Implementation of License Plate Recognition System of Electric Bicycles in Nantong Area

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Abstract. Electric bicycle is a very important means of transportation for Chinese people. The regularization management of electric bicycles is an important means to ensure the orderly operation of traffic. This article will adopt LabVIEW software to identify the number of the new national standard electric bicycle license plate in Nantong area through image pre-processing, image correction, threshold processing, character recognition and other methods. Then the system will determine its place of ownership automatically and save the recognition results to the designated access database of the license plate number, which is convenient for the traffic management department to manage the corresponding violations, and also can effectively inhibit the occurrence of theft or hit-and-run of electric bicycles.

1. Introduction
According to the data released by China Bicycle Association, the social ownership of electric bicycles in China has been close to 300 million in 2019 [1], ranking first in the world. This can be followed by running red lights, parking randomly, retrograde, stealing, hit-and-run and other phenomena. All these will cause traffic accidents and traffic chaos. The introduction of the new national standard further clarifies the production, sales and management of electric bicycles. Like motor vehicles, electric bicycle license plates are the only identification of electric bicycle identity information. The automatic recognition of license plates plays an important role in the realization of traffic management and the establishment of an urban intelligent transportation network. It is the premise and foundation for realizing the intelligence and informatization of the traffic management system. At present, the most widely used vehicle license plate recognition technology in the field of intelligent transportation is mainly for motor vehicles (blue cards), which is widely used in highway traffic, parking plants, toll stations, residential areas, etc., but few applications in non-motor vehicles. The new national standard will further standardize the license plate management of electric bicycles. According to the relevant requirements of Jiangsu Provincial Public Security Department, the number plate of the new type electric bicycle has white characters on green background, anti-counterfeiting marks, uniqueness and the combination of letters and numbers. In this paper, we propose a character recognition scheme based on LabVIEW software for electric bicycle license plates in Nantong area, which can automatically correct pictures and quickly complete character recognition. It effectively improves the management efficiency and management level of the electric bicycle management department, and also has a certain role in curbing the illegal behaviors such as electric bicycle theft and accidental escape.
2. System Design

When the red light is on and the electric bicycle is still driving in the non-motorized lane and the sidewalk, the sensor belt is triggered, and the sensor in the sensor belt responds to the high-resolution camera to take a picture. The captured picture will be transmitted to the controller terminal. The controller terminal processes the received color image and identifies the license plate. At the same time, the illegal electric bicycle license plate and the owner's photo are displayed in the illegal behavior exposure screen to warn other electric bicycle owners. When the identification is unsuccessful due to no license plate or the license plate is stained or covered and other reasons, the photo of the illegal act is directly displayed. The working principle of the electric bicycle license plate recognition system is shown in figure 1.

![Figure 1. The working principle of the system: 1. an electric bicycle running through red lights, 2. the location of sensors, 3. the zebra crossing, 4. telephone poles with controller terminals, 5. high-resolution cameras, 6. the exposure display screen for illegal activities.](image)

First, the controller terminal preprocesses the received color pictures, including color space extraction and conversion, image enhancement, brightness adjustment and other algorithms. After that, we use image morphology algorithm, threshold processing, particle analysis and filtering algorithm to obtain clearer binarized pictures of license plates. In the OCR training part of the license plate characters, the NI Vision Assistant software is used for character template training to form a license plate character template library. When the license plate character recognition is successful, the system will record the license plate number, license plate territory, and recognition time into the Access database. When the electric bicycle has no number plate, the number plate has large stains or occlusions, or the installation position of the number plate is not standard, the system will save the captured photos in the license plate number database for manual viewing. The overall scheme of image processing is shown in figure 2.

![Figure 2. The overall scheme of image processing.](image)

3. Color Image Preprocessing

3.1. Color Model Selection and Conversion

This paper uses the HSI (hue, saturation and intensity) color model, and selects the S (Saturation) component. This component is closely related to the way people perceive color, and represents a measure of the degree to which a pure color is diluted by white light. For the license plate with white
characters on green background, the s component can be close to 1 [2], which can not only effectively suppress the environmental variables in the captured image, but also highlight the license plate and its number characters. Each component in the HSI color model can be converted from the RGB model by equations (1)-(3) [3]. The captured original image, its component images of the RGB color model and the converted HSI color model are shown in figure 3.

