Vehicle Identification and Tracking using Images Sequence

Conference Paper · September 2007

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ABSTRACT

The real time measurement and analysis of various traffic parameters such as speed and number of vehicles are increasingly required in traffic control and management. Image processing techniques are now considered as an attractive and flexible method for automatic analysis and data collections in traffic engineering. Various algorithms based on image processing techniques have been applied to detect multiple vehicles and track them.

In this paper, a method for moving vehicle identification and tracking is presented using consecutive digitized image sequence. The algorithm preprocesses consecutive images using gray scale and median filters. To extract vehicles from a traffic scene, difference between three consecutive images were taken and input to an edge detection filter that uses Sobel edge detection operator. Blob counting technique was applied to estimate the position and size of the moving vehicles in the image. To estimate the trajectory and count the individual vehicles, predicted area technique was applied to the blobs. The result of this work can be extended to classify vehicles and estimate speeds of individual vehicles from an input video source.

1.0 INTRODUCTION

Automatic vehicle identification and tracking is an ongoing research area in most of the developed countries. Image processing and computer vision techniques seem to be the most attractive way of carrying out the identification since it provides wealth of information to the system. By using image processing and computer vision techniques the system can identify the vehicles individually and extract the information related to each individual vehicle such as speed, registration number, color and type of the vehicle. These types of information are highly valuable in the identification of the vehicle and especially for providing security. The additional parameters that can be extracted from an automatic monitoring system such as flow rate of the traffic, queue length of traffic, vehicle count and speed of vehicle are very important for controlling and managing the traffic. In general, the information that can be extracted through an automated system can be used effectively to manage the traffic flow by maintaining optimum timing for traffic signals and identifying the violators of traffic rules. This will eventually lead to the economic benefits and increase the productivity.

Although number of research studies has been conducted in many countries in the area of automatic vehicle identification, to our knowledge there are no research studies conducted in Sri Lanka in this area. However, the use of vehicles in Sri Lanka, especially in the cities has increased rapidly in recent years. Traffic congestion has become a major issue in many populated cites. Therefore, the control of vehicles and identification of traffic violators to maintain discipline is becoming a necessary task.

This paper presents results of a study to identify moving vehicles from a consecutive image sequence and an algorithm to track the path of individual vehicles. The consecutive image sequence is taken by video acquired with down tilted camera from a bridge.

Various methods have been proposed to extract moving vehicles from image sequence and track the vehicle. To build a real time monitoring system simple procedures have advantages over complex procedures. The basic steps required to extract moving vehicles from consecutive image sequence can be described as follows.

1. Select three consecutive RGB images
2. Apply gray scale and median filters
3. Create difference of images as image2-image1 and image3-image2
4. Detect edges of difference images
5. Generate intersects of difference images
6. Apply threshold, dilation and erosion filters
7. Extract moving blobs from the images

After identifying the moving vehicles from the images sequence, developed predicted area algorithm was used to track the vehicles. Each of the above steps is discussed in detail in the proceeding sections of this paper.

2.0 METHODOLOGY

The inputs to the system were the images of vehicles captured by digital camera mounted on a bridge. At the beginning, images taken from a side of the traffic route were analyzed for suitability but ran into difficulties when processing these images. The main drawback was that when there were multiple vehicles on the traffic route, the vehicles tends to overlap in the image view or covered by the shadow of the vehicles in the near side of the road making it impossible to track. The image sequence obtained from an overhead bridge was more suitable for our purpose since it provided an unobstructed view of the traffic route.

Taking consecutive images from a traffic scene is difficult with a fix camera as it generates noise in images due to the movements of the camera. The solution to this problem was to obtain a video sequence of the scene and then extract the frames from the video.

The video sequences were captured from a 10 meter high overhead bridge using digital video camera. The resolution of the video was 640x480 and frame rate was 30fps. The consecutive images extracted through the video became the inputs to the image preprocessing stage.

2.1 Preprocessing

The extracted RGB images were converted into grayscale in the first stage of the preprocessing. Then, each of the converted grayscale images was median filtered using a 3x3 filter kernel to remove noise [3]. Figure 1 shows an output image after the preprocessing stage.

Fig. 1 Output image after the preprocessing stage

2.2 Moving vehicle Identification

To identify the moving vehicles in the images, the nonmoving background must be removed. Two basic techniques are popular in the moving vehicle identification. The first technique, obtains a frame with only the background that can be subtracted from the images in which there are vehicles [1]. This method has some drawbacks since it is difficult to get a back background image on congested highway with correct lighting level with no vehicles present. The second technique calculates the difference between consecutive images to extract the moving vehicles [2]. From these two methods, the second method was suited for our purpose.

