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Video Based Vehicle Detection and Counting Using Digital Image Processing

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Abstract: ***Vehicle detection and counting is very much important for the purpose of upgrading and widening the road. The information obtained from the traffic monitoring can be used in planning the budget for road maintenance. The traffic monitoring can be done automatically or by detecting and counting the vehicles manually using human labors. In manual method of traffic monitoring the person records the data using tally sheet which may leads to the human errors and most of the automatic traffic census system used nowadays focuses on detecting and counting the vehicles by using devices called magnetic loop detectors. These devices are costly and once installed, cannot be removed. So, it is necessary to build the system that is capable of detecting and counting vehicles without involving persons for traffic monitoring and costlier devices to detect and count the vehicles. For that purpose in this work simple cameras are used for detection and counting of vehicles.***

Keywords: Detection, Counting, Background subtraction, Canny edge detection, Kalman filter.

I. INTRODUCTION

The traditional method of vehicle detection and counting uses sensors such as loop detectors, ultrasonic sensors which may causes damage to the road surface. Meanwhile, many of these sensors need to be installed in urban areas, so the installation cost of this work is very high. To overcome all these problems, it is necessary to develop a system that is able to detect and count the number of vehicles automatically. An automated traffic census system based on image or video processor using digital image processing is designed here which uses simple cameras for detecting and counting the vehicles. The images obtained from the camera are divided into frames. These frames are then transformed into gray frames using the RGB to Gray Scale Conversion and these gray frames are given as an input to the system to perform edge detection. By using Canny Edge Detector Algorithm, vehicles are detected and then a specific region is selected as a region of interest and the vehicle is tracked till it goes out of the region of interest. After that backgroundsubtraction is performed using vehicles Blob area. To determine different types of vehicles every frame is compared with the previous frame, if the vehicle is present in both the frames and difference in their x and y coordinates is less than max (Width, Height) pixels then it is considered as a same vehicle. If the difference is more than max (Width, Height) pixels, then it is considered as 2 separate vehicles. Finally, vehicle counting is performed using Kalman Filter. An implementation of this work is performed using MATLAB.

II. DESIGN METHODOLOGY

The design methodology of vehicle detection and counting is based on the traffic video and it contains two main parts, detection and counting. The block diagram of the vehicle detection and counting method based on Digital Image Processing is shown in below figure

Fig 1: Block Diagram of video based Vehicle Detection and Counting.

The design methodology of vehicle detection and counting based on Digital Image Processing has 5 steps namely Input Frames, Object Detection, Detection Zone, Background Subtraction and Object Counting.

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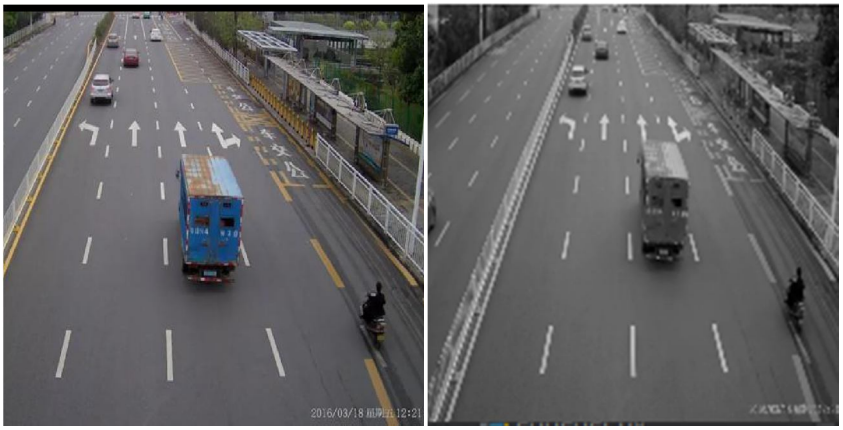
A. *Input Frames*

The input frames are the Inputs to the System. The video of the vehicle is captured using a video or a still camera. This video thus obtained is stored in mp4 format. The images are taken from this video for processing purpose. The images should be in such a way that the vehicle in the image is clearly and completely visible. The images thus obtained are converted into frames at the rate of 18-20 frames per second. After that, these Frames are transformed into Gray Scale Frames by using the RGB to Gray Scale Conversion. Then, this Gray Scale Frames are given as an input to the system to perform the Object Detection using Canny Edge Detector Operator.



