Algorithm for Vehicle Detection using Image Processing

C Krishna Prasad, Lavanya S, Manikanta S Rao, Nandu Rajeshwari K, A Benjamin Joseph

Electronics and Communication Department, Kammavari Sangham Institute of Technology, Bengaluru, India

Abstract: Detection of Vehicles is a very important part of ITS (Intelligent Transport System). Traditional method of detecting vehicles from video is image subtraction which is not effective as it is susceptible to changing levels of brightness. In this paper we propose an algorithm using image and video processing. Image processing is the analysis and manipulation of a digitized image, especially in order to improve its quality. This algorithm can detect vehicles from an image in a more precise manner even with varying levels of brightness. First, images are taken of the road in different traffic conditions. These images are processed in a suitable color model which can create a clear differentiation between the vehicle and the road. Next, this image is further processed into a binary image which retains a certain amount of noise. Noise removal techniques are used on the image and the final image is generated. In the final image the vehicles can be clearly identified from the road. This entire process can be translated to be used for video processing also.

Keywords: Image Processing; Intelligent Transport System; Colour Model; Binary Image; Noise Removal.

I. Introduction

Vehicle detection is an important part of Intelligence Transport System (ITS). The goal of vehicle detection is to separate the vehicles from background, and its detection result has a direct impact on post image processing. By establishing early vehicle detection and warning, it is possible to provide more time for a driver to take an appropriate action to resolve driving conflicts, and consequently to decrease the possibility of crashes.

In order to achieve this video can be divided into a number of frames each of which can be processed separately and a decision can be taken based on the output of each frame after being processed. Once this is done subsequent frames of a particular video and can further compared and more results can be inferred out of it. This algorithm makes use of a single color model and is further processed into a binary image as it is easier to separate background information in such images. Further, the noise also has to be removed from the images for improved detection.

This paper only talks about processing single frame (image) using MATLAB software. If implemented in ITS, this algorithm can revolutionize accident alert and detection systems and make them more effective.

II. Related Works

A series of research has been conducted in the field of image processing and how it can be used to enhance an image and how certain objects can be identified or highlighted in images.

Xiao Luo, Huatao Zhao, Haru Toshi and Ogai, Chen Zhu propose a video detection method to well recognize the buses. A foreground detection is employed to find moving vehicles and then training classier consisting of Adaboost algorithm. Also canny operator is used to locate bus characteristics and detect the bus with modified HSV model [1].

R. Malladi and J. A. Sethian talk about noise removal, shape recovery and image enhancement. PDE based algorithms is made use of for this purpose. The noise removal techniques used in this paper contain only one enhancement parameter which is automatically chosen in most cases [2].

Vehicles are classified into dedicated lanes using machine learning techniques and image processing in the novel idea proposed by Selim S. Sarikan, A. Murat Ozbayoglu and Oguzhan Zilcia. Image classification is based on similarity between heat maps generated from the training set [4].

A new vehicle detection algorithm is proposed that is based on linear CCD images which has three parts. Wavelet transform is used for target extraction from the image. Then binary image is processed for data of each line. On this basis vehicle segmentation is performed.

III. Algorithm Used

The entirety of the algorithm can be divided into 4 sub-parts

1. Image Acquisition
2. Color Preprocessing
3. Conversion to Binary Image
4. Noise Removal

A. Image Acquisition

The first step in the process is the collection of data for the input of the algorithm to process. As we are using image processing and not making use of video directly, we take only certain number of frames out of the video. It is better to consider more number of frames for higher accuracy. These frames should be of various traffic conditions like that of empty roads, vehicles nearer to the camera, away from the camera and vehicles at a moderate distance from the camera. This variety of images gives a clearer picture of different values of brightness, hue, saturation etc. that exists in different traffic conditions. We have also considered images from different times of the day so that the system works efficiently in all cases.

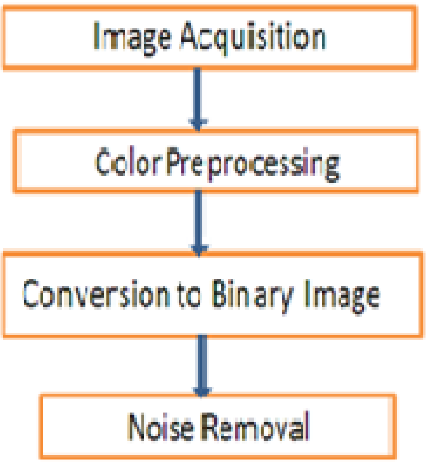

Fig 1. Steps used in Algorithm

B. Colour Pre-Processing

Pre-processing is a very important part of image processing, the aim of which is to improve the image data by either suppressing unwanted distortions called noise or enhance certain image features, important for further processing of the image. For the purpose of image pre-processing, we have converted the acquired image data to different colour models. A colour model is an abstract mathematical model describing the way colours can be represented as a finite ordered list of numbers, typically as three or four values or colour components. When this model is associated with a precise description of how the components are to be interpreted (viewing conditions, etc.), the resulting set of colours is called colour space. To suit the requirements of the algorithm for rear-end vehicle detection, specifically the HSV colour model is selected.

