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Design of Vehicle Information Recognition System Based on Machine Vision

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Abstract: In order to solve the shortcomings such as low efficiency and poor reliability of the traditional vehicle management system, this paper proposes a vehicle information recognition system based on machine vision. The system uses the LabVIEW development platform, to realize data acquisition, processing and recognition of vehicle license with machine vision technology, and the design of image acquisition read, image preprocessing, license plate location, character segmentation and character recognition and other five VI. This system has the advantages of high recognition accuracy, short time, strong reliability and good market prospects, and will play a significant role in the field of traffic management.

Keywords: LabVIEW, license plate recognition, machine vision.

1. INTRODUCTION

With the development of social economy, the number of vehicles is increasing rapidly, with increasing traffic problems, so the establishment of a scientific and efficient traffic management system is extremely important [1, 2]. Intelligent Transportation System (ITS) is the inevitable trend of traffic development in the future, which is the frontier research topic of electronic information technology for application in the transportation field. License plate recognition system (LPRS) is an important part of intelligent transportation system, which plays an important role in regulating the traffic management and reducing traffic accidents [3]. In recent years, people have carried out extensive research on the license plate automatic recognition technology, but due to the complexity of algorithm and the difficulty of system implementation, there are still some problems need to be solved, so it is necessary to conduct an in-depth study on this technology [4, 5].

In the traditional vehicle recognition system, people act as the main character of recognition. This requires a lot of manpower and resources, but due to human factors the error and interference is inevitable [6, 7]. Vehicle information recognition system based on machine vision is different from traditional recognition method, which has realized the intelligent processing of vehicle information. The system of intelligent vehicle information recognition mainly in the license plate recognition, can largely alleviate the problems such as traffic congestion, vehicle inspection, parking area and highway fees, and thus greatly saves manpower and material resources and reduces human error, interference and other factors.

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2. SYSTEM DESIGN

This system adopts advanced virtual instrument technology, combined with perfect machine vision processing algorithms, realizing the vehicle license plate recognition as output in the LabVIEW development platform. This system consists of two parts: hardware equipment and software algorithm. It uses USB camera as image acquisition hardware equipment to complete license plate image capture, transmission and storage.

Based on the research of related visual algorithm of license plate recognition, this paper develops the software system on the platform of LabVIEW so as to achieve the work of image preprocessing, license plate location, character segmentation and character recognition, and the software process is shown in Fig. (**1**).

This paper uses LabVIEW as the software development platform. LabVIEW is graphical programming software with a very rich interface, algorithms and other controls. It can complete the data acquisition, data processing, target control, data analysis and other functions; in addition, it uses the icon method to assemble software system and can easily create a dedicated virtual instrument. LabVIEW is a tool for end-users. It can enhance the ability to build the own science and engineering systems, and provide a convenient way to achieve instrument programming and data acquisition system. It can greatly improve work efficiency when using it for the principle of research, design, test and implement instrumentation system.

This paper uses USB camera as image acquisition hardware equipment, combined with the VideoCapX control to achieve image acquisition and transmission. VideoCapX.ocx control is a multimedia ActiveX control, provided by the Fathsoft Company, it sets all kinds of performance through integration, and the USB Camera, IP network camera and other images or video capture device can be fully accessed

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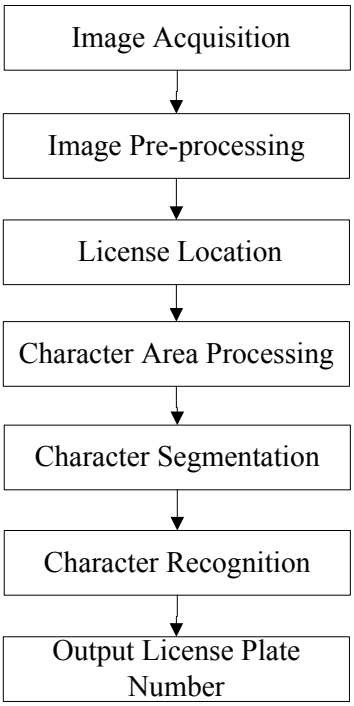

Fig. (1). License plate recognition software processing.

Fig. (2). original image.

through the VideoCapX.ocx control. It has the full access to RGB pixel data interface functions and is more in line with the application of low-cost market.

3. IMAGE PREPROCESSING

Because of the existence of noise, tilt, stain, traces in the license plate image and improper adjustment of various parameters during the filming and other reasons making a perfect license plate image is not easy and thus has a low quality. Therefore, it is needed to perform a series of preprocessing of the image such as color segmentation, graying, binarization, tilt correction, ranks of segmentation and so on.

Fig. (3). Image after color segmentation.

3.1. Color Image Segmentation Based on HSV Model

HSV model is a color model for user perception, focusing on color representation [8]. The first step in the license plate image preprocessing is the color image segmentation. In order to locate the position of license plate accurately, the system uses the segmentation method for color image based on HSV model.

