

Applying Image Recognition Technology to Intelligent Security Management Systems

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Abstract-A building safety management system based on image processing technology, which includes the license plate recognition, face recognition, and Radio Frequency Identification (RFID) systems are investigated in this paper. The system integrates three functional capabilities, which can effectively control access to user identity and to control management building security. The image technology is used to do license plate and facerecognition. In order to recognize the license plate and face thecolor space conversion, segmentation, and image processing technology is applied. Finally, the integration of RFID image processing is applied to automatic security management system. Only the identified users can pass through the gate of building to make sure the security.

Keywords-image processing technology; license plate recognition; face recognition; radio frequency identification

I. INTRODUCTION

The security of public space and building is paid more attention in recent years. The guard is necessary to make sure the safety of people. Most of the users still preserve the human guard. However, the human is easy to make error such as misjudgment and cost of human guard is relative highalso. Therefore, there are many public places do not have guards. In order to have safe activity space, an intelligent automatic security management system is investigated to handle this job. Using this system, the person or the vehicle does not on the list of database is not allowed to enter the gate to enhance the people security.

In this paper, an integration system which includes Radio Frequency Identification (RFID) [1] and image processing [2-3] is applied. If people like to pass through the gate, the system will check the RFID and face recognition [4-6] by using

imagetechnology. If vehicles like to pass through the gate, the system will check the RFID, license plate [7] and face recognition by using image technology. The image processing technology which includes thecolor space conversion, segmentation, and some other image processing technology is applied in this paper. This technology is convinced to have effective control and good identity confirmation. It can integratedifferent informationeffectivelyand overcome the traditional security problems also.

An intelligent security management system is developed in this paper. The system process is shown in Figure 1. The image identification section contains the license plate recognition algorithm and face recognition algorithm. This paper presents a complex image recognition technology based on user security management system to have effective control and good identity confirmation.

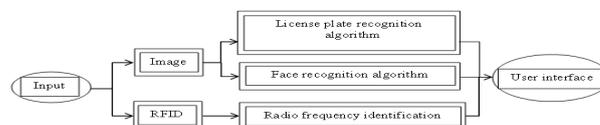


FIGURE I. SECURITY SYSTEM ARCHITECTURE

II. LICENSE PLATE RECOGNITION ALGORITHM

License plate recognition system uses the camera to capture images of vehicles, then transfer captured images to a computer through a series of image processing procedures. The process includes the former image processing, license plate location, license plate characters segmentation, and license plate character recognition. First, it captures a video image and does the pre-processing steps. In order to save computation time the RGB color image is converted into grayscale images.

And then, it uses histogram equalization to enhance the image contrast and brightness adjustment, so that the image processing operations can be done at the same standard, as shown in Figure 2. Because there is background noise, the system uses edge detection method and morphology to highlight the candidate block the plate and set the filter criteria to find the location of the license plate. In this paper, a vertical sober edge detection method is applied.

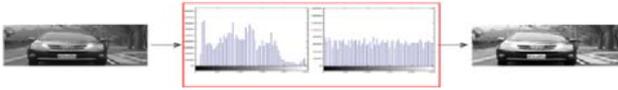


FIGURE II. IMAGE PRE-PROCESSING

Morphological processing is an important process, which is widely used in target detection, noise removal, segmentation, and block boundary capture. This paper doesn't apply additional noise elimination for simple the processing only using the morphological processing to reduce it. The closing and opening algorithm of morphological processing based on dilation and erosion are useful to fill up the vacancies of segmented foreground objects and to eliminate some noise. These two methods can let the detected objects are more intact to present.

After morphological process, images will form many different sizes of blocks, and then it will set the initial filter criteria to filter out unlikely license plate blocks. If the block area is less than 120 pixels will be removed. According to the actual experimental simulation analysis, it sets the block filter formula is shown as Eq. (1) and (2). If the image is actual location of the license plate which meets the above two conditions will be filtered out and shown in Figure 3.