Two difference images were formed by taking the difference between three consecutive images after the preprocessing. These were formed by taking the difference between the gray values stored in each pixel between image 2 and image 1 and then between image 3 and image 2. Grayscale images consist of values stored in pixels that range from 0 to 255. Thus, the difference images were also consisting of pixel values ranging from 0 to 255 [3]. Figure 2 shows a difference image obtained from subtracting two consecutive images.

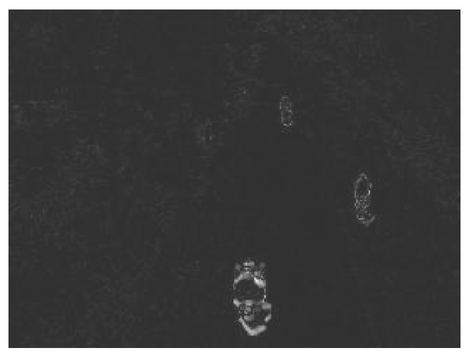

Fig. 2 Difference image

In order to enhance the moving blobs, after taking the difference images, edge detection algorithm based on Sobel edge detection operator was applied to each of the difference images. Edge detecting is a process of detecting discontinuities in intensity values. The first order edge detection operator such as Sobel detects the edges by searching for the maxima and minima of the first derivative of the intensity profile along vertical as well as horizontal direction. The maximum and minimum values are the values exceed or below the threshold values which are defined by the user [3]. At this stage, gray scale images were converted to binary images. In binary images, each pixel value is represented by a value 0 or 1. Figure 3 shows a binarized image after applying the Sobel edge detection operator.

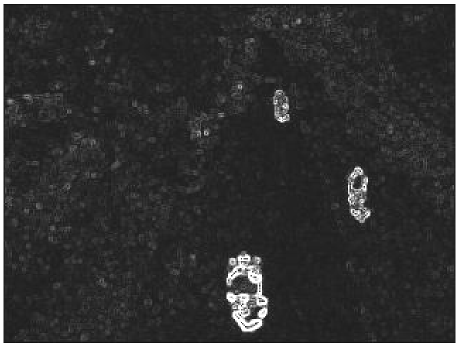

Fig 3 Output of binaries image after applying the Sobel edge detection operator

In order to combine the two difference images, two Sobel edged images were processed and formed an intersect image. This step helps to remove extra noise present in the edged images which are generated by moving trees and other oscillatory moving objects. Figure 4 shows intersect image of two difference images.

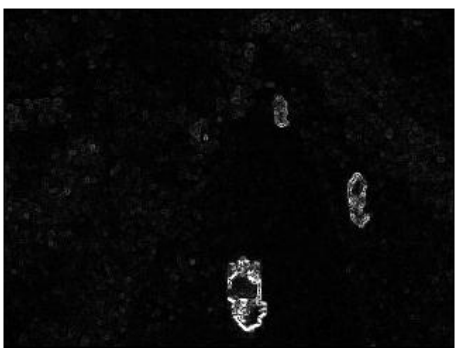

Fig. 4 Intersect image of two difference images

To remove any other remaining noise from the output image of intersect process, threshold filter was used. Threshold filter basically removes noise in pixels that are less than a given threshold. In this work threshold value was set at 50. Figure 5 shows an output image after applying the threshold filter.

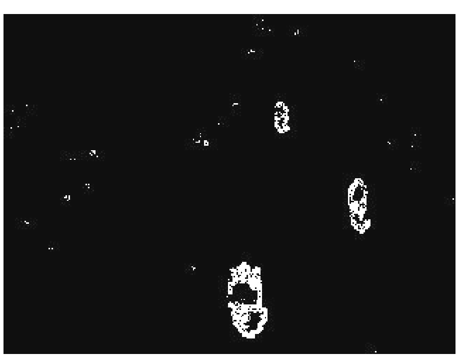

Fig. 5 Output image after threshold filter

To identify individual objects from the image, separated small blobs should be connected to each other. Otherwise, blobs do not form closed polygons that we can identify as individual vehicles. To overcome this problem and to create closed curves, two morphological operators were used. First, dilation with 3x3 restructuring element to increase the size of the moving area of the edged image was applied. Then, erosion filter using 3x3 restructuring element to bring back the image to its original size was applied. Figure 6 shows the output image after dilation and erosion phase.