The HSV colour model is an alternate representation of the standard RGB (Red, Green and Blue) colour model. HSV stands for Hue, Saturation and Value which are the individual components of the model. This colour space describes colours (hue or tint) in terms of their shade (saturation or amount of grey) and their brightness value. Hue is the colour portion of the colour model, and is expressed as a number from 0 to 360 degrees. This is shown in table-1:

Table 1. H-Component colours and their respective components

Colour	Angle
Red	0-60
Yellow	60-120
Green	120-180
Cyan	180-240
Blue	240-300
Magenta	300-360

Saturation is the amount of grey in the colour, from 0 to 100 percent. A faded effect can be had from reducing the saturation toward zero to introduce more grey. However, saturation is sometimes viewed on a range from just 0-1, where 0 is grey and 1 is a primary colour. Value works in conjunction with saturation and describes the brightness or intensity of the colour, from 0-100 percent, where 0 is completely black and 100 is the brightest and reveals the most colour. The HSV colour space is used when selecting colours for paint or ink because HSV better represents how people relate to colours than does the RGB colour space.

This is shown in figure-2. Only one of the components was used in the algorithm. In order to conclude that HSV model is more suitable, we converted and segregated the collected images into different components of various models, using MATLAB.

C. Conversion to Binary image

In this part of the algorithm, we converted the images from saturation model to binary images. In a binary image each pixel assumes one of only two discrete values corresponding to on (1) and off (0) analyzing an image this way makes it simpler to distinguish its structural features .In this case, it becomes easier to separate the vehicles from the background. In MATLAB, a binary image is represented by uint8 or double logical matrix containing 1's and 0's representing white and black respectively.

First we tabulated the minimum and maximum values of the selected component of HSV for the road region in each image and found the range of each image on averaging it. The average value fell between 12.88 at the lower end and 30.26 at the higher end. All the pixels within the range were made black and those outside the range were made white. Figure-3 shows a binary converted image.

D. Noise Removal

In electronics, noise is an unwanted disturbance in an electrical signal. Noise generated by electronic devices varies greatly as it is produced by several different effects. In image processing noise usually takes the form of random variation of brightness or colour information in images. This noise is usually electronic noise that can be either generated from the sensors and circuitry of the digital camera or Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. Noise in images is an undesirable by-product of the captured image that distorts and disrupts the desired information. The different types of noises that can occur in digital images are Gaussian noise, Salt and pepper noise, Shot noise, Quantization noise (uniform noise), anisotropic noise and Periodic noise.

(a)

(b)

(c)

(d)

Fig 2. (a) RGB image (b) H-component of the image (c) S-component of the image (d) V-component of the image

Fig 3. Converted binary image

In our proposed algorithm for vehicle detection, all other information in an image other than approaching vehicular information is considered to be noise. This noise could be responsible for obscuring the desired information regarding incoming vehicles and also setting off false alarms. Hence noise removal for the proposed algorithm is of utmost importance.

Noise in images usually appears as a high frequency signal, and hence filtering techniques are typically employed for noise reduction in image processing. But since in the proposed algorithm the procured image is converted to a binary image, conventional filtering methods cannot be used as both vehicular information and noise is converted to binary bit 1. Therefore Erosion and Dilation techniques is employed for reduction of noise in the said algorithm.

First step of noise removal in the algorithm is Erosion. The basic idea of erosion technique is similar to soil erosion, it erodes away noise along with the boundaries of the object. Erosion removes the white noises in the binary image, but it also shrinks the object. Therefore in this case of noise removal erosion is followed by dilation. Dilation is just the opposite of erosion. Dilation increases the white region in the binary image and hence has the effect of retrieving the eroded vehicular information. Since is the noise is completely eliminated in the previous step of erosion it will not be brought back due to dilation but the object area increases. Eroded and dilated images are shown in figure-4 and 5.

Fig 4. Eroded image

IV. CONCLUSION

The study conducted in this paper presents a comprehensive view of an algorithm that is used for vehicle detection from video. The algorithm that is used is more effective, as it is adaptable to varying levels of brightness. The algorithm focuses on using the S-component of the HSV model to distinguish between the vehicles and the road. The RGB component is first converted to the S-component and then the S-component is converted to a binary image based on the average S-vales of the road and the vehicles. For noise removal the algorithm depends on erosion and dilation models. Vehicle detection based on image processing technology has attracted much attention and will remain an active research area in the future. Future scope of image and video processing in the field of Intelligent Transport Systems may be the integration with artificial neural networks to improve the rate, accuracy and efficiency of vehicle detection and also give the system the ability of learning on filed and make slight adjustments where ever required instantaneously.

Fig 5. Dilated image

REFERENCES

[1] Xiao Luo, Huatao Zhao, Haru Toshi Ogai, Chen Zhu, "A novel video detection design based on modified AdaBoost algorithm and HSV model", 2017.

[2] R. Malladi, J. A. Sethian, "A unified approach to noise removal, image enhancement and shape recovery", 2017.

[3] M. Matsubara, H. Tokutome, K. Nishiyama, M. Aoki, K. Tanaka, "Development of a new multi-purpose image processing vehicle detector and its implementation in the Tokyo Metropolitan Traffic Control System", 2002.

[4] Selim S. Sarikan, A. Murat Ozbayoglu, Oguzhan Zilcia, "Automated Vehicle Classification with Image Processing and Computational Intelligence", 2017.

[5] Mallikarjun Anandhalli, Vishwanath P. Baligar, "A novel approach in real-time vehicle detection and tracking using Raspberry Pi", 2017.

[6] Apiwat Sangnoree, Kosin Chamnongthai, "Thermal-image processing and statistical analysis for vehicle category in nighttime traffic", 2017.

[7] Fan Yao, Chu Yanli, "Study of a new vehicle detection algorithm based on linear CCD images", 2015