Automatic Traffic Estimation Using Image Processing

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Abstract

As we know the population of city and number of cars is increasing day by day. With increasing urban population and hence the number of cars, need of controlling streets, highways and roads is vital. In this paper, a system that estimates the size of traffic in highways by using image processing has been proposed and as a result a message is shown to inform the number of cars in highway. This project has been implemented by using the Matlab software and it aims to prevent heavy traffic in highways. Moreover, for implementing this project following steps must be considered: 1) image acquisition 2) RGB to grayscale transformation 3) image enhancement and 4) morphological operations. At first, film of highway is captured by a camera has been installed in highway.

Then, the film comes in the form of consecutive frames and each frame is compared with the first frame. After that, the number of cars in highways is specified. At the end, if the number of cars is more than a threshold, a message is shown to inform the traffic status. By this message we can predict the need to reduce the size of traffic carried. Experiments show that the algorithm will work properly.

Keywords*: traffic analysis, image processing, motion vehicle tracking, filteration, morphological operation, gamma correction*

1. Introduction

Most of the city traffic is controlled by sensors and cameras shall be installed in big highways and streets. But existence of a system for detecting the size of traffic automatically will be felt [1]. Such systems can allows to extract information from the bigger traffic issue and helps us decide to improve the traffic policy [3, 4] .The paper aims to render automate control system for traffic on highways and streets [2].

The system using image processing has been implemented where upon it entailed the following results: 1) Density 2) Streets and roads in order to census counted three cars 3) monitor off roads 4) Detect the occurrence of accidents and violations occurred as well as motion detection car is a dangerous spiral[7].Scientists and other researchers suggested other different ways . Technically, this system is based on computers and cameras. The project components includes: (A) hardware model (B) software model [1, 2].

A) Hardware model:

Image sensors: In this project the images are captured by a USB web camera have been used. PC: a pc as a general purpose central unit for various image processing tasks has been used.

B) Software model:

For our algorithm; software Matlab has been used. Some steps for implementing this algorithm are as follows: 1) Receiving video via camera and convert video input to two images 2) RGB to Grayscale conversion on received images 3) image enhancement 4) Morphological operations. The rest of the paper has been divided as follows: In Section 2 the main steps of suggested method is proposed. The gamma correction for image enhancement is discussed in Section 3. Section 4 talks about the different types of vehicle tracking and operations. In Section 5 morphological operation has been presented. Rest of the paper shows the suggested algorithm and flowchart in summary and Section 6 deals with the results of experiments. Last section talks about conclusion.

2. Our Proposed Method:

Our proposed method consists of two phases.

Phase 1:

First images are captured by camera. The first images of highway when there is no traffic will be taken. The first image of highway has been considered as a reference file and stored in a specific location in the program. RGB to Grayscale Conversion in order to achieve image enhancement is done.

Phase 2:

At first, images are captured from the highway. RGB to Grayscale conversion has done on the hierarchy of images. Then, gamma correction has been applied on each Gray images. At the end, vehicle tracking is done. Generally, vehicle tracking included two parts: 1) Background elimination; 2) lane masking.

3. Gamma correction

There are lots of method can be utilized for Gamma correction. One of the most significant methods has been proposed in this paper is called *Image enhancement.*

For achieving to Gamma correction, the relationship between light input and output signals must be considered. This has been defined by following equation:

$$S(o) = k.(e)^{\lambda}.(E)$$

$S(o) = k.(e)^{\lambda}$ is output signal gain and a constant k , E is the exposure time that is related to intensity and specifies the number of vehicles is linear. Thus, when $\lambda = 1$, a double logarithmic plot of exposure time or intensity versus output current will yield a straight line. A majority of the video camera systems utilized in optical microscopy adhere to this relationship. Since $\lambda < 1$, dark features in the image become brighter, but overall image contrast is reduced between the very bright and midtone grayscale values. When $1 < \lambda < 3$, bright features become darker and overall contrast is increased. It should be noted that image contrast adjustments using gamma should be that image contrast adjustments using gamma correction factors enable utilization of the entire range of pixels in the image.

