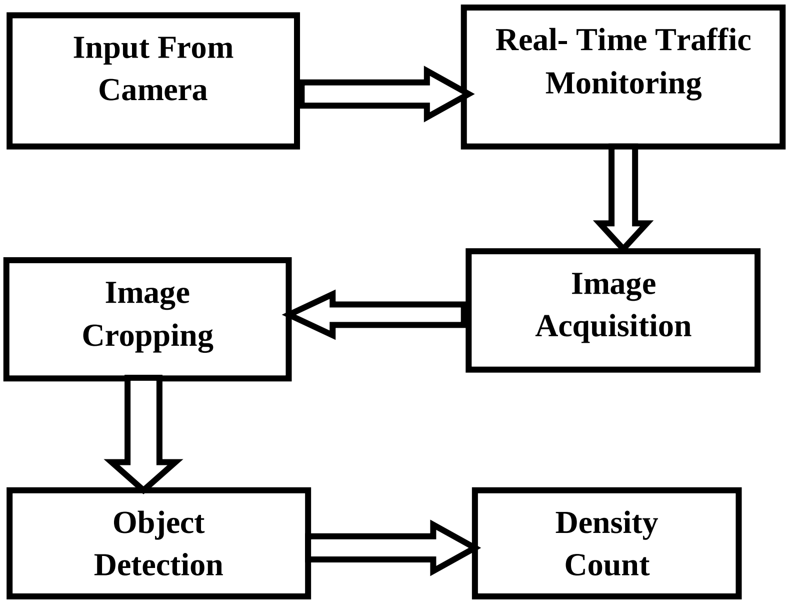

Fig 1: Block Diagram of the Proposed Model

2.1 Processing of Video Signal and Image Acquisition

The work starts with processing the live video using MATLAB software. The video camera is stationary, which is mounted on the pole near the traffic signal. The next stage is to extract the frames continuously from the real time video coming from the stationary camera. This raw digital data is further processed by converting the images from RGB (Red-Green-Blue) to grayscale in order to further process the images. Initially the system captures the image of a vacant road when there is no vehicle present; this image is used as a reference image.

Fig 2(a) shows the reference image which is captured from the live video when the road is empty.

The next section explains the procedure to select region of interest where the vehicles are present.

2.2 Image Cropping

The second step is to select the targeted area by designing image cropping algorithms in MATLAB. The purpose of cropping is to identify the road region where the vehicles are present and exclude the unnecessary background information. This unnecessary information is fixed in every frame of the live video because the camera is stationary. To crop the required area, reference image has been used, Fig. 2(a), which has no road traffic. First, a binary image of having the same dimensions is created, as in the reference image, then the road area has been shaded white, and the leftover region as black, as shown in Fig. 2(b). Finally, the multiplication of the reference image with the cropping black and white image results in the final desired target area which is illustrated in Fig 2 (c).

The next part explains the procedure of object detection.

(a) **(b)** **(c)**

Fig 2: (a) Reference Image taken from the Live Video from [12], (b) Defining the region of interest, (c) Selection of the target area

2.3 Object Detection

The third step is the object or vehicle detection in order to identify and count the vehicles which are present in the targeted area shown in Fig. 2(c). To perform the object detection, first the frame from the real time video sequence is extracted as illustrated in Fig 3(a).

The next step is to convert both images; the reference image and the real time image into grayscale and then the absolute difference of two images will be determined. Since the dimensions of the road are fixed therefore the difference image only highlights the presence of vehicles in the desired target area. The difference image is illustrated in Fig. 3(b).

(a) **(b)**

Fig 3: (a) Real-time image extracted from the live video taken from [12], (b) Difference of reference and real time image

Fig. 3(b) shows the presence of vehicles in the desired target area but the visibility of the vehicles is not much clearer in that image. In order to improve the visibility of the vehicles, the difference image is converted to a binary image based on a threshold value. The resulting binary image is shown in Fig. 4(a), where the presence of any object is more improved. In order to determine only vehicles in the desired area, multiplication of the cropped image, Fig. 2(b), with the enhanced version of the difference image, Fig. 4(a), is carried out. The product image is illustrated in Fig. 4(b). In Fig. 4(b), the unnecessary information is filtered out and it only highlights the presence of vehicles in the desired area.