Because the Chinese license plate background is blue, so the first step in this paper is to determine the corresponding gray range of blue RGB of license plate background color, and then using method of converting RGB model to HSV model, finally split the reasonable blue license plate area. The images contrast of before and after color segmentation is shown in Figs. (**2** and **3**).

3.2. Image Gray Processing

Gray processing is the process of converting a color image to gray image. A color image is divided into three components R, G, B and the amount of data is enormous. So in order to facilitate the calculation processing of computer, by reducing the calculation time, the color image needs to convert into gray image for subsequent processing. There are three algorithms of image gray processing: maximum value method, average method and weighted average method.

This paper uses average method to change the color image to gray image, as shown in formula (1):

$$H = 0.229R + 0.588G + 0.144B \quad (1)$$

The gray image convert by this formula can better reflect the luminance information of the original image.

3.3. License Plate Localization

The main purpose of license plate location is to determine the specific location of license plate region from the gray image after pretreatment, by deleting the part which does not include vehicle character information and putting the identification information part into the recognition system.

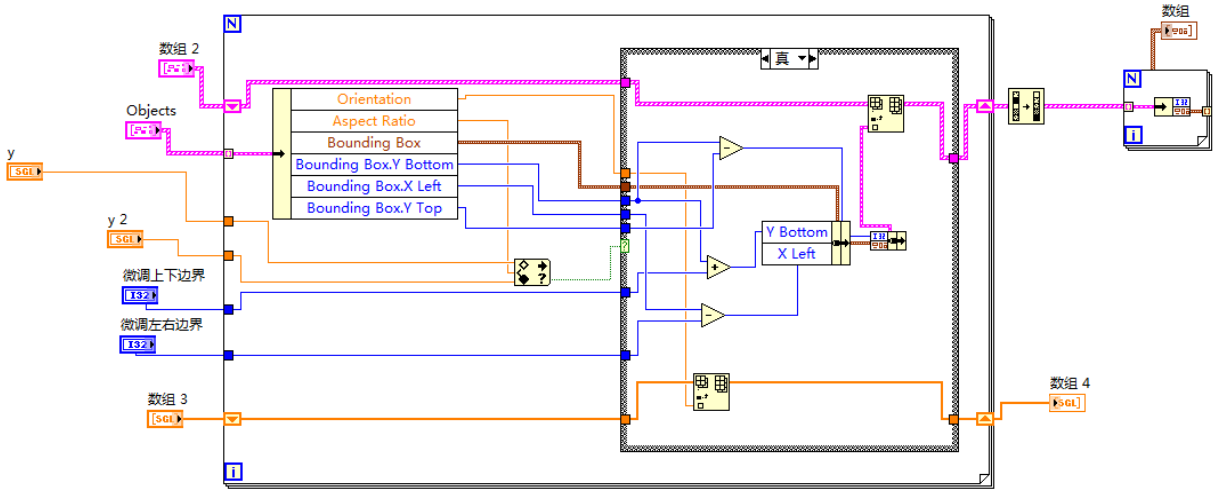

Fig. (4). Sub-vi block diagram of plate rough location.

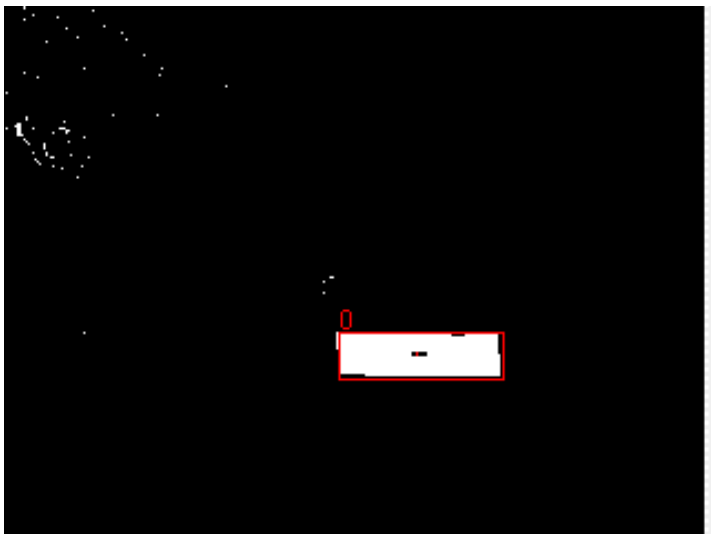

Fig. (5). Rough location of license plate region.

The pixels of the image are calculated as shown in equation (2):

$$P_e = \sum_{i=1}^{L} \left| P_i - P_{i+1} \right| \quad (2)$$

In the formula, P_e is the pixel change, L is the length of scan line, P_i is the pixel scan line of *i* point. When the change in pixel value is greater than a certain threshold during the scan line of the license plate area, the plate area can be found at both ends of the initial straight line segment, then set the segment as a starting and scan from top to bottom. Using the continuous projection feature to set the border area of the plate, when the number of white spots reaches the maximum value in a rectangle, consider the area contains the license plate coarse positioning successfully. The sub-VI block diagram of plate coarse positioning is shown in Fig. (**4**), and Fig. (**5**) that shows the rough location of license plate image.