4. Types of Vehicle Tracking

For analyzing vehicle tracking in video sequences, two methods are common:

1) Object definition based on object contour extraction

2) Vehicle tracking based on motion detection

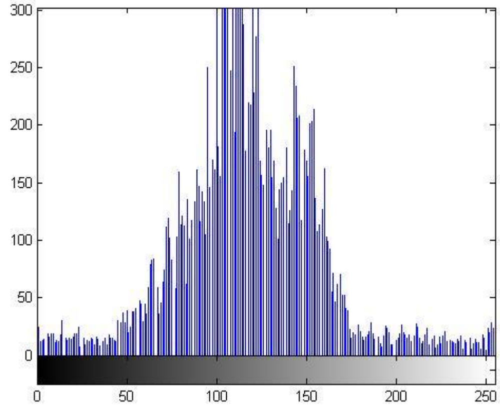

Figure 1. Mathematical Graph Changes Gamma for 20th Frame

4.1. Vehicle Tracking based on Contour Extraction

Vehicle tracking based on contour extraction is one of the most common methods for tracking vehicles. This type of tracking has been consisted of six steps. Each step has its specific algorithm. As an example, Lane masking method has been used to separate vehicles in one direction. This is important because it allows the processing of data over a frame to be done. The formula for Masking Algorithm is as follows:

$$N(P) = M(P) \times V(P)$$

Where $M(P)$ is amount of the point in original frame and $N(P) = M(P) \times V(P)$ is the new point in output image. Considering the above formula, $V(P)$ is the value for masking point such as P. If pixel has been removed, $V(P) = 0$; otherwise, $V(P) = 1$. Masking must be applied to each RGB image separately.

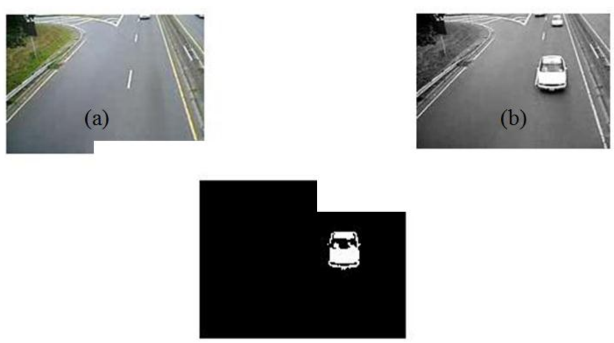

Figure 2. a) Background Image b) After Gamma Correction c) After Subtraction

The algorithm eliminates all objects shared in background frame with other frames and just will be left the vehicles has been added to other frames. The algorithm may be influenced by conditions such as swinging trees, move lawn lighting, the clouds, rain, snow and the others. In practical applications, some other factors like season, weather and etc., should be considered. The algorithm has been applied using the following equation:

$$D(x,p) = \{I(x,p) - B(p)\}$$

In this equation, $B(P)$ is the average of the RGB values for each point such as P in the background of chosen frames. Moreover, $IB(x,p)$ shows the pixel color value for point P in a frame such as X. RGB image has been generated by removing background traffic image such as $I(x,p)$. The results have shown in Figure 4. Then, a vehicle frame must be put in the observation area. This operation can be done by the edge detection algorithm based on computing image derivatives. The first derivative must be calculated in order to detect some modifications in density image frame rate. For determining the maximum rate, Second derivative has been considered. The important thing is that to know there isn't only a general recognition technique for all images work well. Some recognized algorithms are useful for applying median filteration. These methods have been used for edge detection techniques. Three kinds of these methods have been presented as follows:

1) Laplace 2) Sobel 3) Prewitt.

