Traffic Monitoring System

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ABSTRACT

Vehicle counting process provides appropriate information about traffic flow, vehicle crash occurrences and traffic peak times in roadways. An acceptable technique to achieve these goals is using digital image processing methods on roadway camera video outputs. This paper presents a technique for video based monitoring system using a combination of various techniques including object detection,edge detection etc.

Index Terms—Frame Subtraction, Edge detection, Morphological operations

1. INTRODUCTION

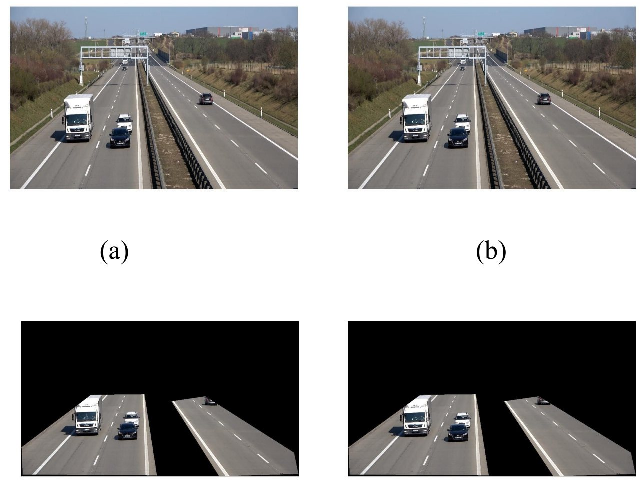
Traffic jams have become a major problem in many countries especially India. One possible solution to the problem of traffic congestion is to design efficient traffic monitoring systems which gives us an accurate estimate of the number of cars entering or exiting a road. This paper uses a video footage of an overhead traffic camera and provides a technique to estimate the number of cars exiting and entering the road. The technique used in this paper extracts moving vehicles by frame subtractions and then uses Image processing techniques to remove noise and highlight the area occupied by moving cars. The paper proposes an algorithm to count the number of vehicles after all the steps of image processing. This estimate can then be use to manage the traffic efficiently and prevent traffic jams.

2. VEHICLE EXTRACTION

In this section we present a method to extract traffic information from the video frames. We have used the video traffic "production ID_4261469.mp4" to analyze the techniques.Our goal is to count the number of vehicles present in the frame. To accomplish this task we will use the background subtraction method where the current frame is taken as foreground and the previous frame is taken as background.By subtracting the background frame from current frames we can determine the traffic density. Following are the methods used to achieve our goal.

A. Masking Of The Frames

To get the better results we will first mask the image to gather only that part of the frame which we want in output. Mask is created using Matlab ROI free hand tool to extract only a particular part of the image.



(a) (b)

c) d)

Fig 1 a)RGB Background b)RGB Foreground c)Masked Background d) Masked Foreground

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 to get the more acceptable results in comparison to original RGB images. Fig 1c) and Fig 1 d) will be converted to grayscale. Here we will be using Matlab function rgb2gray to convert the image to grayscale.

C. Sobel Edge detection

Then we apply sobel edge detection mechanism on grayscale background and foreground image to get the output as Fig 2 a) and Fig 2 b). It performs convolution on input image I using (1) and (2) as the convolution kernel to get the gradients in x and y direction respectively.Then the final gradient is calculated using (3) .

$$Sx=[+1\ 0\ -1;\ +2\ 0\ -2\ ;\ +1\ 0\ -1]*I \quad (1)$$
$$Sy=[+1\ +2\ +1;\ 0\ 0\ 0\ ;\ -1\ -2\ -1\ ]*I \quad (2)$$
$$BGp=\sqrt{Sx^2+Sy^2} \quad (3)$$

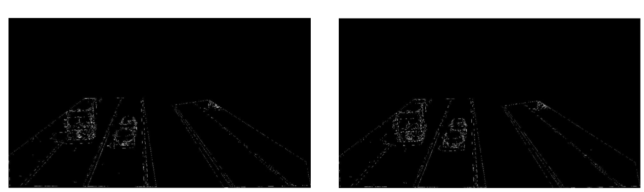


Fig 2(a) Sobel output of background image (b) Sobel output of foreground image

D.Direct Subtraction

In this step we will subtract Fig 2 a) from Fig 2 b) to get the image which will now on be used to detect the vehicles.

E.Noise Removal

After this we need to do some noise removal to remove the noise introduced by subtraction. We will use a median filter of size 2X2 to remove the salt and pepper noise from the subtracted image (Fig 3 (a)). We have chosen a filter of this size after a series of experiments and analysis.The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. Median filter also known to preserve the edges.This is done using the matlab function of medfilt2.

