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Vehicle Density Measurement System for Traffic Control

[1] Pellakuru Yaswanth, [2] Polu Bhagath Sai, [3] Pasupuleti Yashwanth,[4] Naidu Siva Bhaskar, [5] Dr. K. Santhi Sagar Reddy

[1]UG Scholar, [2]UG Scholar, [3]UG Scholar, [4]UG Scholar, [5] Professor
[1]Electronics and Communication Engineering,
[1]Narayana Engineering College, Nellore, India

Abstract: Nowadays, there is a need of human power for counting the vehicles which pass on highways. The automatic vehicle density measurement system is proposed to overcome that need of human power. This system is used for detecting and counting vehicles in surveillance video which uses segmentation with initial background subtraction using the morphological operator to determine salient regions in the sequence of video frames. This system can be used to maintain good traffic management. The video is captured from the camera and this algorithm detects vehicles using the image processing techniques. The two major techniques used in this algorithm are background subtraction and morphological processing. Background Subtraction as well as morphological processing are important applications in image processing because of their wide range of uses. Background Subtraction is used to enhance the objects in image. Morphological operations are used to remove noise and as well as to adjust image in such a way to detect objects in an image. The simulation work of this algorithm is done in MATLAB (Matrix Laboratory) which is a very strong scientific tool.

Index Terms - density, segmentation, image Processing, Morphological operations, MATLAB

I. INTRODUCTION

The increase in the vehicle counting leads to many troubles by causing traffic in highways. As a result, it causes accidents, congestion in traffic and other drastic problems which lead to tough transportation over highways. To solve every problem in traffic we should attentive over vehicles. In this case vehicle detection and counting is necessary to avoid those activities. Manual surveillance video of traffic is tough where result cannot be accurate and efficient. Automation in traffic surveillance is indeed here. The main objective and scope of this project is to detect and count vehicles by inserting a good quality traffic video. The following are the basic things to be done for the vehicle detection and counting. The video is monitored continuously for detection of vehicles. The video is segmented in frames and they are counted. To control traffic management image processing has been introduced. It is Easy to calculate traffic density which is cost effective. Image processing can detect vehicles in any climatic conditions. Using the information given by image processing technique, the user will get traffic density at the location of his choice.

The system consists of cameras that monitor traffic by capturing videos. Extracts video frames at regular intervals and frames are compared to determine whether there is traffic or not. Image Processing is a technique to enhance raw images received from cameras/sensors placed on space probes, aircraft and satellites or pictures taken in normal day-to-day life for various applications. An Image is a rectangular graphical object. Image processing involves issues related to image representation, compression techniques and various complex operations, which can be carried out on the image data.

The operations that come under image processing are image enhancement operations such as sharpening, blurring, brightening, edge enhancement etc. Image processing is any form of signal processing for which the input is an image, such as photographs or frames of video; the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it.

II. RELATED WORK

An Automatic vehicle counting system has been described in [5] which makes use of video data acquired from stationary traffic cameras, performing causal mathematical operations over a set of frames obtained from the video to estimate the number of vehicles present in a scene. It is just the ability of automatically extract and recognize the traffic data e.g. total number of vehicles, vehicle number and label from a video. Counting vehicles gives us the information needed to obtain a basic understanding over the flow of traffic in any region under surveillance. So, the first data we have tried to gather is counting of vehicles from available traffic videos from various libraries. In each video frame, Gaussian mixture model differentiates objects in motion from the background by tracking detected objects inside a specific region of the frame, and then counting is carried out. The goal of his research is to develop an automatic vehicle counting system, which can process videos recorded from stationary cameras over roads e.g. CCTV cameras installed near traffic intersections / junctions and counting the number of vehicles passing a spot in a particular time for further collection of vehicle / traffic data. A simple approach was carried out to tackle the problem by using Gaussian Mixture Model based object detection, a non-predictive regional tracking and a counting of tracked objects based on simple rules.