Fig. 6 Output image after dilation and erosion

The image we obtain after applying morphological operators consists of moving blobs of vehicles. To get the position of vehicles, first, position of all the blobs in the image including the small noise blobs were extracted. Connected component algorithm was applied to get the positions. Connected component algorithm extracts the position, width and height of all the connected pixels in an image. Then by specifying a region of the traffic route and minimal height and width of a blob that may represent a vehicle, position of the moving vehicles were extracted.

When selecting a region of the traffic route, the road section can be selected by avoiding payments and other areas of the image. Since the apparent size of the vehicle change with the visual depth and with the type of the vehicle (for example, motor bike to motor car), when choosing a size for the blob, several trial values were used to look for an optimal size. In the preset work, minimal width and height of a blob was selected as 15 pixels. Positions of the vehicles were extracted at this stage and the positions were recorded in an array for the tracking stage.

2.3 Tracking

To get the path of individual vehicles, the position of vehicles in the array should be process accordingly. The array that records the positions of the vehicles is a two dimensional array and elements are made up from objects to form a blob class. A blob class made up from three integer variables which consist of centers of the vehicles and their ID's. Search in predicted area algorithm was used to change the ID of each blob so that ID can be used to track the path of individual vehicles. The search in predicted area technique search through the whole two dimensional array and mark the vehicle centers located in a predefined search area. This process allows us to identify the individual vehicles from the traffic scene. The collected vehicle information was stored separately with its vehicle class which can facilitate later to extract traffic information. Figure 7 shows an output image of vehicle tracking stage.

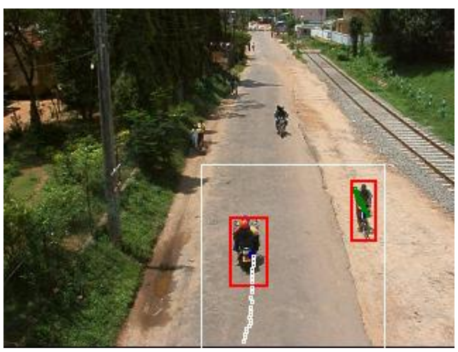

Fig. 7 Output image of Vehicle tracking stage

In the above figure, large square box represents the vehicle tracking region. Only the moving objects in this area will be tracked. Two small boxes around the objects are the regions of identified moving vehicles. As shown in the figure, two vehicles in the selected region have been identified as moving vehicles and the other remaining vehicle outside the region has not been identified. The path of individual vehicles has been indicated as trails in the figure.

3.0 PERFORMANCE

Pilot tests were carried out to test the performance of the developed system based on identification of the vehicles in the road by the image processing algorithm and tracking algorithm. The system was designed and developed using Microsoft Visual studio 2005 and C# as the programming language. Image processing functionalities were taken from AForge.Net image processing library [4] and functionality to extract frames from a video is taken from article from an external library [5]. The test videos were taken from a digital video camera of resolution 640x480 and 30fps.

The algorithm was developed to detect moving vehicles in the selected area. When the vehicles move away from the camera they become smaller and difficult to be detected from noise such as moving trees. Therefore, the selected area is chosen so that the moving vehicles are not too small to detect. The system was unable to detect vehicles that were not in the selected area. When there were other moving objects in the processing area, they were identified as moving vehicles too.

In a busy traffic route, vehicles may travel close to each other. Even though humans can identify two vehicles that are very close to each other, the developed algorithm may recognize two vehicles as one vehicle. The opposite of this happens when there is a large single colored vehicle travel in the processing region. The system misclassifies the large vehicle as several moving vehicles. This problem can be avoided by placing the video camera away from the region of interest.

4.0 CONCLUSIONS

In this paper, an image processing technique designed for the extraction and tracking of moving vehicles from a traffic scene was presented.

The implemented system can be easily modified to gather statistical data related to traffic scene by improving its functionality. Speed detection and vehicle counting is a one such area where the system can be quite useful. The work is in progress to achieve the above goals. A difficulty with the vehicle tracking is the occlusion problem. It occurs when two or more vehicles overlap in an image scene. Methods that can handle such situations should be integrated into the present system. Future work could be focus on improving the efficiency of the algorithm by using code optimization techniques and to develop a method to handle problems of shadows.

5.0 ACKNOWLEDGMENT

Financial assistance given by the National Science Foundation, Sri Lanka for the research grant number RG/07/E/03 is greatly acknowledged.

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