(a) (b)

Fig 2: (a) RGB Image (b) Gray Scale Image.

B. *Object Detection*

The Gray Scale Images are given as input for the Object Detection. The images obtained are divided into different areas or sections by edges. The main Objective of detecting edges is to extract the portion of image that contains useful information such as shape, position, the object size in the image, image sharpness, and enrichment etc. There are several edge detection algorithms in image processing such as Canny, Sobel, Prewitt, Robert edge detection etc. The performance of the canny edge detection algorithm is better than all other algorithms. So, in this project for object detection Canny Edge Detection Algorithm is used.

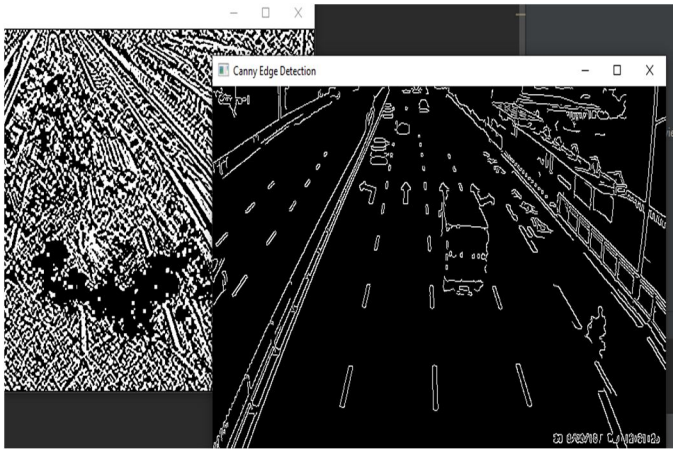


Fig 3: Edge detection using Canny Edge Detection Algorithm.

The Canny Edge Detection algorithm operates in a multi-stage process such as Gradient calculation,noise reduction, Non-maximum suppression, double threshold and Edge Tracking by Hysteresis. At first it removes the noise present in the image using the Gaussian Filter and then image gradient is performed to highlight regions of the image with high spatial derivatives. The algorithm then tracks along these regions in order to suppress the pixel which is not at the maximum. Finally, through hysteresis, this algorithm uses two thresholds and if the magnitude of these thresholds is below the first threshold, then it's set to zero. If the magnitude of two thresholds is above the high threshold, then it's considered as edge and if the magnitude is between the 2 considered thresholds, then it's set to zero until and unless the path is there from this pixel to a pixel with a gradient above the second threshold.

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C. Detection Zone

A detection or observation zone is a region that is defined to display moving vehicle's edges in a bounding box at the time when the vehicle enters it. This detection zone is in the middle of the screen and covers 1/3 of screens 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 include both small and long vehicles and the main goal of defining it is to avoid perspective challenges and wrong type counts.

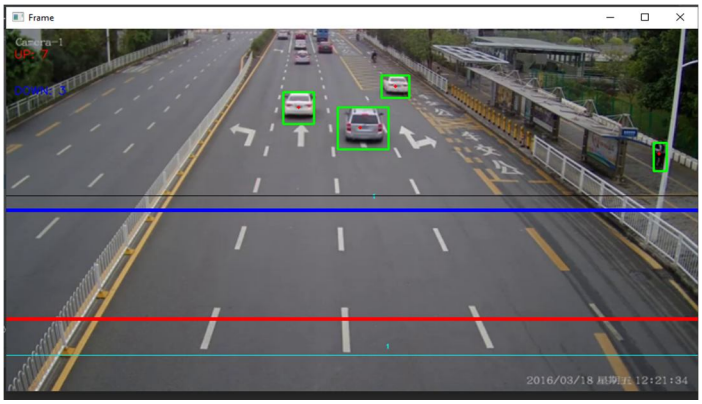

Fig 4: Detection Zone.

D. Background Subtraction

As the name itself indicates Background Subtraction is the process of separating out foreground objects from the background in a sequence of video frames. The main objective of background subtraction is to build the background and then compare every frame of the sequence to this background in order to discriminate the regions, called foreground.