A vehicle detection proposed by B. Pawar has mentioned in [10], In which, the vehicle detection was based on morphology. Vehicle detection system works on two basic steps: Generation of Hypothesis in which, location of possible vehicles is hypothesized from image and Verification of Hypothesis in which hypothesis is verifies. Motion based hypothesis is highlighted with the working model based on the vehicle activity. This method calculates the variation between scene captured and sensor by utilizing relative motion. It is an attempt to propose and implement algorithm and system which is real-time oriented and vastly adaptive to traffic videos and road depend on domain specific knowledge on vehicle, road and control. In concern to automatic driving, accident avoidance and pursuit some important aspects are need to evaluate like vehicles present on road and situations of traffic while driving. It is really defying task to create a system that automatically identify the vehicles moving in opposite / same direction and tracking them constantly from traffic video. The most elementary difficulty in this kind of system is the environment that continuously changes and contrasts of light.

The system uses structure (size) phenomena to detect objects. Proposed algorithm is based on number of steps including video fragmentation, morphological processing and masking. Experiment is carried out on video frames of traffic videos. Which are taken through traffic camera, different types of traffic videos are experimented to check the variation of detection.

A unique algorithm for vehicle detection and vehicle tracking in video frames has been designed. This system has been developed using gaussian mixture models (GMM) and method of blob detection. By learning the background, first the foreground will be differentiated from background so that the detection of vehicles becomes simple as mentioned in [11]. This differentiation is done by GMM. And then to find the moving objects correctly, the noise is removed with the help of morphological operations. In each frame, the movement of objects is known by applying blob detection methods. To define rectangular boxes around each object, binary computation is done. Finally tracking and counting of vehicles is done based on the rectangular boxes drawn. But in this model GMM is used which does not consider spatial information and this is the major disadvantage for this system.

As mentioned in [14], Traffic management and information systems rely on a suite of sensors for estimating traffic parameters. Currently, magnetic loop detectors are often used to count vehicles passing over them. Vision-based video monitoring systems offer a number of advantages. In addition to vehicle counts, a much larger set of traffic parameters such as vehicle classifications, lane changes, etc., can be measured. Besides, cameras are much less disruptive to install than loop detectors. Vehicle classification is important in the computation of the percentages of vehicle classes that use state-aid streets and highways. The current situation is described by outdated data and often, human operators manually count vehicles at a specific street. The use of an automated system can lead to accurate design of pavements (e.g., the decision about thickness) with obvious results in cost and quality. Even in large metropolitan areas, there is a need for data about vehicle classes that use a particular street. A classification system like the one proposed here can provide important data for a particular design scenario. The proposed system uses a single camera mounted on a pole or other tall structure, looking down on the traffic scene. It can be used for detecting and classifying vehicles in multiple lanes and for any direction of traffic flow. The system requires only the camera calibration parameters and direction of traffic for initialization.

III. EXISTING SYSTEM

An efficient algorithm for vehicle detection has been designed in this section. This method is divided into four phases as – Basic processing phase, Edge detection phase, Morphological operation phase and vehicle detection phase. As each phase of the algorithm has its own importance, all the four phases of this method play an important role in detecting the vehicle in an image given as input. The steps for detecting the vehicles are as follows,

A. Basic processing phase:

In this phase, the image frame which is captured from the camera fixed at a position is taken as input to the algorithm. As the image taken is a colour image, the image is firstly converted from RGB to Gray as it is the first and foremost step followed in image processing. Then the frame which is obtained after converting to grey scale should be binarized. Binarizing the image helps us in processing the image efficiently in later stages.

B. Edge detection phase:

This is the important phase in this methodology because for detecting any type of objects present in an image, first we need to highlight them. So, we should now highlight the boundaries of the object for which edge detection is applied. Edge detection is one of the most important applications in image processing. In this algorithm we have used "Sobel" operator for edge detection.

C. Morphological operation Phase:

In this phase a series of morphological operations are applied on the image to make it suitable for the vehicle detection in the next phase. Erosion and dilation comes under morphological operations. The operations are performed with the help of structuring element. Structuring element of suitable size and suitable shape are chosen based on the size and shape of the object to be detected.

