Journal of Image Processing Theory and Applications (2021) Vol. 4: 18-23
Clausius Scientific Press, Canada
DOI: 10.23977/jipta.2021.41003
ISSN 2560-6239

Monitoring System Based on VIN Recognition

Yijun Liu[1], Xin Zhang[2], Shuyang Jiao[2], Heng Luo[2], Rui Cao[2]

[1]*College of Electronic Science and Engineering, Jilin Univeristy, Changchun, Jilin 130000*

[2]*College of Communication Engineering, Jilin Univeristy, Changchun, Jilin 130000*

Keywords: Vehicle Monitoring System, VIN Recognition, Target Tracking

Abstract: With the increase of motor vehicles, more and more traffic violations such as obscuring the license plate, decks, and other means to evade punishment of crimes has also increased, which have seri- ously endangered public safety. In response to this phenomenon, this article combines target detection, text recognition, target tracking and other technologies to develop a vehicle monitoring system based on VIN recognition. By collecting and recognizing the VIN characters under the front windshield and comparing with the information in the database, the deck vehicles can be found in time, which will provide furtherpro- tection for public traffic safety.

1. Introduction

The vehicle identification number (VIN) is an important feature of a motor vehicle. It consists of a combina- tion of seventeen letters and numbers and contains important information such as the manufacturer, engine, and chassis number of the vehicle. It is usually located in the lower right corner of the front windshield of the vehicle. It is a unique serial number for each motor vehicle. Therefore, in the daily management of motor vehicles by the traffic police department, the VIN has a very important position. With the widespread application of HD road monitoring systems, tracking illegal vehicles by VIN recognition has gradually be- come a new development direction. Based on this, this paper studies the motor vehicle monitoring system through VIN visual recognition to realize the dynamic capture, recognition and comparison of VIN at roads and bayonet points, and provides convenience for the management of the traffic police department.

2. System Structure

The system consists of hardware parts and software parts, including a service layer, a data layer and a user layer, which is shown as Figure 1. The service layer includes a collection module and a calculation module. Its function is to collect and recognize the VIN, license plate, color and other information of the motor vehicle at the bayonet, and send the information to the data layer. Then the data layer classifies, compares, and filters the received data, and presents the abnormal data to the user layer through the interface for further decision-making by the user.

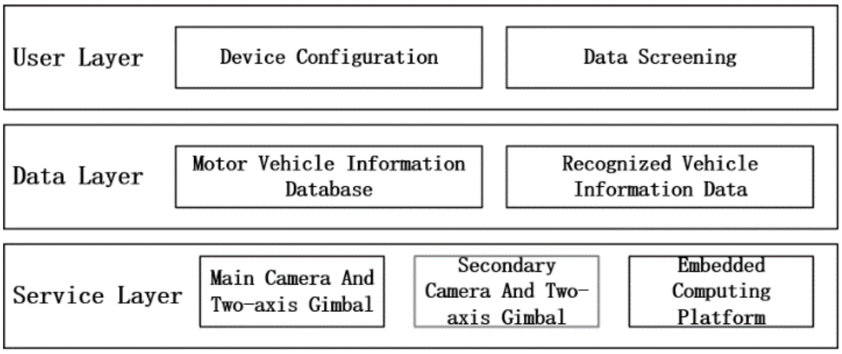

Figure 1: System Structure

2.1 Service Layer

(1) Collection Module

The collection module of the service layer is composed of a main camera and a secondary camera. The main camera is equipped with a telephoto lens and a two-axis gimble. It is used to track and collect the VIN in the lower right corner of the front windshield of a motor vehicle in real time. The advantage is that the depth of field is short, which is onvenient for subsequent text recognition. The secondary camera is equipped with a short-focus lens, which has the advantage of a large viewing angle, and it is used to observe global information around the bayonet, and realize functions such as vehicle detection, license plate recognition, and motor vehicle color recognition.

(2) Calculation Module

The computing module of the service layer adopts an embedded computing platform with ARMV8-64- bit processor and Nvidia GPU, and is equipped with a Linux operating system. It is used for preprocessing, feature extraction, information identification and information transmission of the collected images. It has the advantages of low consumption, high stability, and strong image processing capability. At the same time, it can ensure real-time identification and information transmission with the help of the operating system to implement scheduling between multiple tasks.

2.2 Data Layer and User Layer

(1) Data Layer

The data layer is composed of the vehicle information database of the traffic police department and the information uploaded by the service layer. Among them, the database of the traffic police department contains all the registration information of the vehicle, while the information uploaded by the service layer contains the VIN, license plate number and color of the vehicle passing through the bayonet.

