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Video road vehicle detection and tracking based on OpenCV

Wei Hou[1st]
Shaanxi Polytechnic Institute
Electrical Engineering
Shaanxi, China
e-mail: 26813951@qq.com

Dongsheng Xia[2nd]
Shaanxi Polytechnic Institute
Department of Electrical Engineering
Shaanxi, China
e-mail: 376002707@qq.com

Hoekyung Jung[3rd*]
Pai Chai University
Department of Computer Engineering
Daejeon, Korea
* Corresponding author e-mail: hkjung@pcu.ac.kr

***Abstract*-Video surveillance is widely used in security surveillance, military navigation, intelligent transportation, etc. Its main research fields are pattern recognition, computer vision and artificial intelligence. This article uses OpenCV to detect and track vehicles, and monitors by establishing an adaptive model on a stationary background. Compared with traditional vehicle detection, it not only has the advantages of low price, convenient installation and maintenance, and wide monitoring range, but also can be used on the road. The intelligent analysis and processing of the scene image using camshift tracking algorithm can collect all kinds of traffic flow parameters (including the number of vehicles in a period of time) and the specific position of vehicles at the same time, so as to solve the vehicle offset.It is reliable in operation and has high practical value.**

Keywords: video surveillance; vehicle tracking; OpenCV; static background; background model; CAMSHIFT algorithm.

I. INTRODUCTION

Computer vision[1], as a multidisciplinary cross-field, involves image processing, computer graphics, pattern recognition, artificial intelligence, artificial neural networks, psychology, physiology, physics and mathematics. Although there has been a lot of research in this area, it has only been in the field of intelligent video surveillance system robot visual navigation, medical guidance diagnosis, industrial robot vision system, mapping, physical three-dimensional reconstruction and recognition, and intelligent human-machine interface until the last ten years.

Intelligent transportation system is a comprehensive application of advanced information technology, data communication transmission technology, electronic control technology, sensor technology, and computer processing technology to the entire transportation system, thus establishing a kind of large-scale and all-round play a real-time, accurate and efficient integrated traffic management system. Its purpose is to make people, vehicles and roads work closely and harmoniously to unite, greatly improve transportation efficiency, ensure traffic safety, improve environmental quality and increase energy efficiency.

It has very important theoretical significance and practical value for traffic safety and traffic control, and it is the basis of video intelligent transportation system. Commonly used vehicle detection methods include ring detection, microwave detection, ultrasonic detection, and video vehicle detection.

The basic content of video sequence image moving target analysis is to use the imaging system or existing files to extract the moving target from the continuous video sequence image, at the same time to identify and track the extracted moving target, and understand and describe its behavior. The motion analysis of video images is based on digital image processing.

Involve many fields and disciplines such as digital image processing, pattern recognition, computer vision, artificial intelligence[2].

Compared with traditional vehicle detection technology, video vehicle detection has the following advantages: easy installation and maintenance, the camera is installed on the side of the road, installation and maintenance does not need to close the road, and the road will not affect normal traffic; an ordinary CCD camera can detect within a few hundred meters For multi-lane traffic information, there is no sensor device that can provide such intuitive and detailed traffic information parameters as based on computer vision processing, which can record traffic scenes for later query; at the same time, the visual system is also a passive perception System, it has almost no effect on the surrounding environment, even if there is no interference between the same visual system. Based on the above-mentioned advantages, the vehicle detection technology based on video images has a huge promotion effect on the development of intelligent transportation systems, and has great practical significance for daily life and the country's economic development.

This article uses OpenCV (23) and VisualC++6.0 to build an experimental plaorm, and uses a stationary camera to shoot a vehicle AVI video for testing.

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II. SYSTEM OVERALL PLAN

First convert the recorded video to a video format supported by OpenCV. For example, Uncompressed RGB, 24 or 32 bit, Uncompressed YUV, 4:2:0 chroma subsampled, identical to 1420 can be processed for AVI video encoding formats, or installed on the computer The decoder xvid.

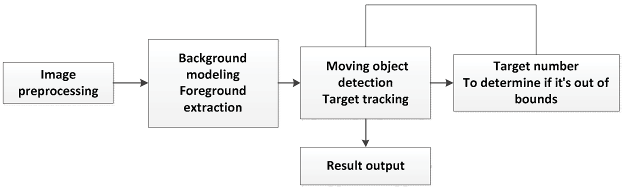

Figure 1. Overall block diagram of the system

Using OpenCV's moving object tracking data structure and function library, a video vehicle analysis system[4]is established for the detection and tracking of vehicles on the road. The composition of the video vehicle analysis system is shown in Figure 2.