3.4. License Plate Segmentation

License plate segmentation is an important part of vehicle license plate recognition system. The processing result whether correct or not, has been affected by many factors. One of the most serious problems is the incomplete processing results of binary; the second is the license itself interfering factors, such as license plate damage, reflective and uneven brightness *etc*. These reasons will make the captured image quality poor and have a lot of noise. Furthermore, when an image is captured, the location imbalance makes some difference in the horizontal segmentation. This system uses color segmentation method, in view of the plate characteristics of blue and white background, well establish the corresponding gray range of HSV of this plate, then count the number of specific color pixels in the identified area so as to determine the approximate region of license plate. By extracting sub- VI functions of the operator VI, and operator VI and Inclination derivation VI, it can successfully extract

Fig. (6). Extraction of gray license plate.

Fig. (7). Image after binarization.

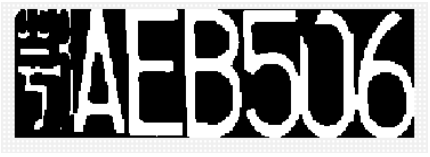

Fig. (8). Character binary images after removing the upper and lower frame.

the gray image of license plate. The segmented image is shown in Fig. (**6**).

4. CHARACTER AREAS PROCESSING OF LICENSE PLATE

Positioning through the above method is located approximately, and segmentation is cutting the license plate image out of the rough location, so there are still interference factors such as background and noise on the obtained image besides target characters. In order to extract the target character conveniently, binarization, border removal and image correction is required.

4.1. Character Image Binarization

The process of changing a gray image into binary image is called binarization. The so-called binary image is an image whose memory matrix only has 0 and 1 values. It is convenient and simple to analyze the binary image through the concept of geometry than processing the gray image, and it can improve the reaction rate of license plate recognition system greatly.

The key of image binarization is threshold selection, according to the threshold T, to distinguish the foreground and background in the image. Suppose the original gray image is converted into binary image, then the formulation of binarization is shown in equation (3):

$$g(x,y)=\begin{cases} 1, & f(x,y)\geq T \\ 0, & f(x,y)<T \end{cases} \tag{3}$$

In the formula, the gray value of pixel which coordinates is of original image. It is the binary flag of transformed pixel, where 0 represents black spots, and 1 represents white spots. In the binary image, the whole image is black and white. In the actual license plate processing system, binary image conversion must be guaranteed not to lose the original information and no additional vacancies are allowed. This system designs a method of automatic threshold selection. The plate image after binarization is shown in Fig. (**7**).

4.2. Removal of Character Region Frame

After binarization, the character region becomes a black and white image, and the excess black region may be remained. Therefore, in order to ensure the recognition accuracy, we should remove the interference in the complex background as far as possible. Fig. (**8**) is the character binary image after removing the upper and lower frames.

4.3. Correction of Character Image

Because of the impact of external factors, such as the angle of the camera and plate, camera shaking, moving vehicles and other road factors during the shooting, make the character of captured image four directions tilt.

Correction of string is to calculate the change angle of character image, and then restore the original font of character region through the geometric transformation. The correction of character image is divided into two parts: first, using the rotating coordinate method for horizontal angle; second, using character projection method for vertical inclination.

The system carries on the threshold segmentation of character image, and then analyzes the tilt angle of character image by two steps.

(1) Rotating coordinate method for horizontal angle

Suppose the image coordinate before rotation:

$$\begin{cases} x_0 = r\cos\alpha \\ y_0 = r\sin\alpha \end{cases} \tag{4}$$

The image coordinate after rotation is:

$$\begin{cases} x_0 = r\cos(\alpha-\theta) = x_0\cos\theta + y_0\sin\theta \\ y_0 = r\sin(\alpha-\theta) = -x_0\sin\theta + y_0\cos\theta \end{cases} \tag{5}$$

After a series of coordinate transformation according to the formula, calculate the corrected image pixel values of each point to complete image rotation.

(2) Projecting method for vertical angle

This design uses the idea of linear fitting method, calculate the angle between the horizontal X axis and point fitting line which image value is 1 on the above or below the license image. That is:

Calculate the slope coefficient of equation;

1) Calculate the angle;

2) Obtain license plate rotation angle.

Fig. (9). Character recognition result.

5. LICENSE PLATE CHARACTER RECOGNITION

Since the template matching is easy to implement, the anti interference ability is strong, and recognition rate is high, therefore, this paper adopts OCR algorithms based on template matching. Let the binary image size consistent with the character template size for template matching, which ultimately selects the best match as the recognition result. Through a series of preprocessing of the original image to be recognized, and then performs image correction, divide the image into individual characters, the final recognition result is shown in Fig. (**9**).

CONCLUSION

This paper proposes a vehicle detection system based on machine vision, which has a completed function design of license acquisition, preprocessing, image tilt correction, character segmentation and character recognition. It can perform real-time image acquisition and recognition. It has a lot of advantages such as high accuracy, short time and strong reliability, and is important to improve the intelligent traffic management.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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