(2) User Layer

The user layer is composed of two interactive functions: equipment configuration and information com- parison, which are integrated into the graphical interface. The configuration function allows users to view the working status of the server and configure related parameters to change the working status of the service layer, such as adjusting the camera exposure time. The information comparison function allows users to sort, compare and filter all the information in the data layer, which can help users find and track abnormal vehicles in time.

3. System Principle

3.1 Working Process

When the system is turned on, the main camera maintains its initial position and keep closed, and the secondary camera starts to collect global images near the bayonet. When the secondary camera detects that a motor vehicle is approaching, it runs the VIN positioning algorithm to obtain the area of interest of VIN, and at the same time, the system turns on the main camera, uses the two-axis gimbal to control the main camera to keep track and collects the area of interest of VIN. In addition, the secondary camera will run the color recognition algorithm and the license plate recognition algorithm, and finally package the information and send it to the data layer, as shown in Figure 2.

3.2 VIN Positioning

VIN positioning algorithm adopts the"front windshield segmentation & relative position offset". Since VIN is usually located in the lower right corner area of the front windshield and has a fixed relative position to the center of front windshield, the position of VIN can be determined indirectly by the front windshield. In addition, the front windshield has the characteristics of good light transmission, the pixel value and saturation in the digital image are low, and it has obvious edge and straight line characteristics. Therefore, the front windshield can be accurately realized through edge detection and straight line detection. The division of the mirror, and then realize the positioning of VIN.

When the image collected by the secondary camera is input into the VIN positioning algorithm, the 3- channel RGB image is firstly preprocessed to convert into a single-channel grayscale image.Then the grayscale image is convolved with a Gaussian kernel of size 17, for the purpose of retaining the overall gray-scale distribution characteristics of the image, smoothing the image and reducing the interference of noise. Edge detection uses the Canny operator to calculate the gradient of adjacent pixels in the image, and perform non-maximum suppression on the gradient to obtain the edge and calculate the magnitude and direction of the gradient at each pixel, as shown in equations (1)-(4). Use convolution template H_x and H_y to calculate directional derivative:

$$H_x = \begin{bmatrix} 0 & 0 \\ 1 & 1 \end{bmatrix}, H_y = \begin{bmatrix} 1 & 0 \\ 1 & 0 \end{bmatrix} \quad (1)$$

$$d_x = f(x,y) * H_x, d_y = f(x,y) * H_y \quad (2)$$

Calculate magnitude and direction of the gradient:

$$grad = \sqrt{d_x^2 + d_y^2} \quad (3)$$

$$\theta = arctan\frac{d_y}{d_x} \quad (4)$$

The straight line detection is divided into two parts: the horizontal straight line on the upper and lower borders and the oblique straight line on the left and right borders. Firstly, the Hough transform is used to detect all straight lines that meet the length in the edge image.Then, match the slopes of all detected straight lines, and filter the straight lines that meet the requirements.Finally, all the endpoints are scored according to the Euclidean distance between the endpoints of the straight line, and the four corner points of the windshield boundary are obtained, which are respectively marked as ABCD as Figure 4 shows. Take C as the reference point and make a rectangular area $A'B'C'D'$ to satisfy $A'B' = C'D' = \frac{1}{4}CD$, $A'D' = B'C' = \frac{1}{5}BC = 2B'C$. This rectangular area can be considered the area of interest of VIN.

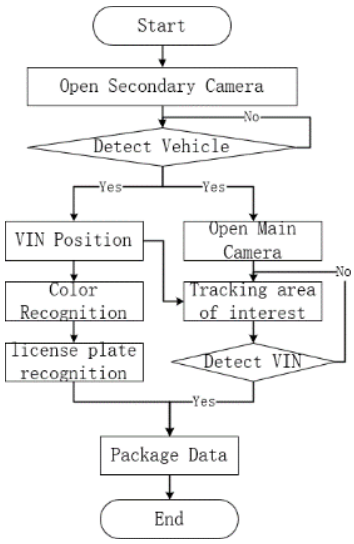

Figure 2: System Structure

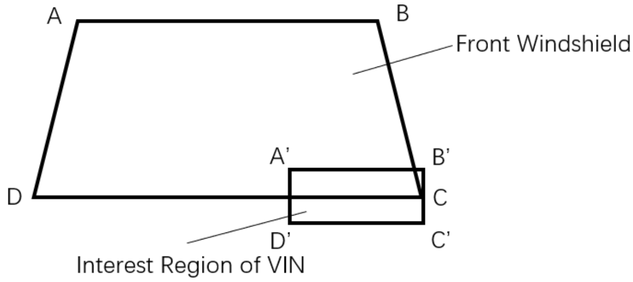

Figure 3: VIN Positioning

3.3 VIN Recognition

The VIN recognition adopts the general OCR recognition method based on deep learning technology. Ac- cording to the application scenarios of OCR, although the VIN recognition is a typical case of dedicated OCR, the use of traditional dedicated OCR will face many problems such as the uncertainty of the identification scene and the diversity of fonts, while the general OCR supports the combination of Chinese and English numbers to identify and long Text recognition, so it is more appropriate to choose a general OCR recognition idea.