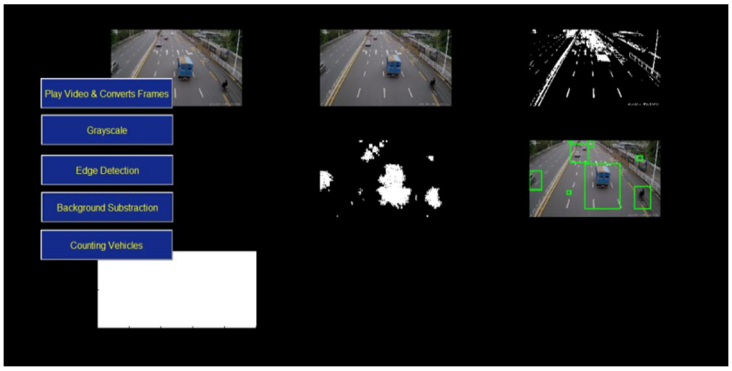

Fig 5: Background Subtraction.

Background subtraction is the technique for separating the foreground elements with background. For this purpose vehicles blob area is used to calculate height and width of the vehicle. In this method every frame is compared with the previous frame, if the vehicle is present in both the frames and difference in their x and y coordinates is less than max (Width, Height) pixels then it is considered as a same vehicle. If the difference is more than max (Width, Height) pixels, then it is considered as 2 separate vehicles. After this vehicles are covered with the square boxes.

E. Object Counting

Object counting is very much important for studying modern traffic and it can be achieved by using different techniques, such as manual counts, use of pneumatic tubes, magnetic sensors etc. In this work however, automatic vehicle detection is achieved using image processing, because it is less expensive and fast method of counting. Large cities can get traffic recordings from cameras and process the information, but it is very much difficult for smaller towns without such infrastructure or even assigned budget. By taking into consideration, all these difficult situations Kalman filter is developed to count the objects and it only requires users to have access to a fixed video cameras placed at an elevated point and a computer with a powerful processor. In this work the images are processed automatically through the Kalman filter code using MATLAB software.

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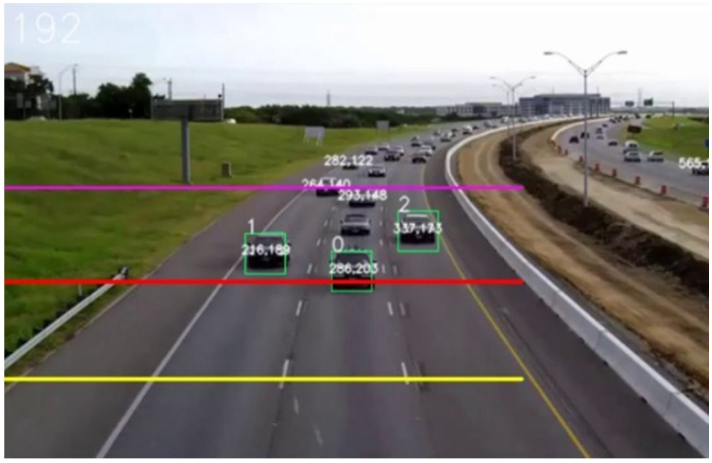

Fig 6: Vehicle Counting.

III. RESULTS AND DISCUSSIONS

The design proposed in this project is developed using MATLAB programming. Reading cars.mp4 is used for detecting, counting and classification purpose. Here first frame conversion is done to convert RGB to grayscale images using rgb2gray command in MATLAB. After this edge detection, background subtraction is performed based on the algorithms to detect and count the vehicles.

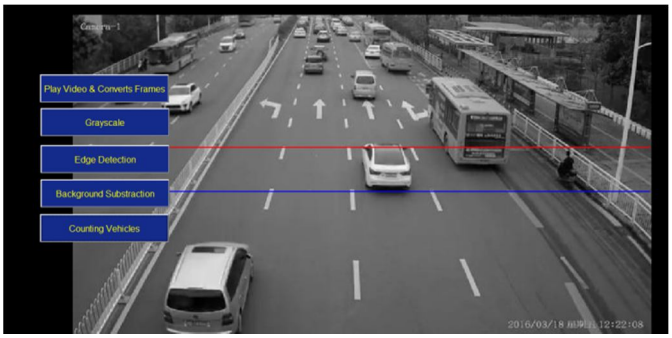

Fig 7: Image considered for the vehicle detection and counting using digital image processing.

Fig 8: Result of vehicle counting.

As shown above based on the algorithms different categories of vehicles are counted. Here total number of trucks counted is 1 and total numbers of cars counted are 11 so, the total number of vehicles counted is 12.The vehicle counter designed in this project based on the Kalman filter is capable of counting the vehicles in both directions.