(a) **(b)**

Fig 4: (a) Binarization of the difference Image, (b) Image highlighting the presence of vehicles in the targeted area

2.4 Traffic Density

The next step is to calculate the traffic density in the desired target area. In order to determine the traffic density, the vehicles are marked first and then their numbers are counted. The algorithm search for a set of connecting pixels. In order to consider a connected region as a vehicle, a minimum threshold has been defined. However, it is possible that more than one region of a vehicle is detected using the above criteria. This problem could be overcome by finding the overlapping bounding boxes of the selected regions and thus smaller and highly overlapping regions are filtered out. The results are shown in Fig. 5, where each detected vehicle is surrounded by a bounding box and the top-left region shows the number of vehicles detected on the road, as currently it is 6.

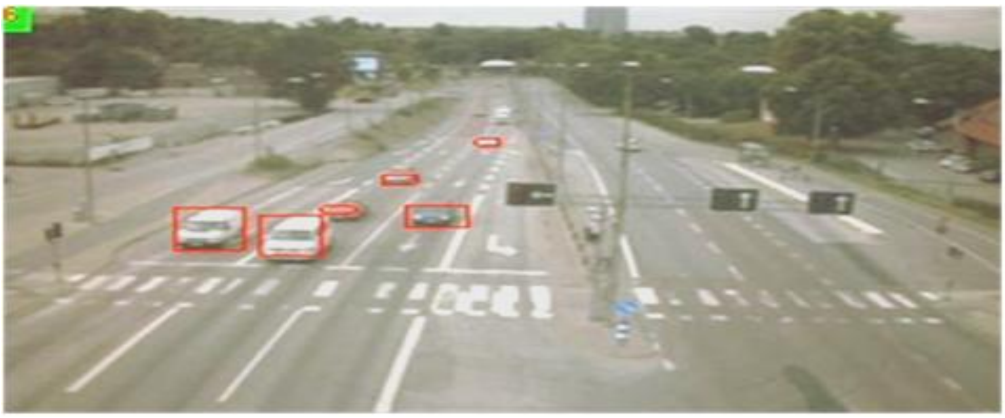

Fig 5: Image shows the detected and counted vehicles

3. WORKING OF THE SYSTEM

The research is carried out in order to reduce the traffic congestion by calculating the traffic density in a particular direction of the road by using image processing algorithms. The system starts with an image acquisition process in which the live video is processed by the stationary camera, mounted on any pole. Then one frame per second continuously extracts from the live video and processed each frame by converting it into grayscale. For the reference image an empty road image was selected, when there is no traffic on the road. The second step is the image cropping in which, the targeted area is selected, the area where the vehicles are present and filtered out unnecessary surrounding information. Next phase, determines the presence of objects in live video by taking the absolute difference of each extracted frame with the reference image. Then the presence of objects is enhanced by binarization of the difference image. Then the final step is to calculate the traffic density in the desired target area by counting the number of vehicles in that region. To perform this, first, the vehicles are marked in the targeted region by scanning all the connected objects, and filtering out smaller and overlapping objects.

In order to deal with noise added due to different lighting conditions at different times of the day, a set of reference images have been captured and stored at different time slots of the day. The system cycles through these reference images according the current time of the day.

4. CONCLUSION AND FUTURE WORK

This paper discusses a method for estimating the traffic density on the lane by using image processing. The advantages of this proposed technique is that there is no need to use aerial imagery or complex sensor based systems. The proposed system is very cost effective as it does not require installation of any additional devices, such as RFIDs.

This work can be enhanced further by proposing a system which identifies the presence of emergency vehicles (like an ambulance or fire brigade) and by giving preference to those emergency vehicles. Secondly, it can be enhanced by using VANETs (Vehicular Ad-hoc Networks) as it provides road safety and intelligent transport system [3].

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