In addition, in order to enable the system to adapt to the variable characteristics of outdoor ambient light, the author designed the ”exposure time sweep” method to improve the robustness of the algorithm. That is, the main camera first adjusts the exposure time within a certain range, collects multiple images, and

Then preprocesses the multiple images using weighted mean grayscale transformation, top hat transformation and binarization. Finally, all images will be scored according to the integrity of the image characteristics after preprocessing. And the 3 images with the highest scores are retained as input images for text detection and used as a basis for mutual verification in the final text recognition stage.

4. Experimental Results

The experimental platform adopts Nvidia Jetson TX2, which is equipped with ARM-A57 six-core CPU and NVIDIA Pascal GPU. Under the Ubuntu16.04 operating system, using Python language to locate and identify the VIN of 107 images of different colors and car models. Figure 4 shows the process and results of the VIN positioning algorithm, Figure 5 shows the comparison of the images collected by the ”exposure time sweep” for the same target, and Figure 6 shows the preprocessing and recognition results of the grayscale and top hat transformation of the text recognition. According to the experimental results, it can be found that under different light conditions, using the ”exposure time sweep” method can ensure the integrity of the VIN text information in at least one image, and greatly improve the stability of the system operation when the real-time requirements are not high.

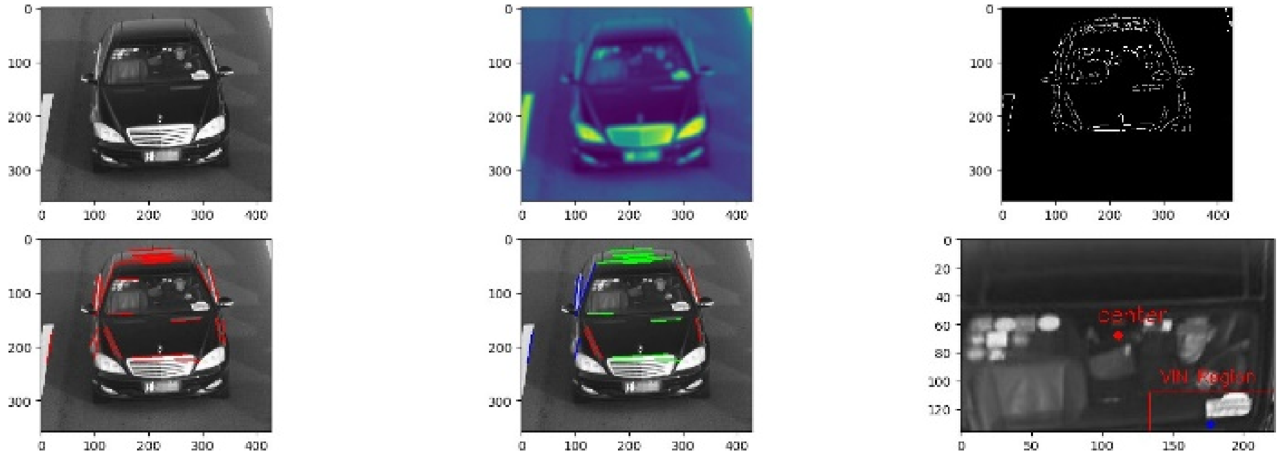

Figure 4: Results of VIN Positioning Algorithm

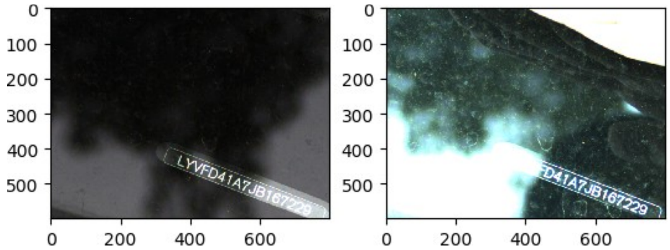

Figure 5: Exposure Time Sweep

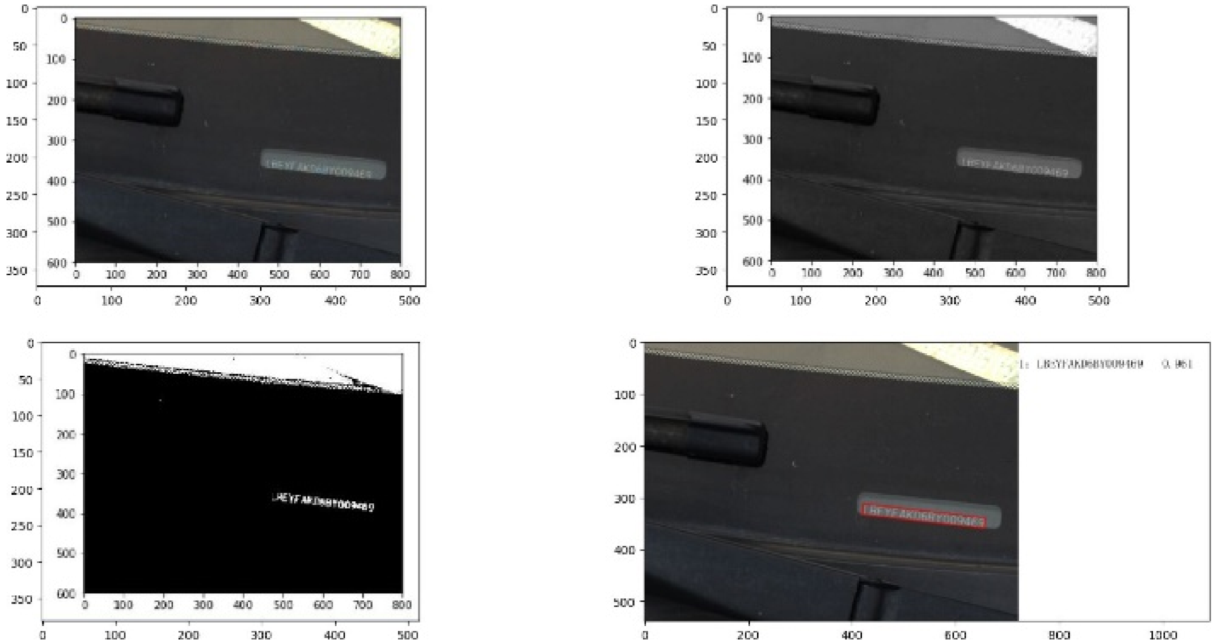

Figure 6: Preprocessing and Recognition

5. Conclusion