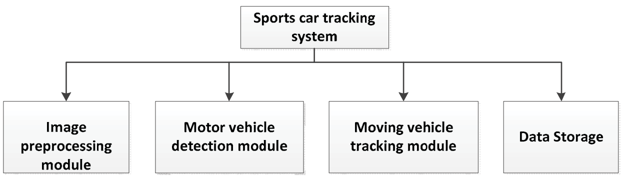

Figure 2. Video vehicle analysis system

A. Image preprocessing module

Many of the current video files are recorded and collected by color CCD cameras. During the collection, transmission and recording process, they are often disturbed by various noises, including the influence of external light and shadows, as well as camera imaging errors, optical path disturbances, and systems. Noise caused by circuit distortion, etc. It can be said that images in reality are generally noisy images. Therefore, in the process of image processing, before high-level processing such as edge detection, image segmentation, feature extraction, and pattern recognition, it is very important to select appropriate algorithms to remove noise interference as much as possible. Important pretreatment step[5][6].

This experiment uses image preprocessing such as image gray change, image denoising, image binarization, and mathematical morphological filtering.

B. Image grayscale

Image gray-scale is to eliminate the color information in the color image, and only contains the brightness information. In the computer, the grayscale image is quantized and divided into 256 levels from 0 to 255, 0 is the darkest (all black), 255 is the brightest (all white), and in the RGB model, if R=G=B, Then the color (R, G, B) means grayscale color.

The grayscale process is to make the RGB components of the image take equal values. Considering the rationality of the image, this article uses the following formula for grayscale conversion:

$$Gray=0.299R+0.587G+0.114B \tag{1}$$

$$R=G=B=Gray \tag{2}$$

The grayscale of the image in the OpenCV function library can be realized by the Cvtcolor (const CvArr* src, CvArr* dst, int code) function, where src is the original color image, dst is the processed image, and code is the color space conversion method, Here the code is defined as Cv_RGB2GRAY[7].

C. Image binarization

Image binarization is used for image segmentation. Image segmentation methods usually include threshold method, edge detection method, area tracking method, etc. Among them, image domain value segmentation is a widely used image segmentation method. It uses the difference in grayscale between the target and the background to be extracted in the image, and treats the image as a combination of two types of regional targets and backgrounds with different gray levels. Select an appropriate threshold to determine whether each pixel in the image should belong to the target or the background area, so as to generate the corresponding binary image and get the target to be detected[8]. The principle of binarization processing is: set a certain threshold T, you can use T to divide the image data into two parts: the image larger than T

The prime group and the pixel group smaller than T.

Let the input image be $f(x,y)$ And the output image is $f'(x,y)$ then

$$f'(x,y) = \begin{cases} 1, f(x,y) \le T \\ 0, f(x,y) > T \end{cases} \tag{3}$$

or

$$f'(x,y) = \begin{cases} 1, f(x,y) \ge T \\ 0, f(x,y) < T \end{cases} \tag{4}$$

The above is the principle of image binarization, that is, threshold segmentation. Its purpose is to divide the image into two parts, the target and the background. In actual processing, for display needs, generally 255 is used to represent the background, and 0 is used to represent the object[9].

In OpenCV, image binarization is realized by function voide cvThreshold.

In this experiment, when the threshold value of 15 is selected, a lot of useless information is also extracted as the target, and when the threshold value of 60 is selected, the segmented target is distorted, so the selection of the threshold is crucial for detecting the target. effect. Experiments have verified that for vehicle detection, the threshold of 20 is the best value.

D. Mathematical Morphology Filtering

This experiment adopts MorphologyEx advanced morphological transformation, through the combination of expansion and erosion and coordinated set operations, a powerful family of morphological operations can be constructed. The most common ones are opening and closing operations. Although the background is static in a broad sense, the video shooting itself will inevitably appear jitter, so that the background of each subsequent frame will more or less deviate from the background, and then a lot of white spots will be produced. If the closed operation is performed, that is, first expand and then corrode, many white spots will be merged, and it is difficult to eliminate when corroded, while the open operation can well remove the error information.

In this experiment, a lot of white dots were merged by the closed operation first, and the error information was removed during the open operation.

III. CAMSHIFT ALGORITHM FLOW DESIGN

A. Moving vehicle tracking module

In the process of target tracking, this experiment uses the CAMSHIFT algorithm, which can effectively solve the problem of target deformation and partial occlusion, and the calculation efficiency is very high.

B. CAMSHIFT algorithm flow

First select the initial search window of size S, and then upsample the H channel of each pixel in the window to obtain the hue (Hue) histogram of the moving target, and then save the histogram as the color histogram of the search target model. In the process of target tracking, for each pixel of the current frame image of the camera, by querying the target's color histogram model, the probability that the pixel is the target pixel can be obtained. After the above preprocessing, each frame of the video is transformed into a target color probability distribution map, also called a target color projection map. In general, the projection image is converted into an 8-bit gray-scale projection image, the pixel value with probability 1 is set to 255, the pixel value with probability 0 is 0, and other pixels are also converted to corresponding gray values. Figure 3 is a flow chart of the CAMSHIFT algorithm[10].

