Design of License Plate Recognition System Based on Embedded Platform for Temporary Monitoring

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***Abstract*-- In recent years, the issue of environmental pollution is more and more important. Some people may drive the car to sparsely populated areas and throw a lot of garbage near rivers, which will cause serious environmental pollution. So, the official organizations have to deploy temporary cameras to monitor human activities in these areas. Many commercial surveillance solutions can be deployed; but the cost is too high to be deployed at wilderness. In addition, the environment of the wilderness is too complex, and the traditional solution is not capable for the scenario. In this paper, we design a real-time and low-cost license plate recognition system on embedded platform, which can be deployed at roadside for temporary monitoring. The system can adjust different algorithms to fit different situations to recognize the license plate. In the experimental results, the overall recognition accuracy of the license plate number is 87%.**

I. INTRODUCTION

License plate recognition (LPR) can be used in the general road traffic monitoring, parking control and so on. In order to accurately find the license plate and to correctly identify the license plate number, many image processing technologies should be used, such as detection of the target, filtering noise, license plate number recognition, etc.

The main four steps of LPR includes object capturing, license plate extraction, character segmentation and character recognition. Object capturing uses the background subtraction [1] to find out the car's location in foreground, then these locations can be used to find the possible license plate position. Next, the characters have to be partitioned for one by one recognition. The binary part of the commonly used method is divided into two types, one is the global threshold, such as Otsu algorithm [2]. The other is a regional threshold such as the adaptive threshold [3]. The vertical edge was identified as the edge of the character and the license plate background color difference is obvious [4]. These features are often used to find out the location of the license plate. Accurate segmentation of the characters will have a significant effect on subsequent character recognition. As mentioned in [5], the character's feature can be used. In the method of character recognition, the images of characters are trained or sorted according to the image information, including Support Vector Machine (SVM) [6] and Neural Network (NN) [7].

In this paper, we design a real-time license plate recognition system with the embedded camera equipped with 720p resolution on embedded platform. At wilderness environment, there will have a serious light influence in different environment, which makes it harder to find the good contours or edges. So, the system needs to adjust the current light effect according to the pixel intensity parameters. With the adjusted parameters, we use two different license plate features to find possible license plate areas.

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II. PROPOSED METHODS

Fig. 1 shows the proposed flow chart of the license plate recognition system proposed in this paper. In different environments, in order to be more adaptable to the current environment, the license plate recognition system can be started through the Bluetooth communication to set the ROI and some suitable parameters for the current algorithm. Then, possible license plate locations are identified with parallel processing of the proposed two features to reduce the effect of light effects. After the character segmentation and recognition, the final statistical analysis of the continuous collection of the license plate number will be used to determine the final results.

A. License plate extraction

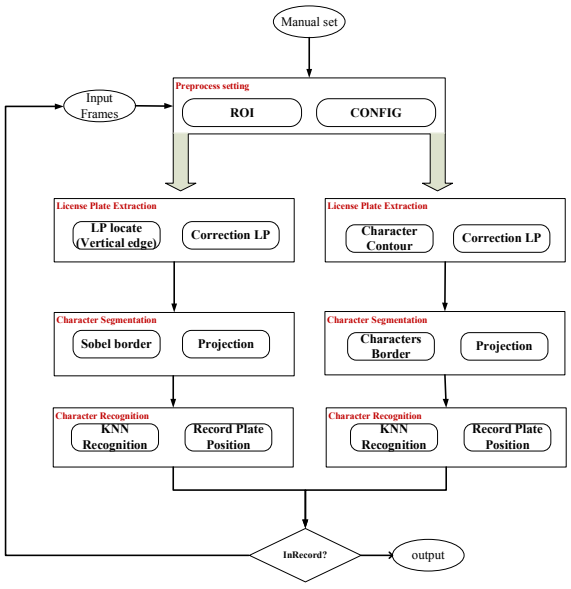


Fig 1 System flow chart of the proposed LPR

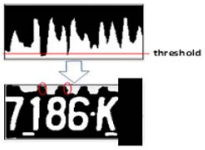
With the adjusted parameters, we use two different license plate features to find candidate regions which may be the license plate. The first approach uses the vertical edge to find the location of the possible license plate. The Sobel method is used to find the vertical edge region, and then use Otsu binarization to find out the contour area. Next, the morphology of the broken area will be connected to get a more complete possible license plate candidate area. Another feature used to identify plate locations is the character contour with width and

height scale. The reason for using two methods to find the plate is that we can make up for their own shortcomings and can effectively find the possible license plate location at wildness environment. In near distance from the camera to the license plate, the second feature is very suitable to find the license plate area. All features with aspect ratios 0.2 ~ 2.3 are collected and arranged from left to right by x-axis. Next, a set of characters are look for to determine the position that may be the license plate area.

B. *Character segmentation*

The license plate found by the previous stage will contain many noise, so we have to use the vertical / horizontal projection to clear the noise shown as Fig. 2. Although the projection can roughly find the location of the character contour edges, but in some cases the character's contour may close to each other. So, we use the aspect ratio of multiple characters to further split the characters shown as Fig. 3. The aspect ratio of one character is lower than 0.7, and aspect ratio of two characters is between 0.7 and 1.4, etc.

(a). horizontal projection to reduce noises



(b). vertical projection to reduce noises

(c). final result

Fig 2 Using horizontal/vertical projection to remove the noise

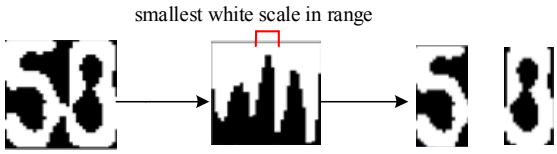


Fig 3 Segmentation of connected characters

C. *Character recognition*

Taiwan license plates are divided into old and new types. Before recognize the old or new license plate characters, the character font type must be trained and recognized at first. In the system, we use the K-nearest neighbor (KNN) classifier for character recognition and create classification files for old and new characters.

III. EXPERIMENTAL RESULTS

This section collects some Taiwan license plate images from the Internet for testing the license plate recognition methods, as well as the roadside monitoring videos which are recorded at outdoor roadside to test the results. Table 1 shows the performance results of two proposed license platform approaches include vertical edge (Approach I) and character contours detection (Approach II) on PC and Pi3. Both the test videos are 720P. Table 2 presents the accuracy of the proposed license plate recognition. The test data includes 60 license plates containing two videos and 48 pictures captured at wilderness environment. The results show that the accuracy of plate extraction can achieve 98.33%, and the accuracy of character segmentation can approximate 97%; however, the accuracy of character recognition is just 91.33% because some ambiguous fonts and dirty characters in the plate will confuse the recognition.

Table 1 Performance (fps) comparisons for plate on PC and Pi3 platforms

	Approach I		Approach II		Both I and II	
Video(720P)	1	2	1	2	1	2
PC	31.2	20.4	31.9	32.1	21.3	18.1
Pi3	2.9	1.7	3.1	3.9	2.1	1.4

Table 2 Accuracy results of each step in LPR

	Correct No.	Accuracy(%)
Plate Extraction	59/60	98.33
Char. Segmentation	369/381	96.69
Char. Recognition	337/369	91.33
Total		86.83

IV. CONCLUSION

In this paper, we designed a low-cost license plate recognition system on the embedded platform. The accuracy of the proposed system is not as good as commercial solutions; however, in some situations deploy traditional high-cost camera station is not convenience or costly at wilderness environment. Many nodes of the proposed system can be deployed to achieve reliable IoT-based surveillance system. Some deep learning algorithms will be used in the future to improve the accuracy.

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