The "Vehicle Monitoring System Based on VIN Recognition" designed in this paper based on computer vision technology has great practical significance in assisting traffic police departments to find and track suspected vehicles. In the future, with the continuous development of road monitoring systems, it will be possible to use the high-definition zoom lenses to achieve VIN multi-directional positioning and acquisition. The vision of the system's full application in road monitoring will also be gradually realized.

References

[1] Xue Yuan, Yifei Meng, and Xueye Wei. "A Method of Location the Vehicle Windshield Region for Ve- hicle Occupant Detection System". Proceedings of 2012 IEEE 11th International Conference on Signal Processing (ICSP 2012). Ed.YUAN Baozong RUAN Qiuqi TANG Xiaofang. Institute of Electrical and Electronics Engineers, Inc., 2012, 780-783.

[2] James Mistry, Matthew Naylor, Jim Woodcock. Adapting FreeRTOS for multicores: an experience re- port [J]. Software: Practice and Experience, 2014, 44(9): 1129-1154.

[3] Wang Liangliang, Wang Guodong, Zhao Yi, Pan Zhenkuan.A fast vehicle detection algorithm based on window features [J]. Journal of Qingdao University (Natural Science Edition), 2019, 32(03): 1-7.

[4] Wang Yunqiong, You Zhisheng. Fast car window positioning algorithm based on the mean value of color difference [J]. Computer Applications and Software, 2004(01): 78-79+117.

[5] Hu Shousong. Principles of Automatic Control [M]. Beijing: Tsinghua University Press2014.

[6] Liu Binkun. Research on Vehicle Identification Code Recognition Technology Based on Android Plat- form [D]. Dalian Jiaotong University, 2017.

[7] Liao M, Wan Z, Yao C, et al.Real-time Scene Text Detection with Differentiable Binarization. 2019.

[8] Shi B, Bai X, Yao C. An End-to-End Trainable Neural Network for Image-based Sequence Recognition and Its Application to Scene Text Recognition. 2015.