All methods mentioned above do mask or kernel operations that provide the following results:

$S_x = (a_2+a_3+a_4) - (a_0+ca_7+a_6)$
$S_y = (a_0+a_1+a_2) - (a_6+ca_5+a_4)$

$S_x = (a_2+a_3+a_4) - (a_0+ca_7+a_6)$ is Gradient in direction X and $S_y = (a_0+a_1+a_2) - (a_6+ca_5+a_4)$ is Gradient in direction Y and M is the module of Gradient.

A_i is pixel covered by mask 3×3. $a_0, a_1, a_2, \ldots a_7$ refers to move from the top left corner that the mask off has begun. If the threshold is much larger than $M(M > threshold)$, $M(x,p) = 1$, otherwise $M(x,p) = 0$. Mask off almost has been applied on all image pixels except the edge area. As a result, image size has decreased because of border effects of 2 pixels in each direction. Gradient in direction x and y has been illustrated in Figure 3.

The symbol "$\longleftarrow$" means the partial derivative has been calculated as the difference in density between two points are adjacent (the difference between them is equal to 1).

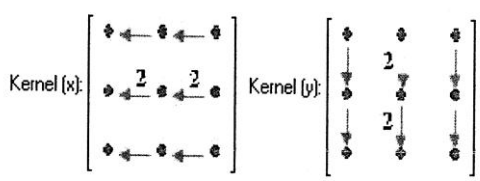

Figure 3. Sx **Derivative in Direction** x, Sy **Derivative in Direction** y

Sobel filter is very similar to Prewitt. The only difference is C weighting coefficient that for Prewitt filter is equal to 1. If early images are good contrast and be without noise, they are also appropriate for edge extraction.

As mentioned above, when the field gradient is larger than the threshold, the larger value will be considered.

Another method can be considered, is to assume that the gradient is larger when the second order intensity gradients of zero crossing according to the gradient field operations compared to zero crossing.

After all, Gauss Laplace equation with an additional derivative conducted by Gaussian Convolution has been presented as follows:

$$I(i,j) = \Sigma s(l\ ,k) \times G(i-1, j-k)$$
$$G(i,j) = \Pi A/2 \times exp(-(i2+j2)/\ 2A2)$$

In this equation, A is considered as width of gauss function such as G.

Contour linking: the next step of processing is connecting the separate sections of the original objects into a closed contour .to ensure, suppose the RGB image has been converted to binary.

In general, the two methods of edge linking are classified as follows:

1) Local edge linkers that connect any point consider neighbors.
2) Global edge linkers that consider all edge points at the same time according to the equation constraints similarities edge.

Contour labeling has been utilized to mark and count the frames. For vehicle tracking in the video hierarchy should mark through the image.

Another method is marking the geometric center of an image. For finding the geometric center of an image following equation has been used.

$$xc = \Sigma xi/n \quad , \quad yc = \Sigma yi/n$$

Where, $xc = \Sigma xi/n$ and $yc = \Sigma yi/n$ are the center coordinate of vehicles and xi, yi are axes coordinate of image points N limit.

To tracking our vehicles all intervals between image frames n in the vehicles and all vehicles in the coordinate frame $n + 1(xk, yk)$ of centers should be off. In summary, by using the following equation vehicle tracking can be applied.

$$dx = [(x_k - x_c)2 + (y_k - y_c)2]^{1/2}$$

4.2. Vehicle Tracking based on Motion Detection

Active contour based tracking; a dual to the region based approach is tracking based on active contour models, or snakes. The main idea of this work is to have a representation of the bounding contour of the object and keep it updating dynamically. One of the advantages of having a contour-based representation instead of a region based representation is reducing the computational complexity.

However, the inability to segment vehicles that are partially occluded remains. If one could initialize a separate contour for each vehicle, then one could track even in the presence of partial occlusion $(Koller, et\ al., 1994a)$. Moreover, initialization is the difficult part of the problem! Consider the example: if the vehicles enter the detection region partially occluded, the system will group two vehicles into a single object and it will cause to significant measurement errors.

5. Morphological Operation

While point and neighborhood operations are generally designed to modify the look or appearance of an image for visual considerations, morphological operations have been used to understand the structure or form of an image.