Block Aspect ratio:

$$2 \leq Length / Width \leq 2.2 \quad (1)$$

Block pixels:

$$4400 \leq AreaPixels \leq 4800 \quad (2)$$

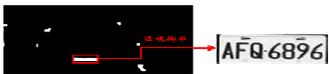


FIGURE III. LICENSE PLATE LOCATION RESULTS

After capturing the license plate position, the image noise which is less than 60 pixels will be filtered out. And then the clear license plate will be shown. Segmentation is based on projection histogram analysis to find their proper segmentation threshold values. Pixel distribution state and the cumulative amount of the image project onto the coordinate axis. Based on its distribution histogram, the algorithm identifies a local maximum or minimum of the cumulative pixel position. The algorithm sets the segmentation threshold to achieve the purpose of segmentation. This paper uses horizontal positioning projection split upper and lower boundaries of the amendments. The vertical projection of character segmentation achieves correct position and cut out characters, the result is shown in Figure 4.



FIGURE IV. LICENSE PLATE SEGMENTATION PROJECTIONS

After cutting through the vertical projection, it gives the license plate characters in each block of the image. This algorithm splits character image block after normalization to image size, the results are shown in Figure 5. And then the algorithm starts the character recognition process. In this paper, a model comparison method is applied to complete the final alignment results. When the image size is specified, it will calculate the correlation coefficient shown as Eq. (3). Where R is the correlation coefficient, A_{mn} is standard model grayscale, \bar{A} is the average value of standard model grayscale, B_{mn} is the test image gray order, and \bar{B} is the average value of test image grayscale. The highest correlation coefficient of the object is the comparison results.



FIGURE V. CHARACTER NORMALIZATION RESULTS

$$R = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right) \left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}} \quad (3)$$

III. FACE RECOGNITION ALGORITHM

Face recognition algorithm consists of three parts, which are human face location detection, facial image capture and formalize the region, and principal component analysis comparison. After the face images are captured, the system uses color space conversion and analyzes the region of face. The Otsu's method is used to make image segmentation to have more precise position of human face. The face recognition is based on the identification of the principal component analysis framework to establish facial feature space. Finally, the algorithm uses Euclidean distance to determine the size of the human face identity.

Face location detection step consists of two parts, which are human face image pre-processing and the human face correction and calibration. First, the pretreatment step is the color space conversion and the image analysis to aim the face image area. It will detect the human face image region. Subsequently, the system uses morphological processing to remove unwanted component and then more accurate face position can be marked.

Traditional RGB color images are susceptible if light intensity is changed. In this paper, the $L^* a^* b^*$ color space conversion is chosen to do human face detection component analysis. The $L^* a^* b^*$ color space for the color opponent space is based on CIE-XYZ color space coordinates. L^* represents the luminance component, a^* represents the red/green color component, and b^* represents the yellow/blue component. RGB color images cannot be directly converted into $L^* a^* b^*$ color images. It uses the transformation

matrix shown as Eq. (4) to convert it to CIE-XYZ color space, and then find its X, Y, Z values. The CIE- LAB color space can be obtained by using Eq. (5) to Eq. (8).

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (4)$$

$$L^* = \begin{cases} 116 \times \left(\frac{Y}{Y_n}\right)^{\frac{1}{3}} - 16, & \frac{Y}{Y_n} > 0.008856 \\ 903.3 \times \frac{Y}{Y_n}, & \text{otherwise} \end{cases} \quad (5)$$

$$a^* = 500 \times \left(f\left(\frac{X}{X_n}\right) - f\left(\frac{Y}{Y_n}\right) \right) \quad (6)$$

$$b^* = 200 \times \left(f\left(\frac{Y}{Y_n}\right) - f\left(\frac{Z}{Z_n}\right) \right) \quad (7)$$

Where $X_n=0.9515$, $Y_n=1.0000$, $Z_n=1.0886$, and $f(t)$ is shown as Eq. (8).

$$f(t) = \begin{cases} t^{\frac{1}{3}}, & t > 0.008856 \\ 7.787 \times t + \frac{16}{116}, & \text{otherwise} \end{cases} \quad (8)$$

The conversion result is shown in Figure 6. Figure 7 is the $L^* a^* b^*$ color space components of human face image.



