Digital Image Processing Technology for Test-Cumulus System

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Abstract: In order to solve the aggregation problem of handwritten scores in papers, this paper studies the realization of fractional cumulative system based on digital image processing. The whole process includes the preprocessing of the image, the segmentation of the fractional region, the character recognition based on the artificial neural network, and the summation of the scores. By experimenting with a certain number of images, a higher accuracy cumulative score is obtained, which further validates the validity and accuracy of the various methods used in the system. It also shows that Matlab has performance in dealing with digital images Superiority.

1. Introduction

In the national education industry, in order to reduce the burden on teachers and staff and improve their efficiency, more and more application software and practical systems are used in daily learning work[1~3]. In the existing marking mode, although there are card readers, subjective questions can't be completely abandoned, and the task of the reviews is still heavy, not only to judge the correctness and rationality of the answers, but also to aggregate the final scores, and the summary scores take up a lot of time, which inevitably reduces the efficiency of the reviews[4]. The introduction of the accumulative system can effectively solve the problem of manual score summarization[5]. Compared with the manual summary of scores, the accuracy and reliability of the accumulative system is higher and faster.

The research based on the image processing of the accumulative system mainly refers to the noise reduction processing of the collected picture information, the use of Hough transformer to extract the line, the rotation of the skew line according to the deflection angle to obtain the horizontal line, the search for the red number position and segmentation of the score, the final score is accumulated. After the system divides the scores, the artificial neural network algorithm is used to identify the characters in the handwritten digits, and the character recognition result with higher accuracy is obtained by the error feedback method.

2. Digital Image processing

2.1 Hough transformer

The Hough transformer is a parameter estimation technique using the voting principle[6], which is mainly used to separate certain geometric features with uniform features from the original image. It projects all the point set on the straight line or curve in the original image to the intersection of all the straight lines in the parameter space, and performs a simple accumulating operation on the points existing in each divided accumulator unit in the parameter space to find the peak value of each accumulator[7], and the position in the original image corresponding to the accumulator unit in the parameter space where these peaks exist is the existence of a straight line or a curve, thereby detecting a straight line or a curve in the image.

2.1.1 Hough transform detection line

According to the duality characteristic of the dotted line[8], each point in the input space

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corresponds to a straight line in the output space. When different points on the same line are mapped to the output space, there are common intersection points, and there are (x_i, y_i) (x_j, y_j) two points determine a line, thus applying an accumulator A(q, k), using a two-dimensional array to represent the number of times which the recorded q-k space line passes through the point, the initial record is 0. For the point (x_i, y_i), the mapping to the parameter q-k space is a straight lines equation:

$$q=y_i-kx_i \quad (1)$$

corresponds to all the points that the straight line passes through as the accumulator space:

$$A(q, k) = A(q, k) + 1 \quad (2)$$

Similarly, for the point (x_j, y_j) get the straight lines equation:

$$q=y_j-kx_j \quad (3)$$

The accumulator is incremented by 1, the accumulator of the intersection (q', k') of the two straight lines, q' is the intercept of the line determined by the two points, and k' is the slope. In order to increase the accuracy, all the points on the line y=k x+ q are Hough-mapped[9], and a series of straight lines in the mapping space k-q are obtained, and the accumulators are voted. The number of votes of the intersections of these lines must be the highest in the local area. At this time, a threshold T is set, and it can be considered that the accumulator value is greater than T is a straight lines parameter. The specific input space line and the corresponding output space line are shown in Figure 1 and Figure 2 respectively.

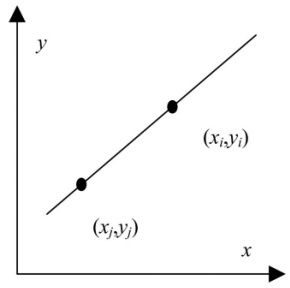

Figure 1 Input space line

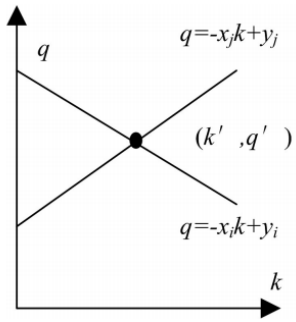

Figure 2 corresponding output space line

2.1.2 Hough transform detection curve

For a curve as an arc on a circle, if the equation of the circle $(x-a)^2+(y-b)^2=r^2$, because there are 3 parameters, if it is Mapped to the parameter space, it will be three-dimensional, Whether it is calculation speed or logic, the difficulty has increased a lot. However, in many cases, the radius of the target to be detected can be considered to be fixed or within a certain range, so that the equation of the circle can also be mapped to a two-dimensional space with only two parameters a and b. For example, the parameter equation of the input space a-b corresponding to the point is

$$(a-x_i)^2+(b-y_i)^2=r^2 \quad (4)$$

It can be known from the equation that the curve is a circle with radius r in a point circle relationship with the output space. Also apply an accumulator space A (a, b, r), the accumulator value corresponding to all points on the circle:

$$A(a, b, r) = A(a, b, r) + 1 \quad (5)$$

When multiple points of the input space are mapped to the output space, it can be found that these circles also have a common intersection point, which is the coordinates of the center of the circle in the input space, as shown in Figure 3.

