Traffic Density Analysis using Image Processing

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ABSTRACT
Real time traffic density prediction and analysis have recently gained popularity as compared to traditional traffic density system using CCTVs. The popularity and need of traffic monitoring at public places, industrial sector, and residential areas have supported the widespread use of real time traffic monitoring. The motion of the vehicle is one of the basic parameter for identification of the flow of traffic on roads. The traffic flow on the roads can be basically categorized into heavy, medium and low traffic. Majorly thresholds that are used to correctly classify the traffic in any frame. Background subtraction, edge detection, optical flow estimation, BLOB(Binary Large Object) detection, magnetic loops, computer vision filtration techniques, closure operation are some techniques that are combined by various researchers and used to correctly classify the nature of vehicular traffic in a frame. However, the vehicular movement's nature is dynamic and unpredictable. For traditional techniques that are been used over years have a few challenges including the color of the road and obstacles such as shadow and illumination. The colors of majority of vehicles observed on roads are white, silver, and black. The roads also are cement based or tar-based those make them an obstacle in traditional systems. This paper presents a new blend of various studied techniques for Traffic Density Analysis.

Keywords
Vehicular traffic, binary large object, intelligent traffic system, Background Subtraction

1. INTRODUCTION
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. Vehicular traffic has various issues that make it difficult to be monitored. It might be the climatic changes, fog, smog or 24 hours electricity supply for closed-circuit television (CCTVs) to function uninterruptedly to capture the video. Vehicular traffic estimation can also be a challenge due to the pedestrian traffic present on the roads. Vehicle counting is also a hectic task for real-time applications, where processing each and every frame would not be a feasible task to perform. There have been various methods inculcated to monitor and control traffic. Earlier, landmark method has been used for the same [15]. The method is found to be inefficient for the humongous traffic currently present on the roads. Then, magnetic loops came into picture. Magnetic loops could not completely solve the problem due to their high maintenance cost and not being able to bear heavy vehicular weights. Sensors have been widely used for a very long period of time for traffic density estimation. But sensors have their own limitations. They perform low level sensing [10].Generally, sensors have a limited range of operations. Conventional methods had their cameras implanted on ground level. Elevating these cameras gave a wider scope of operation for the traffic detection and estimation. Recently, mobile systems are widely used to collect the vehicular count using Global Positioning System (GPS) through satellites that collect information periodically. Still the non-linear behavior of the traffic cannot be completely analyzed by any of the methods mentioned above. Therefore, a framework has been introduced that would help in increasing the computational speed of the existing system and would also help in improving the traffic management for intelligent visual surveillance [4].

2. LITERATURE SURVEY
Traffic Density Analysis using different techniques is present in various research works. Traffic density analysis can be performed on individual vehicles or a group of vehicles that form a BLOB. Various other methodologies are discussed in this section.

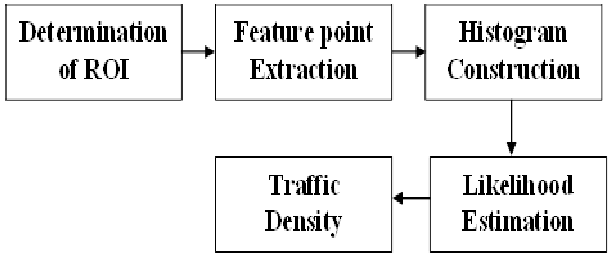

Figure 1 Block diagram for Traffic Density Estimation based on Topic Model

Razie Kaviani et al.[1], Parvin Ahmadi, Iman Gholampour, method for traffic density estimation using topic model as shown in figure 2.1. In this paper, a new framework for traffic density estimation based on topic model is proposed, which is an unsupervised model. This framework uses a set of visual features without any necessity for individual vehicle detection and tracking, and discovers the motion patterns automatically in traffic scenes by using topic model. Density forecasting is done by extracting low-level features and applying topic models on it. The framework initially extracts frames from the video input for further processing. Region of Interest(ROI) determination is primarily used to filter out the unwanted region from the frame and to obtain the region of interest i.e. the vehicular traffic. After ROI determination, feature extraction is applied on the objects by dividing them temporarily into non-overlapping short clips to construct the histograms[12]. Then Shi and Tomasi[5] is employed for corner detection to obtain the feature points. Each pair of consecutive frames, optical flow is estimated using key points by Lucas-Kanade method [6]. Histogram of words which constitute the inputs of the topic model are created by means of accumulating the visual words over the frames of each video short clip. Model learning is applied on them to estimate the likelihood for the learned motion patterns from the video clips. Now the topic model is trained using light-density and then density estimation is carried out. This framework does not accurately estimate traffic when there is a drastic climatic change and also the natural language processing used for learning the traffic patterns makes it complicated for usage in real-time processing.