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IV. CONCLUSION

This project presents the successful implementation of Vehicle detection and counting using simple video or image processor which uses the images captured by the simple cameras unlike the traditional methods which uses the sensors and cost of these sensors is very high. In this project for the purpose of object detection Canny Edge Detection Algorithm is used. By comparison of various edge detection algorithms, it is ensured that Canny Edge Detection algorithm is the most efficient one. The benefit of using this technique is that it is faster compared to the traditional methods and coding is done using MATLAB software. But the only problem is that it gives poor performance in bad environmental conditions.

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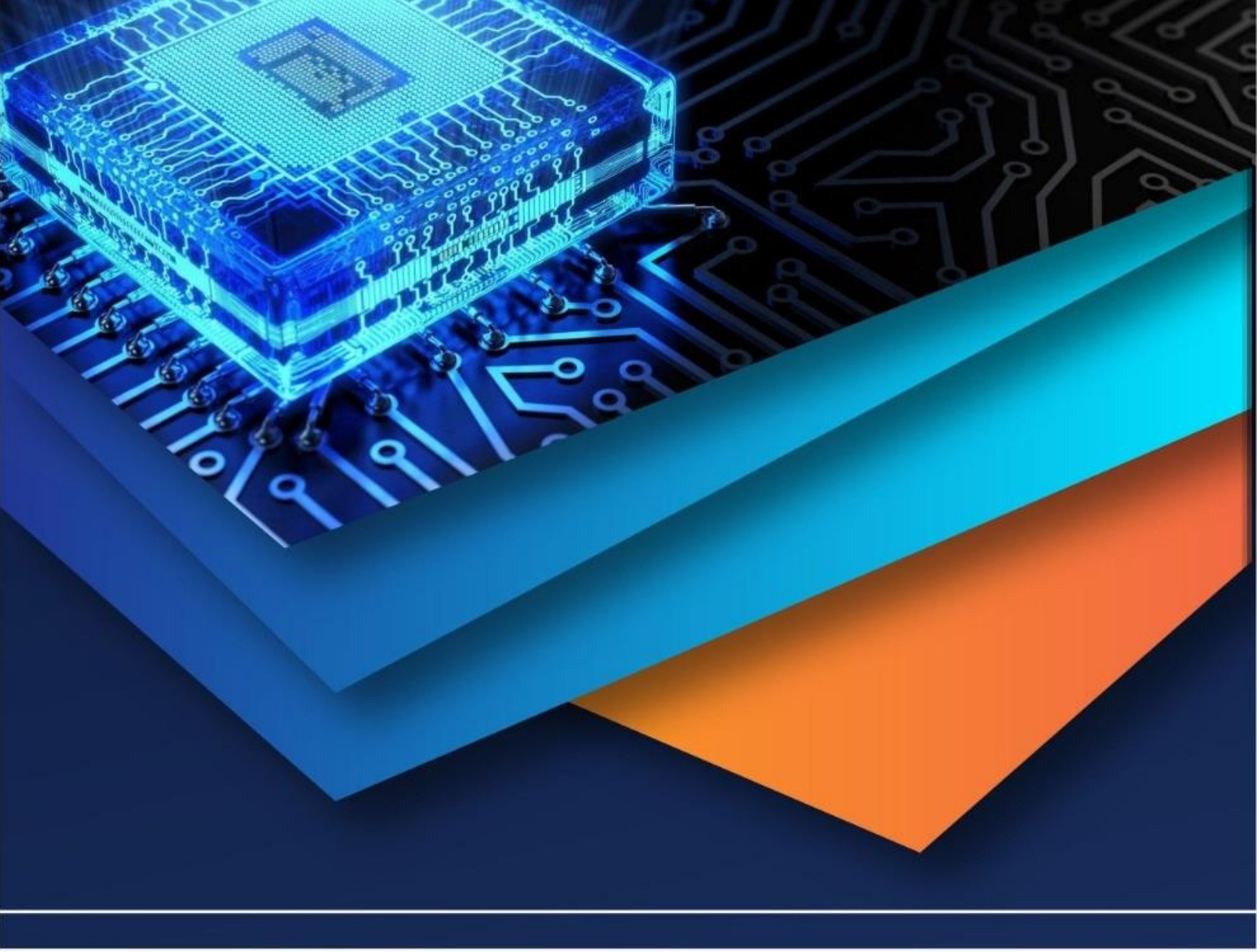

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