D. Vehicle detection phase:

In this phase, connected components analysis is done to remove the connected components which are fewer in number comparing with the size mentioned in the command. The size is initialized based on the size of the object to be detected. And finally, using the regionprops, rectangular box is allocated to each vehicle detected in an image.

First, the image is taken as input to the algorithm. Then this image is converted from RGB to grey scale for better and easy processing. In the next step, the image is binarized with the suitable threshold taken. After binarizing the image, the edge detection operator is applied. The operator used here is "Sobel" operator. This operator is used to emphasize and brighten the edges of the objects in the image. With the help of edge detection, the tracking of vehicle would become easy. Then dilation and erosion operations are performed based on the shape and size of structuring element taken. Dilation connects all the necessary objects in the image. Erosion removes unwanted pixels from the image. Then based on the connected components set of pixels vehicles are detected and bounding boxes are drawn around each vehicle.

IV. PROPOSED SYSTEM

Fig 1 gives an outline of the moving vehicle identification and density measurement in a video sequence. The framework utilizes a current video sequence and the first frame is taken as the reference frame for vehicle detection. The other frames are considered as the input frames. The backgrounds are eliminated by comparing the input and output frames. In the event that a vehicle is available in the input frame it is continued. The vehicle detection is in this way tracked by different procedures, specifically, blob analysis method and background method.

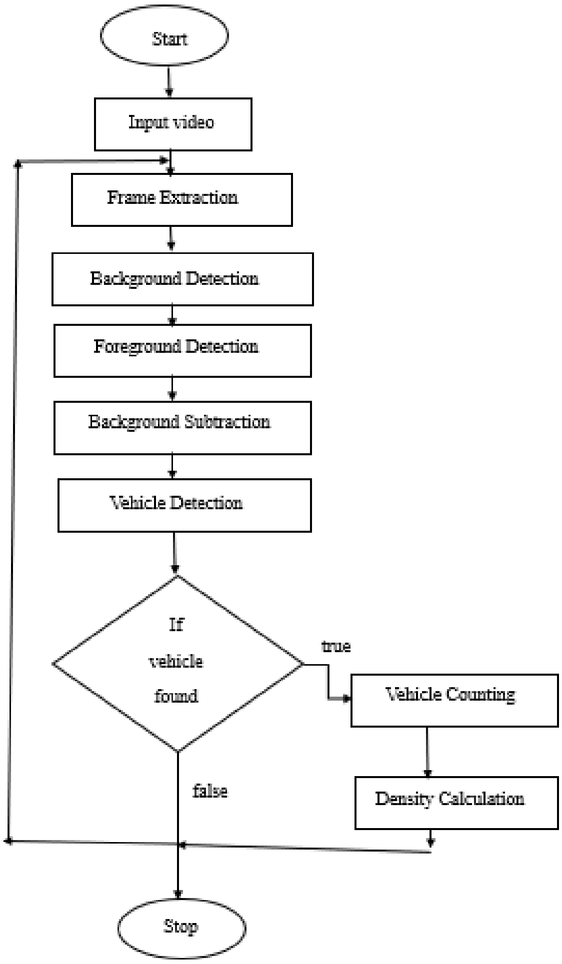

Fig 1 Flow chart of vehicle density measurement system

The first step of the process is giving input video which is a sequence video frames. And then the system extracts the frames from the video. Among those frames, the first frame is considered as a reference frame which is maintained as background image. And then background is detected which is first frame as discussed above. And next step is to detect foreground. Foreground can be detected among the frames by measuring the difference between reference frame and remaining frames. The frame difference will be performed on the binary images which are obtained by converting RGB images into GRAY scale images and then by converting GRAY scale images into binary images which is known as black and white images. Binary images have thresholds in which while colour represents 1 and black colour represents black for frame difference.

Next step is to detect vehicles from the images. Vehicle detection will be done based on the frame difference by subtracting the background from the input frames other than first frame which is reference frame. If the vehicles are found in any video frame, then those vehicles can be counted and the density at that particular time will be calculated based on the number of vehicles detected at that particular time frame. This process continues until the video goes to the end. After that, the program will be terminated automatically.