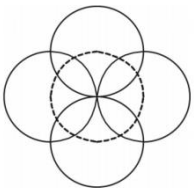

Figure 3 Multi-point mapping to output space

In the accumulator, the value of A (a', b', r') is locally highest. If there are multiple circles, we can also set a threshold T. For A (a, b, r) The point greater than T can be considered as a circle with a radius of r and a center of (a, b).

2.2 Red handwriting search

The HSV color model evolved from the CIE three-dimensional color space[10]. In the HSV color model, each color is represented by hue (H), saturation(S), and color brightness(V). The hexagonal pyramid stereoscopic diagram shown in Fig 4 is its three-dimensional space representation.

In this model, the bottom surface of the hexagonal is on the horizontal plane of the coordinate system, which includes two important parameters of the model, one is the hue and the other is the saturation. The hue is rotated around the longitudinal axis of the coordinate system, and the position of the six standard colors are indicated on the Figure, with the adjacent solid colors being separated by $60^{\cdot}$. Saturation is changed in the horizontal direction, and the lowest saturation is at the origin of the coordinate system. The color brightness is on the longitudinal axis of the coordinate system and various continuously in the vertical direction.

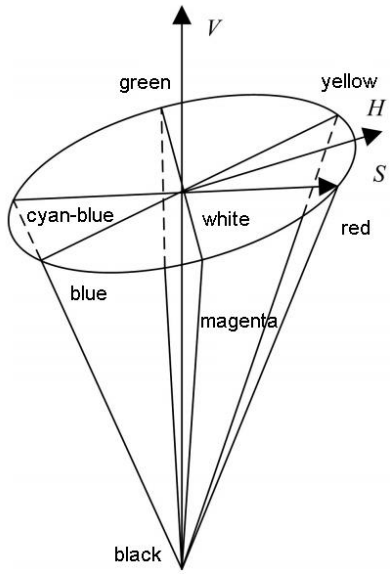

Figure 4 The hexagonal pyramid stereoscopic diagram

Make nonlinear transformation from the RGB color space to the HSV color space, as shown in Figure 4, assuming that the center coordinate point of the ellipse is "white", the distance between the focus of the H-axis on the ellipse and "white" is the radius r, where between "yellow" and "white" is the maximum radius r_{max}, between "green" and "white" is the minimum radius r_{min},for the chromatic aberration area where the hue H controls red, yellow, green, cyan and magenta, the

distance from the maximum radius r_{max} and the minimum radius r_{min} during the counterclockwise rotation from the H-axis are set to g and h, Then the transformation of each color on the hue H is controlled by the maximum radius r_{max} between "yellow" and "white" and g, b and r, the specific transformation is:

$$h=\begin{cases} undefind, r_{max}=r_{min} \\ 60°\times\frac{g-b}{r_{max}-r_{min}}+0°, r_{max}=r, g\geq b \\ 60°\times\frac{g-b}{r_{max}-r_{min}}+360°, r_{max}=r, g<b \\ 60°\times\frac{g-b}{r_{max}-r_{min}}+120°, r_{max}=g \\ 60°\times\frac{g-b}{r_{max}-r_{min}}+240°, r_{max}=0 \end{cases} \quad (6)$$

The transformation for saturation S can be controlled only by the maximum radius r_{max}, as follows:

$$s=\begin{cases} 0, r_{max}=0 \\ \frac{r_{max}-r_{min}}{r_{max}}, others \end{cases} \quad (7)$$

For color brightness V is the maximum radius r_{max} between "yellow" and "white":

$$v=r_{max} \quad (8)$$

3. Implementation of a cumulative score system

3.1 Implementation steps

The implementation steps of the cumulative score system studied in this paper are as follows:

Step.1: Image input: Pass the photos to be processed to the computer and load the recognition system;

Step.2: Image preprocessing: image conversion, image edge detection, denoising, line extraction, image rotation, etc

Step.3: Area localization and segmentation: Searching for the approximate location of the handwriting score from the pre-processed registration score domain image, denoising the image morphology and then segmenting the rectangular region where the score is located in the test paper;

Step.4: Character segmentation: separate the scores of each topic from the rectangular area where the score is located, and then separate each character by a single character;

Step.5: Single-character recognition: This step is based on the intermediate result obtained in the previous step. For each segmented character image, analyze and extract the features, and the established neural network is used to continuously learn the training to determine the type of the character;

Step.6: Score summary: judge the weight of the recognized character in the score, determine whether it is in ten or one place, then calculate the score of each title, then sum all the scores of the questions, and output the result.