G.Morphological closing

Now we will perform morphological closing of the image with 16X16 square structuring elements. Morphological operations create output image of the same size by applying structural element. The most basic morph closing operations are dilation and erosion. The closing operation dilates an image and then erodes the dilated image, using the same structuring element for both operations.It is basically used for filling small holes while preserving edge and shape of the image.Fig 3 b) show morphological closed image.This procedure will give us the image with closed contours.

H. Flood Fill operation

After that we will perform flood fill operation to fill the small holes in the closed contours which are performed after morphological closing and we will get an image with solid foreground objects.

I.Binarizing Image

Now we have to obtain a binary image from the flood filled image. For this we will use the otsu threshold method to obtain the threshold(T_{otsu}) needed to convert grayscale image to binary image. But to enhance the binary image quality we will multiply the otsu threshold by 0.8[1]

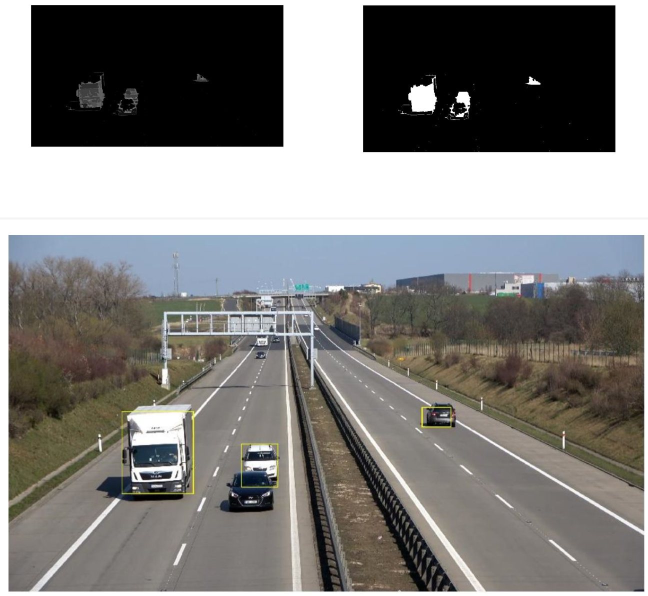
Gbinary={1 if if pixel value>=T_{otsu}*0.8
{0 else

J. Morphological opening

It is used for removing small objects from the image while preserving the large objects. The opening operation first apply eroding and then dilates the image[1]

I. Forming bounding box using contour

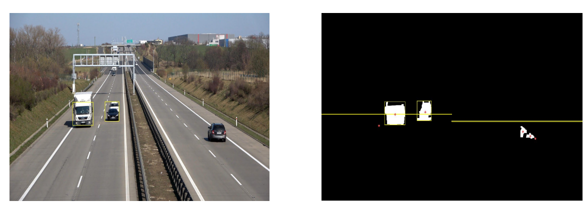
In this operation we will use matlab regionprops function to get a bounding box over all the closed contours in the image obtained from morphological opening. Then after getting all the contours we will insert this in the original image after checking their area. This area threshold (15000) was obtained from experiments to remove the small contours which are generally noise and not removed by median filter



a|b
c|d
e

Fig 3 a) Direct subtraction output b)Morphological closing output c) Flood fill operation output d) Binarizing image output e) Final output after applying all the operations

3. Algorithm for Car Detection



(a) (b)

Fig 4a) Final Output image b)Binary image with centroids and bounding rectangles

The algorithm uses the final image obtained after filling. The algorithm captures only those images whose centroid lie within a given range. In fig 4b) The range has been highlighted by the horizontal lines. The given region has been selected by optimising the hyperparameters as well as for reducing noise detection.Vehicles which occupy an area greater than 15000 sq units would only be captured by the algorithm to avoid capturing noise .If the object satisfying the area criteria is captured on the left half(moving towards the camera) of the image and it's y coordinates lie between 1170 and 1175(both included) then the object is recognised as a moving vehicle. Similarly if the object satisfying the area criteria is on the right half(moving away from the camera), the object is counted as a moving vehicle if the y coordinate of it's centroid lies between 1248 and 1256.

4. RESULT

Counting Method	Moving towards camera(Left side)	Moving away from the camera(right side)	Total Vehicles
Visual Observation	7	3	10
Detection by algorithm	6	2	8

Table 1- Number of vehicles by visual observation and by algorithm

A total of 10 cars were observed as moving by method of visual observation. The designed algorithm was able to count 8 cars. The accuracy of the algorithm for the left half is about 86% and for the right side is about 67%. The overall accuracy of the algorithm is about 80%.

5. CONCLUSION

In this paper we designed a traffic monitoring system has been designed which counts the number of vehicles entering or exiting a road. The designed algorithm gave an accuracy of about 80 percent. The designed algorithm can be deployed to solve real world traffic monitoring with appropriate error corrections.

6. REFERENCES

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