Hue component:

\[
H = \begin{cases} 
\theta, & G \geq B \\
360 - \theta, & B > G 
\end{cases}
\]

Among them, \( \theta = \arccos \left( \frac{1}{2} \left( \frac{(R-G)+(R-B)}{(R-G)^2 + (R-B)(G-B)} \right) \right) \)

Saturation component:

\[
S = 1 - \frac{3}{(R+G+B)^2} \left[ \min(R,G,B) \right]
\]

Intensity component:

\[
I = \frac{1}{3} (R+G+B)
\]

3.2. Image Contrast Correction
To highlight the license plate area and its detailed features, we first use the IMAQ operator in LabVIEW software to transpose the image pixels. If the pixel value of any point in the image is \( x \), the pixel value after transposition is \( (255 - x) \). This can make the license plate area more vivid, and the influence of the background is even smaller. Secondly, contrast enhancement and gamma correction
are performed to reduce the contrast in dark areas, so that the bright areas are brighter and the details are more obvious, while the dark areas are darker and the details are more blurred. Gamma correction is to multiply each pixel value of the original image \[4\], and the transformation equation is shown in equation (4). The image after pixel transposition is shown in figure 4, and the corrected license plate image is shown in figure 5.

\[ s = cr^\gamma \]  

(4)

3.3. Image Morphology and Threshold Processing
After the contrast correction, there are still some impurities in the background of the license plate image. We use the IMAQ Morphology operator to dilate the grayscale image. The black pixels are regarded as impurities or holes, and the small objects are removed from the background through the expansion target. At the same time, the contour of the target is expanded, and to a certain extent, the license plate characters become more complete and easy to identify [5-6]. After binary threshold processing, the particle analysis and filter operators are used to filter out the impurity background outside the license plate area by physical conditions such as the length, width, perimeter and area of particles (black impurity area). The processed image is shown in figure 6.

![Figure 4. The image after pixel transposition.](image1)

![Figure 5. The corrected license plate image.](image2)

![Figure 6. The processed image.](image3)

3.4. License Plate Character Recognition
The license plate character recognition module contains two parts: license plate character OCR training and license plate character recognition. LabVIEW provides the NI Vision Assistant to help us train license plate characters [7]. It can set the relevant parameters of characters to ensure the integrity and accuracy of character recognition. According to the uniform regulations of Nantong license plate,
“苏 F A/B” is the prefix of Nantong City license plate, “苏 F C” is Tongzhou, “苏 F D” is Hai’an, “苏 F E” is Rugao, “苏 F F” is Rudong, “苏 F G” is Haimen and “苏 F H” is Qidong. We select license plates which contain characters and numbers such as “苏”, “F”, “A”, “B”, “C”, “D”, “E”, “F” “E”, “G”, “H”, “0-9” for recognition and training, and the training results are saved in the character library so that the LabVIEW program can be directly called. The character training library is shown in figure 7. The part of the license plate character recognition program is shown in figure 8.

3.5. Determine the Territory of License Plate and Enter It into the Database

After the character recognition of the license plate, the fourth character is extracted and compared with the corresponding characters of all counties and districts of Nantong through the If loop nesting structure to obtain the corresponding territories and display them. Since the Access database is one of the members of Microsoft Office, it is flexible in operation and widely used. The system selects the Access database as the carrier of the license plate character database. On the other hand, NI provides a LabVIEW Database Connectivity Toolkit that is specifically linked to the database. After the LabVIEW software successfully connects to the Access database, the DB operator can read, write, modify, or delete fields and other information in the Access database file associated with it at will [8]. The procedure of writing license plate characters into the Access database is shown in figure 9.

4. Experimental Results and Analysis

The system interface is shown in figure 10, where the “License Plate Path” column selects the license plate photo to be recognized, and the “License Plate Character OCR Library Path” column selects the trained license plate character library. The original image and the character recognition image are displayed in the “Image” and “Image-OCR” windows. “License Plate Characters” and “Territory” respectively show the original character information and the license plate location. The “Table” is used by the system to store the existing license plate information, territory information and recognition time that already in the Access database. The experiment proves that when the illumination is moderate, the new national standard electric bicycle license plate is installed correctly, the surface has no obvious stains or occlusion, and the license plate characters are not damaged, the recognition accuracy rate can reach 95%. When the illumination is too strong or too low, the character recognition is incomplete or there are too many interference factors, there will be a certain misjudgment rate.
5. Conclusion
We propose a character recognition scheme based on LabVIEW software for electric bicycle license plates in Nantong area in this paper. The experiment proves that the recognition accuracy rate can reach 95% under certain conditions. It effectively improves the management efficiency and management level of the electric bicycle management department, and also inhibit the occurrence of theft or hit-and-run of electric bicycles.

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