A. Background Detection:

Learned background detection method is used to extract the salient features from video clips in the general detection approach. This process involves in subtracting the images from background scenes. To determine the background image the first frame is considered as initial background and the resultant different images is threshold. The frame difference takes place to subtract the foreground from the image. And then this background image is used for further processes which are background subtraction and frame difference among the input video frames to detect the vehicles from the input traffic video.

B. Foreground Detection:

An occlusion which is caused by errors and vehicle type can be rectified by detecting the information. After this the foreground dynamic vehicles are obtained by subtracting the background images from the video frames. Post processing technique is used to reduce the noise interference in the video. Foreground can be obtained by removing the background from the images by using frame difference. By applying morphological operations, the system can smoothen the foreground images. Morphological operations include dilation, erosion, opening and closing etc. These techniques are used for image enhancement and noise removal.

C. Background Subtraction

Background subtraction is a widely used approach to detect moving objects in a sequence of frames from static cameras. The base in this approach is that of detecting moving objects from the difference between the current frame and reference frame, which is often called 'Background Image' or 'Background Model'. This background subtraction is typically done by detecting the foreground objects in a video frame and foreground detection is the main task of this whole approach.

Many applications do not need to know the whole contents of the sequence, moreover, further analysis is focused on some part of the sequence because interest lies in the particular objects of images in its foreground. After completing all the preprocessing steps such as deionizing, morphological processing, object localization is carried out and there this foreground detection is used.

All the present detection techniques are based on modelling the background of the image i.e. set the background and detect the changes that occur. Defining the proper background can be very difficult when it contains shapes, shadows and moving objects. While defining the background, it is assumed by all the techniques that the stationary objects could vary in color and intensity over time.

D. Vehicle Detection

Video analysis means analyzing the video to detect the moving vehicle. It can be used in various fields like people tracking, traffic monitoring and video surveillance. There are three different segmentation techniques, namely optical flow method, entropy mask and frame difference. The entire shape of the moving vehicle is not extracted well in frame difference method but it is good in implementation and computation. Reference image and current frame is used by the adaptive background subtraction method. The difference between reference and current frame gives the threshold which is considered as moving vehicle. Vehicle detection flow has shown in Fig 2.

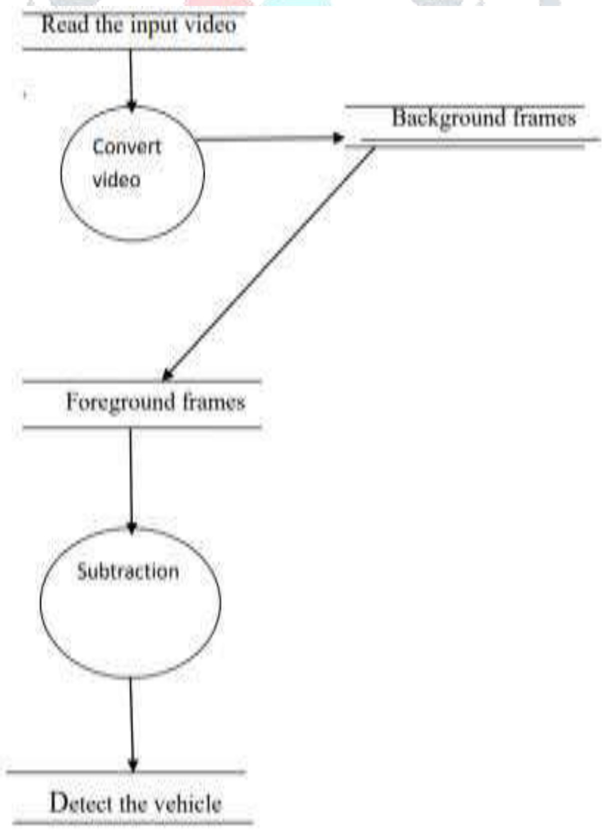

Fig 2 Dataflow diagram for vehicle detection

As shown in the above block diagram, the read image is taken as the input image by converting it to frames. The converted frame is difference from background and foreground image. Image subtraction is used to detect the vehicle in the frame.