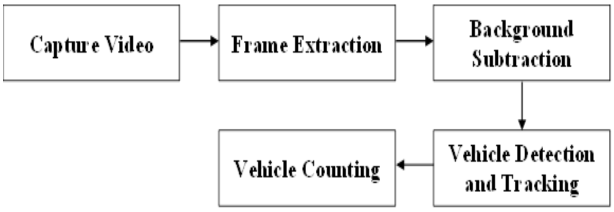

Figure 2.. Block diagram of Analysis and Monitoring of a High Density Traffic Flow at T-Intersection Using Statistical Computer Vision Based Approach

Mohammad Farukh Hashmi et al. [2], Avinash G. Keskar, presented the process for detecting and counting the vehicle is shown in figure 2.2. First the video is captured from the video camera which is placed at the top from which entire T-intersection can be very well monitored. Then the frames are extracted from the videos. In background subtraction method, to find the objects in the foreground, the difference between next frame and the background frame are calculated [7, 8].

After this vehicle detection and tracking is performed. The counting and tracking of vehicles in such a condition by conventional methods of blob detection offer low efficiency as vehicles are closely spaced objects and are treated as a single entity thereby introducing errors in counting. Vehicles travelling through intersections are moving in various directions, various parts of these vehicles may either be occluded by, or themselves occlude, other vehicles[2]. In order to overcome such situations and increase efficiency in counting, a statistical based approach is used. Here detection zones are used. These detection zones are placed at the entrance of the intersection. Vehicles are passed through these detection zones at entrance or the exit region. Due to use of detection zones, there is very less probability that the vehicle is missed. It thus performs better and increases efficiency. For counting the total number of vehicles equation(1) is used, where FPR is false positive rate, W1,W2,W3 are the average weights and R1,R2,R3 are the regions that are taken for observations.

TOTAL NUMBER OF VEHICLES
=FPR(W1R1+W2R2+W3R3) (1)

The observations are taken at different time interval for different regions. Weights are used in statistical calculations for getting the final equation. The weights are the ratio of actual count of vehicle to observed count of vehicle. Then mean weighs are calculated from all the mean values. False positive rate is taken into consideration which depends on the entire calculation of observed values. By using all these terms final equation is obtained. Thus, the final total count of vehicles is obtained by using the obtained equation(1).The main drawback of this process is, it becomes sometimes complicated to detect vehicles using detection zones. Detection zones may not detect vehicles when simultaneously many vehicles are passing on the road.

Md. Munir Hasan et al. [3], Gobinda Saha, Aminul Hoque, and Md. Badruddoja Majumder, presented a method for determining traffic density on various traffic points. Figure 2.3 shows the block diagram of the implemented technique for finding density of traffic. Two methods that is gradient magnitude and direct subtraction simultaneously performed the following process to obtain binary images. At first, frames are extracted from the camera video. Then RGB foreground image and background image is converted into grayscale image using following formula:

$$I = 0.33 * R + 0.33 * G + 0.33 * B \quad \dots (2)$$

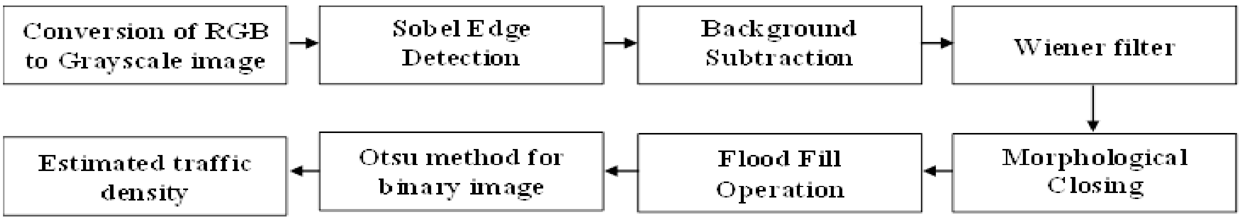

Figure 2.3 Block diagram for Smart traffic control systems with applications of image processing techniques

This gives gray scale foreground and background images. Now Sobel edge detecting operation[9] is performed on these images. Purposely, two dimensional gradient measurements are done using convolution kernel. Both horizontal and vertical gradient is measured to calculate final gradient. This gives the processed images which are subtracted to get foreground objects. Additive Noise is added during subtraction which is removed using wiener filter[10]. This filter inverts the blurring of image simultaneously. On the filtered image morphological closure operation is performed. Here, dilation of image is done followed by erosion using 6*6 structuring element. This process will effectively give us image which have object with closed contours. Flood Fill operation[11] is used to fill holes in the object to get solid foreground objects. At last, Otsu method[12] is used to obtain the threshold value for obtaining binary image. The whole processing is done first by direct subtraction method to obtain binary image and is repeated again by gradient method to obtain second binary image. Two binary images obtained from both methods are converged to single binary image in which total white pixels represents the traffic density. The main drawback of proposed method is that each frame is processed which will take longer processing time. In real time it will be difficult to process each frame retrieve from video thus result in slower prediction of traffic density.

