Vehicle counting method based on Digital image processing Algorithm

Nowadays traffic problems are increasing due to the fast-growing number of vehicles. Traffic flow analysis can be useful for identifying critical flow time periods or determining the influence of large vehicles or pedestrians on vehicular traffic flow, and even documenting the traffic volume trends. Vehicle counting process provides very nice information about traffic flow, vehicle crash occurrences and traffic peak in roadways. This useful information is being used by our group for better traffic management methods, such as changing the timings of traffic lights based on traffic flow. There are several ways to count the number of vehicles passed in a period of time, and therefore estimate the traffic flow, such as using manual counters, portable counters and observers which are mainly hardware dependent or human dependent but the best method or technique to achieve this goal is using digital Image Processing methods on roadway camera video outputs as it is fully automated without any other human or hardware issues or errors. Here we have carried out the process based on a combination of different video-image processing methods including object detection, canny edge detection, frame differentiation and the kalman filter\*. The implementation of proposed technique has been performed by us using c++ programming language and will also be implemented using python programming language at later stage if time permits.

The accuracy or performance of this method or technique in vehicle counts and classification will be also evaluated for proper accuracy of classification and error in vehicle detection targets.

We focus on a software-based novel technique for vehicle detection in roadways and classification od passed vehicles in different specified types. The method which we have implemented detects vehicles in the input video stream, assigns an exclusive identifier for each of them, classifies each vehicle on its distinctive vehicle-type group and finally counts them all. In addition, the method was evaluated and the performance was analyzed using a real condition roadway video feed.

**BACKGROUND INFORMATION**

A. Video Processing

Video processing is a subcategory of Digital Signal Processing techniques where the input and output signals are video streams. One of the best ways to reach video analysis goals is using image processing methods in each video frame. Motions are simply realized by comparing sequential frames. Video processing includes pre-filters, which can cause contrast changes and noise elimination along with video frames pixel size conversions. Highlighting particular areas of videos, deleting unsuitable lighting effects, eliminating camera motions and removing edge-artifacts are performable using video processing methods.

B. RGB to Grayscale Conversion

In video analysis, converting RGB color image to grayscale mode is done by image processing methods. The main goal of this conversion is that processing the grayscale images can provide more acceptable results in comparison to the original RGB images. In video processing techniques the sequence of captured video frames is transformed from RGB color mode to a 0 to 255 gray level. When converting an RGB image to a grayscale mode, the RGB values for each pixel is taken, and a single value reflecting the brightness percentage of that pixel is prepared as an output.

C. Edge Detection

Object detection can be performed using image matching functions and edge detection. Edges are points in digital images at which image brightness or gray levels changes suddenly in amount. The main task of edge detection is locating all pixels of the image that correspond to the edges of the objects seen in the image. Among different edge detection methodologies, Sobel algorithm is a simple and powerful edge detection method.

D. Kalman Filter

Images typically have a lot of speckles caused by noise which should be removed by the means of filtration. The Kalman filter is a powerful and useful tool to estimate a special process using some kind of feedback information. The Kalman filter is used to provide an improved estimate based on a series of noisy estimates. Otherwise simple erode and dilate functions can be used to remove the debris and noise in the image or video after thresholding.

Using image/video processing and object detection methods for vehicle detection and traffic flow estimation purposes has attracted a huge attention for several years. Vehicle detection/tracking processes have been performed using one of these methodologies:

• Matching

• Threshold and segmentation

• Point detection

• Edge detection

• Frame differentiation

• Optical flow methods

**PROPOSED TECHNIQUE**

Different from previous works, the method proposed in this paper uses a combination of both “Frame Differentiation” and “Edge Detection” algorithms to provide better quality and accuracy for vehicle detection. By using the erode and dilate functions, position of each vehicle will be estimated and tracked correctly. The Kalman filter can also be used to classify detected vehicles in different specified groups and count them separately to provide a useful information for traffic flow analysis, but it hasn’t been used by us.

**FLOWCHART OF THE TECHNIQUE PROPOSED**

Video Frames

Detection Zone Analysis

Counting

Image Enhancement

Result

Edge Detection

Motion Analysis

The technique includes these steps: image enhancement process, edge detection, motion analysis using a combination of different techniques, detection zone definition and counting. It is necessary to say that some assumptions made in this work:

• No sudden changes of directions are expected

• No car accidents and crashes are expected

• There is both physical and legal limitations for vehicles

• motion scenes are captured with a view from above to the roadway surface

The proposed technique to detect and count vehicles is presented as below:

A. Grayscale Image Generation and Image Enhancement

To get better results, vehicle detection process should be performed in the grayscale image domain. Hence a RGB to grayscale conversion is performed on each video frame. To achieve an appropriate threshold level and make results more suitable than the input image, each frame should be brought in contrast to background. Among several grayscale transformations, power-law method has been used in this work.

B. Edge Detection

Each image (video frame) has three significant features to achieve detection goals. These features include: edges, contours and points. Among mentioned features, an appropriate option is to use edge pixels. Processing of image pixels enables us to find edge pixels, which are the main features of passing vehicles in a roadway video frame.

The next step is to extract moving edges from sequential video frames and process the resulting edge information to obtain quantitative geometric measurements of passing vehicles.

C. Background Subtraction

Using provided threshold, the static parts of sequential video frames should be cleaned. The main challenge here is that the performance of image analysis algorithms suffers from darkness, glare, long shadows or bad illumination at night, which may cause strong noises. Therefore, the grayscale image might be unspecified in these situations, and make the detection task a bit more complex. Edges essentially separate two various regions which are static region (the roadway) and dynamic region (moving vehicles). The static background is then deleted to locate moving objects in each frame. The result zone leaves only vehicles and some details as moving objects in sequential images which are changing frame to frame. A combination of forward and backward image differencing method and edge detector has been used in this work. According to this method, two sequential frames are chosen and the one frame is compared to its previous frame. Consequently, extracted edges of each frame achieved from previous section are used here. Then the differences of frames can be obtained by subtracting two sequential generated binary images. Where Fn-1 is previous frame, Fn is current frame, this process continues to the last two sequential video frames.

D. Detection Zone

As an observation zone, a region is defined to display moving vehicle's edge in a bounding box at the time that the vehicle enters it. This zone is in the middle of the screen and covers 1/3 of its height and 3/5 of its width (considering minimum and maximum available size of detectable passing vehicles in pixels). This area which contains the most traffic can embed both small and long vehicles and the main goal of defining it is to avoid perspective challenges and wrong type counts. Based on the proposed background subtraction technique, a vehicle is detected in two sequential frames. When a moving vehicle is detected, a bounding box whelming vehicle borders in binary image is drawn.

Based on the test results another important challenge of the technique was to avoid counting nonvehicle moving objects such as people or animals crossing the roadway. To handle this challenge, some basic factors is considered:

1) A Range of Contour Size in the detectable Region.

2) Motion Speed: The detected moving object with relatively low speed must be humans or passing animals and should not be considered.

3)The direction of the moving vehicles differs from animals or humans passing across the roadway, which can be a suitable factor.

Although the proposed technique faced with some challenges, the errors are partly appropriate and do not affect the traffic flow intensity estimation. That is because just an approximation magnitude of traffic flow is needed for analysis.