3.2 Image preprocessing

Image preprocessing is the first step in this experiment and plays a crucial role. In the original image, not only have the outline of the image, the edge information, but also have the color information of the image, and the information will occupy a certain amount of storage space, which leads to a certain degree of reduction in the execution speed when the system solves the problem, the image input is shown in Figure 5.

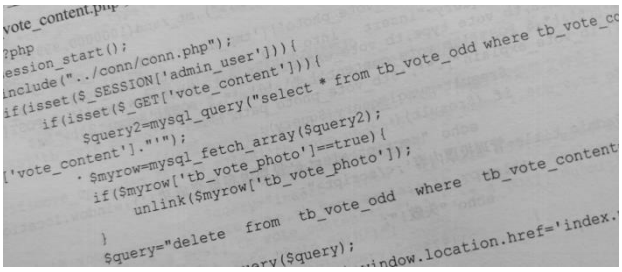

Figure 5 image input

Image preprocessing is a preparation that must be done before the image is analyzed. This simplifies the various information contained in the image, allowing us to more clearly and directly understand the object features in the image. The edge of the image refers to the relatively obvious part of the image where the local brightness changes. It can fully embody the basic features such as the texture and shape of the image. In order to facilitate the use of the Hough transform method to extract the line in the image to complete the determination and correction of the desired target position, the edge detection is first performed on the image. Specific steps are as follows:

Step.1: Perform gray scale conversion on the image to convert the original image into a binary image;

Step.2: Use the canny operator to detect the edge of the images, and denoise in this process[11];

Step.3: Use Hough transform to extract lines

Step.4: Correct the angle of the tilt image.

Specific edge detection and image rotation correction are shown in Figure 6 and 7.

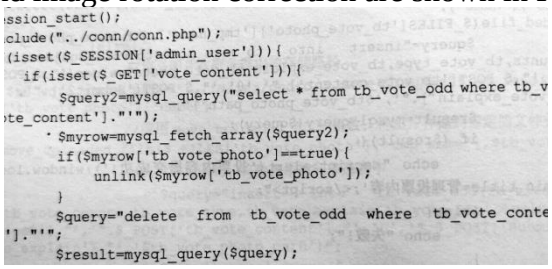

Figure 6 Edge detection

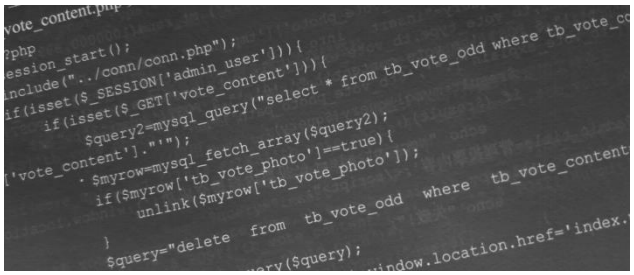

Figure 7 Image rotation correction

3.3 Regional positioning and segmentation

The location and segmentation of the score region is one of the important steps in the implementation of the cumulative score system in this experiment, with the realization of this step, we can confirm the specific position of the score region in the image after correction and accurately segment the regional subgraph where the handwritten score locates in. The image results obtained in this process are used in the subsequent steps, so the accuracy of the segmentation is directly related to the final recognition rate of the entire cumulative score system.

3.3.1 Positioning of score regions

In order to complete the successful positioning and segmentation of the region and observe the basic characteristics of the image, teachers use the red signature pen when judging the volume, the color attribute of the score region is significantly different from the surrounding area. It is

convenient to locate the score region by using this feature. Using the method of color segmentation, the image if first converted from RGB to HSV[12], and the three components of H, S and V of the image are obtained. For the three components obtained from the HSV image are simultaneously defined, the position of the score region can be located, and the regional positioning is as shown in figure 8.

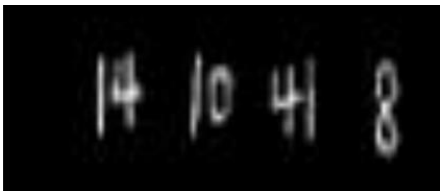

Figure 8 Regional positioning

3.3.2 Segmentation of score regions

Split the score area, find the values in the X and Y directions of the position of the score area, and record the minimum and maximum values, so that you can divide the rectangle area where the score is based on the four data, and divide it out. Due to the quality and clarity of the image, the so-called morphological noise filter consisting of two basic operations of opening and closing is applied here[13], and the unrelated small objects in the object are removed. The segmentation effect is shown in figure 9.

Figure 9 Score region segmentation rendering

4. Conclusion

In this paper, the research on the accumulating score system and the final realization process of it greatly reduce the workload of teachers. In this paper, the implementation accuracy of the system is higher, which is due to the selection of reasonable image processing methods, such as the normalization of the size and position of the segmented characters. And select the appropriate parameters by improving the neural network, the accuracy of the score calculation is further improved. At the same time, the experimental program is relatively simple and meets certain requirements, and the program runs efficiently.

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