V. RESULTS

The entire vehicle detection algorithm is implemented in MATLAB simulation software which is developed by MathWorks. The output at each step of the algorithm is shown in this section. Input video is the sequence of images which is commonly called as frames. Each frame contains some set of pixels. Video will be demonstrated by playing one by one frame. A sample input video frame as shown in Fig 3.

Fig 3 Input Video Frame

The reference frame is the first frame of a video sequence which is used for measuring the difference background and foreground. Reference frame is the one which the difference can be measured for background subtraction. The first frame has been considered as background and by measuring the difference between reference frame and remaining frames the system can detect the objects which are vehicles. Reference frame is the main requirement of this algorithm. To understand the picture of reference frame, see the Fig 4.

Fig 4 Reference Frame

Finally, the reference frame has been taken by the system to perform further operations. The vehicles in the image can be obtained by eliminating the background. This process includes image transformations from RGB to Gray scale as shown in Fig 5.

Fig 5 Gray Scale Image

And then the Gray scale image will be converted into binary image as shown in Fig 6.

Fig 6 Binary Image

After taking the reference the vehicle density measurement system starts observing the traffic for detecting the vehicles. If any vehicle found in the video, it highlights vehicle by drawing center of the vehicle and rectangle container around the vehicle to show it well to the user. And the output video frame contains the three measurements involves “Number of Active Vehicles”, “Total Number of Vehicles” and “Density of vehicles”. “Number of Active Vehicles” represents the number of vehicles present in the active frame. And “Total Number of Vehicles” represents the overall count of the vehicles passed on the specific road or highway. And “Density of the Vehicles” represents the density of vehicles which is normally a multiple of active number of vehicles which is commonly measured for an KM or 100m etc. The vehicle detection has been done by using background subtraction and morphological operations. These techniques used for image enhancement and for good image quality. The images have made with good quality by removing the noise in the images. And the objects have been detected easily by smoothening the object edges by using morphological operations. The result of system has shown in Fig 7.

Fig 7 Output Frame

After displaying the results, the video plays continuously until the end and the program will be terminated after completion of the video. After completion of the entire process the final output will be displayed on the window as video frame which contains the total number of vehicles and overall vehicle density which is the average density of the all frames measured by the system as shown in the Fig 8.

Fig 8 Overall Density

The overall density has been measured by multiplying with a factor which defines the length of the road. With the help of the multiplication factor the system calculates the overall density. The output results which are total number of vehicles and overall vehicle density are highlighted in green colored boxes to get good view.

VI. CONCLUSION AND FUTURE SCOPE

In this project, a method for estimating the traffic using Image Processing is presented. This is done by using the camera images captured from the highway and videos taken are converted to the image sequences. Each image is processed separately and the number of vehicles has been counted. Vehicle detection and counting is necessary in a highway to count the number of vehicles crossing in an efficient manner. Each of the vehicle is detected and outlined in a rectangular box to differentiate foreground and background images. This system follows background subtraction method to identify and detect the vehicles. Because this method has been implemented using Image Processing and MATLAB software, production costs are low while achieving high speed and accuracy.

This system is now designed for the counting and detection of vehicles. Future developments can be given to this system for more experimental effects. Extension to this system will provide the exact counting and detection of vehicles of a live traffic in highways. And further this can be advanced for alarming systems during traffic in highways and also for identification of types of vehicles. The present system uses a single camera for monitoring traffic at an intersection. By using a separate camera for each road at an intersection will allow the system to use video processing which can improve the system efficiency further. The vehicle objects can also be categorized into various classes depending upon the geometrical shape of vehicle for blocking the passage of large vehicles e.g., trucks during day times. The emergency mode can be refined further by installing a GPS receiver in ambulance so that the base station will keep track of the ambulance location on a continuous basis and clear the road whenever will be required.

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