There are three primary morphological functions for achieving these objectives: 1) erosion 2) dilation and 3) hit-or-miss. Morphological operations usually have been performed on binary images where the pixel has two values; 0 or 1. Value of zero has been considered as black and value of 1 as white. Most of the morphological functions operate on 3×3 pixel neighborhoods. The pixel neighborhood is identified into one of two ways; sometimes interchangeably. The pixel of interest lies at the center of the neighborhood and has been labeled x. The surrounding pixels are referred to x, or by their compass coordinate E, NE, N, NW, W, SW, and SE.

In this paper some morphological operations has been done on binary images.

After subtraction, certainly some additional points on the image in order to subtraction have been left and with morphological operation in these parts remove additional points have been removed.

Initially, the objects on the image resulting from subtraction must be removed and then interior and border areas of mark cars in the image resulting from subtraction have been traced.

Figure 4 illustrates morphological operation on the resulting image subtracted.

Figure 4. Image Subtraction

6. Algorithm in Sumarry:

1-start
2-receive the first frame of movie
3-RGB to grayscale conversion
4- for {
    vehicle tracking on the image;
5-   if {number of cars> threshold}
        print traffic is heavy;
     Else
        Write the number of frames under the movie;
     End
  End
6- Go to 4
End

The flowchart of proposed method is illustrated in Figure 5.

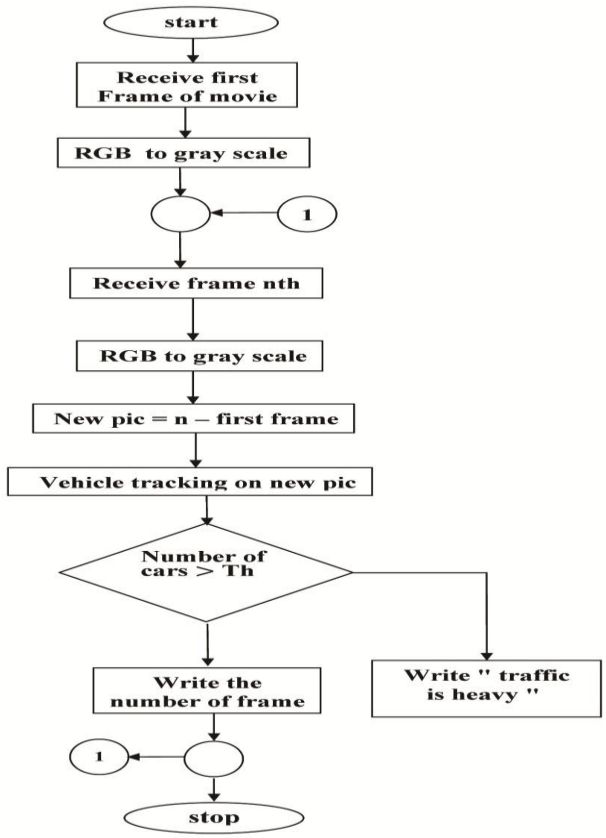

Figure 5. Flowchart of Proposed Method

7. Conclusion

In this paper, 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 cars has been counted. If the number of cars exceeds a specific threshold, warning of heavy traffic will be shown automatically. The advantages of this new method include such benefits as: 1) Non-use of sensors 2) Low cost and easy setup and relatively good accuracy and speed. Because this method has been implemented using Image Processing and Matlab software, production costs are low while achieving high speed and accuracy. In this respect, the method is superior to previously published designs. The method presented in this paper is simple and there is no need to use sensors that have been commonly used to detect traffic in the past. However, one of the most important disadvantages of this method is extreme sensitivity to light. For example, when installed in the road, changes in sun light potentially cause interference with the camera. This problem can be overcome by using specific filters during Image Processing or changes in Matlab code. With some improvements, this method can be used to detect road accidents and identify violations of the spiral movements of cars.

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