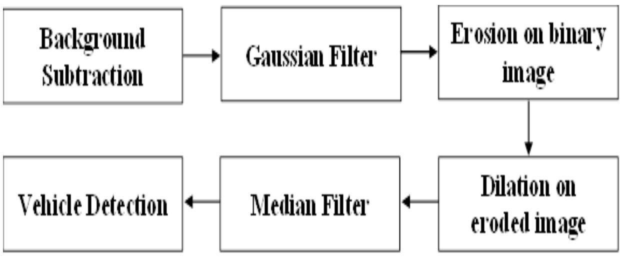

Figure 2.4 Block diagram for Vehicle detection using morphological operations

Gopal Manne, Neetesh Raghuwanshi et al. [13], have presented a method for vehicle detection is proposed using morphological approach based morphological techniques as shown in figure 2.4. This can be used for traffic density analysis. In this method, a filter is developed using morphological operations that reduces the noise in background subtracted binary image. This developed filter is used for vehicle detection.

The proposed methods first extract frames from video. This RGB frames are then converted into Grayscale intensity images which in turn is further converted into binary images. This transformation of intensity image into binary image is basically called as Image quantization [13]. Here a threshold value is taken which quantizes the pixel's value greater than threshold value. After this processing, background subtraction is performed for detecting foreground objects. Now Gaussian noise is added to subtracted image to get 'noisy background subtracted image' [13]. After this Gaussian low pass filter mask of size 5×5 with standard deviation sigma is 0.9 is created for filtration process. This filter is then used for noise removal in 'noisy background subtracted image'[13]. Morphological erosion[14] is applied on this filtered image to shrink the boundaries of regions of foreground pixels and holes within those regions will become larger [14].A disk shaped structuring element[13] is used for erosion purpose. This is followed by dilation of eroded image to fill the holes enlarged by erosion process. Due to left over noise and uneven object boundaries, the image obtained after dilation is again filtered through median filter. This filtration erases black dots called as pepper and fills white dots referred as salt[13].At last, after morphological operation and median filtering on the binary image, vehicle are clearly identified and detected on roads.

The proposed method requires high implementation cost thus reduces its efficiency and robustness of method. Moreover, the method does not effectively reduce the noise and cannot detect the vehicles accurately.

3. PROPOSED SYSTEM

The proposed traffic density analysis system shown in figure 3.1 reads a captured video and extracts the frame. These frames would be extracted periodically to improve the computational power of the system.

After the frames have been extracted, background subtraction technique would be applied on each of these frames. This process would lead us to get a binary image from the frame which would be processed for BLOB detection. BLOB detection would consist of BLOB detection, BLOB analysis and BLOB tracking. Morphological closure operations including erosion and dilation would be used to increase the accuracy of the system for better detection of vehicles. Further region properties of BLOBs are calculated. Various properties are taken into considerations. These properties help a lot in analysing the area of BLOB. Area calculation would give us the density on the roads as low density, medium density and high density depending on the area covered by the BLOBs. These classifications into low, medium and high help us in better analysis of the traffic condition.

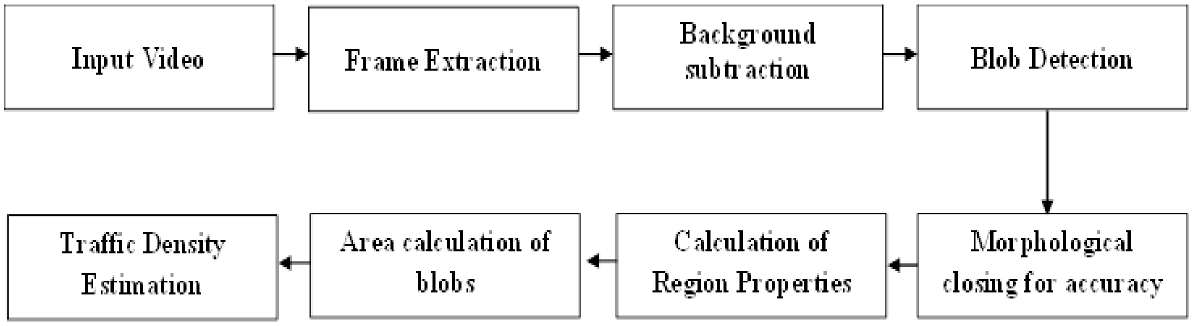

Figure 3.1 Block diagram for proposed system

4. CONCLUSION

Traffic Density Analysis System Using Image Processing discussed in the paper provides a framework that captures video from video camera and periodically extracts frames from them. Periodic extraction of frames would help to increase the processing speed of the framework. The use of blobs increases the efficiency thus improves overall performance of detection and analysis of vehicles. The framework to automatically classify complex traffic videos and determine their traffic density, based on LDA, is one of the most successful topic models. To handle traffic at intersections statistical based approach is used. The algorithm specializes in traffic flow monitoring at a T intersection using a detection zone based approach. By morphological operation and median filtering on the binary image, the moving objects or vehicles were clearly distinguished and hence vehicles could be detected easily. Another method of determining the traffic density is by measuring total area occupied by vehicles on the road and using it as traffic density. Depending on the traffic density a weight is determined for each road and total traffic cycle is weighted for the roads. This way an automated traffic control system may be designed.

5. REFERENCES

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