(a) RGB image (b) $L^* a^* b^*$ image

FIGURE VI. RGB IMAGE AND $L^* A^* B^*$ IMAGE



(a) Luminance component (b) R/G component



(c) Y/B component

FIGURE VII. $L^* A^* B^*$ COLOR SPACE COMPONENTS

In this paper, the Otsu's image area segmentation method is used. By Otsu's image region segmentation method can automatically analyze the optimal segmentation threshold of human face images. The face segmentation histogram analysis

results is shown in figure 8, which are the components of the color space by a^* and b^* conversion. The red dotted line is the threshold values for the analyzed position. Based on the image results, the Otsu's image region segmentation method can effectively separate the face component.

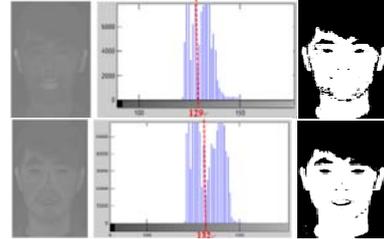


FIGURE VIII. FACE SEGMENTATION HISTOGRAM ANALYSIS RESULTS

Let these two image region segmentations be intersected and the two images will extract a common component. It will obtain a more accurate face region of the image component shown in Figure 9(a). Subsequently, the morphological process is applied to treat the face image. The result of image after morphological processing is shown in Figure 9(b). Figure 9(c) is the corresponding RGB color image position in which the background image has been removed. After the corresponding position of the face image is obtained, it only remain the image characteristic such as eyebrows, eyes, nose, and lips, which are different based on different face. After positioning the image block, which can identify a face in the image composition block size and the range of coordinates. The face component block range coordinates (X_1, Y_1) and (X_2, Y_2), can be scaled by using Eq. (9) to Eq. (12) to obtain correction range coordinate area (Left, Top) and (Right, Bottom). Its relative position is shown in the Figure 10(a), and the actual marked face is shown in Figure 10(b). The human face is not fixed, so the face block size image should be normalized to same size.

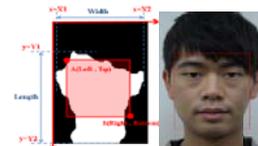


(a) Intersection image (b) Image after morphological (c) RGB image position

FIGURE IX. FACE SEGMENTATION HISTOGRAM ANALYSIS RESULTS

$$Top = Y_1 + Length/0.05 \quad (9) \quad Bottom = Y_1 + Length/1.3 \quad (10)$$

$$Left = X_1 + Width/8 \quad (11) \quad Right = X_2 - Width/8 \quad (12)$$



(a) Correction region of face (b) Mark of human face

FIGURE X. CORRECTION DIAGRAM OF THE HUMAN FACE

After normalizing the human face image size, this paper analyzes through the main ingredient to complete face recognition algorithm. It is widely used in two-dimensional face recognition. After conversion you can use less data to replace the original data, so the advantage of its method can reduce the dimension of image data and can quickly analyze the results. Finally, the algorithm uses the Euclidean distance to find the closest results from training sample library. The difference between the images of human face is projected onto the feature space and to find the weight vector in space. Based on the computation results of Euclidean distance shown as Eq. (13), the system will find the same person's face image between the two vectors have the smallest value.

$$D(x, y) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + \dots + (x_n - y_n)^2} \quad (13)$$

IV. RFID AND USER INTERFACE

In this system one passive 13.56MHz frequency specification of RFID is chosen. The system can directly integrate with the Lab View user interface. First, it needs to set port and transport protocol to establish the reader and the computer transmission channel. After communication interface setup is completed it can build RFID encoding list in the system and it will check the user code to confirm whether he is on list or not. The system also displays the user information in computer. Then the user's identity can be checked easily. Finally, this study integrates the three functions which are license plate recognition, face recognition, and RFID to identify the users. The identification results will transmit to the user interface in Lab VIEW and it will display related information. The security center can monitor the results of operation for each identification sample. Based on real time experiment results, the successful rate is over 90%.

V. CONCLUSION

This study presents an intelligent security management system which integrates license plate recognition algorithm, face recognition algorithm, and radio frequency identification technology to make the security monitor automatically. The system constructs an intelligent image processing technology which can identify the license plate and human face. This system has automatic identification and specific user identity functions. Moreover, the system will transmit identification results to the management interface using Lab VIEW and display related information. The proposed system is convinced that it is not expensive but it has efficient security management capability.

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