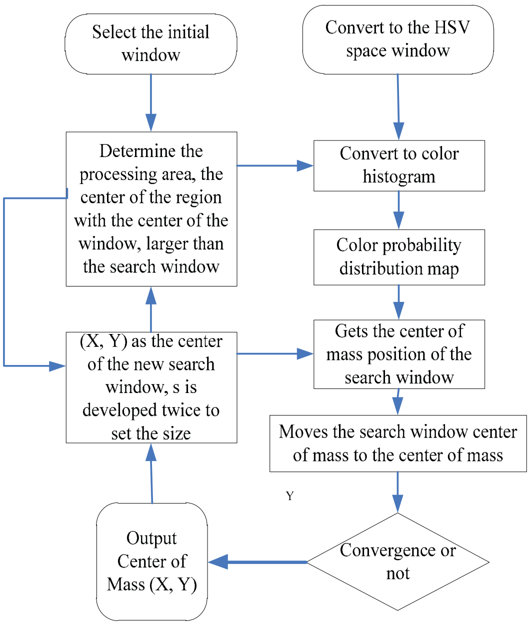

Figure 3. CAMSHIFT algorithm flow chart

IV. EXPERIMENTAL RESULTS AND ANALYSIS

.The Gaussian background modeling method is used this time, and the background obtained is shown in Figure 4.

Figure 4. background image

When the threshold 15 is selected, a lot of useless information is also extracted as the target. When the threshold 60 is selected, the segmented target is distorted, so the selection of the threshold plays a vital role in detecting the target. Experiments have verified that for vehicle detection, the threshold of 20 is the best value, as shown in Figure 5:

Figure 5. Target extraction diagram

There are four stages of actual measurement on the expressway, first, target detection, target tracking, target overlap and target numbering.

Figure 6. Inspection of cars No. 0 and No. 1

After that, track 0 and 1. As shown below:

Figure 7. Target tracking diagram

When there are vehicles overlapping, as shown in Figure 9(a)(b) below:

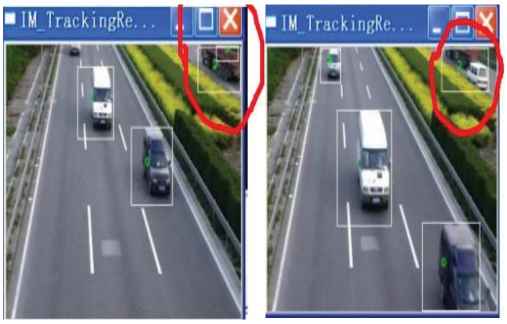

Figure 8. (a) (b) target overlap map

From the figure (a) in the red circle, it can be seen that targets 2 and 3 overlap, but the numbering has not changed, and the correct numbering is still carried out. Picture (b) shows that when the red vehicle No. 2 walks out of the cordon, the white vehicle No. 3 immediately following is changed to No. 2.

This is a major advantage of CAMSHITFT algorithm tracking. Target occlusion, deformation, it can track well.

Number the targets that enter the cordon. For the vehicle numbered 2, the targets in front are 0, 1, ...

If the target numbered 0,1 goes out of the warning line, then the target numbered 2 is changed to number 0. The following is an experimental verification. Figure 9(a)(b)

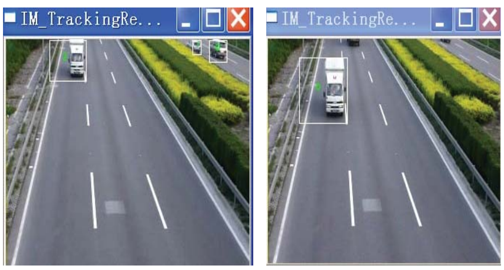

Figure 9. (a) (b) target number

It can be seen from Figure a that the third vehicle entering the cordon is numbered 2; Figure b shows that after vehicles numbered 0 and 1 exit the cordon, the car numbered 2 becomes numbered 0.

V. Conclusion

This article uses the moving object tracking function library and data structure in the computer vision library to construct a vehicle video analysis system for the detection and tracking of cars on the road. Through continuous improvement of the Gaussian background model algorithm, it will not affect the noise suppression effect of the model. In this way, the “shadow” caused by the originally stationary object in the scene can disappear quickly, and eventually it will absorb multiple target tracking. Combining motion estimation and structure information to improve the multi-target tracking algorithm[11]is the focus of future research.

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