An Improved Perspective Transform for Image Distortion Correction

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Abstract—In this paper, we propose a new image distortion correction algorithm. Based on a perspective transform, we add the hue, saturation, lightness (HSL) threshold segmentation and Hough transform to solve the problem of image distortion, and improve recognition accuracy by correcting the edge of the target area. Optical character recognition (OCR) is used as a benchmark to evaluate the performance of the proposed algorithm. The experimental results demonstrate that the algorithm has a wide range of adaptation, good correction and recognition accuracy.

I. INTRODUCTION

In the process of capturing images, particularly in text shooting, there are varying degrees of geometric distortion because of the influence of lens accuracy, imaging system nonlinearity, shooting angle, and other factors. In the process of shooting, for instance, there are some angles between cameras and objects that result in the perspective distortion of the captured images. However, in practical applications, it is typically necessary to obtain the front view of the image; thus, it is necessary to correct the distortion. An increasing amount of attention has been paid to the research of image correction.

At present, there are three main methods to correct an image with perspective distortion: angle detection, camera calibration [1], and projective geometry. Generally, straight line detection and rotation angle detection are used, which are complex and limited in real-world applications. However, when using the Radon transform or Hough transform directly, perspective distortion is ignored [2]. The algorithm for the direct detection of the tilt angle is no longer effective when the camera is close to the object. These methods have great limitation.

We propose a new correction algorithm based on the Hough transform, threshold segmentation, and perspective transform. First, we use the improved Hough transform to extract four straight lines from the image, and then calculate their four intersection points. Finally, we use the perspective transform to correct the perspective image to the front view. The experimental results demonstrate that the correction effect of this algorithm is remarkable.

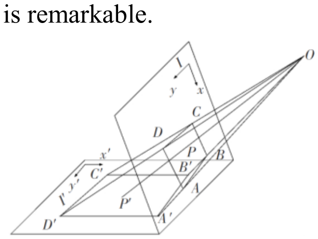

Fig. 1. Perspective transform

II. PROPOSED METHOD

To improve the efficiency of the Hough transform and avoid the detection of repeated lines, the image is first segmented using the hue, saturation, lightness (HSL) threshold, as shown in Fig. 2(a). The HSL color model is a color standard in the industry. A variety of colors are obtained by changing the three color channels of the hue, saturation, and luminance, and the superposition of each channel. There is a specific threshold for a particular scene; the threshold is generally consistent in the same environment.

When there are many lines in an image, the straight lines extracted directly from the Hough transform may be repeated. To avoid repeated detection, we improve the algorithm, as follows: After extracting the straight lines, we record the intersection point of each line and ensure that there is a certain distance between each intersection point, as shown in Fig. 2(b).

Four target points are determined using the improved Hough transform. The coordinates of the four points and the corresponding actual coordinates constitute four pairs of coordinate data. These data serve as a known quantity for solving the perspective parameter matrix. Thus, the perspective parameter vector can be solved, which is used to transform the perspective to the front view, as shown in Fig. 2(c). Finally, the corrected perspective parameters are used to transform the original perspective image, and the correction map is obtained.

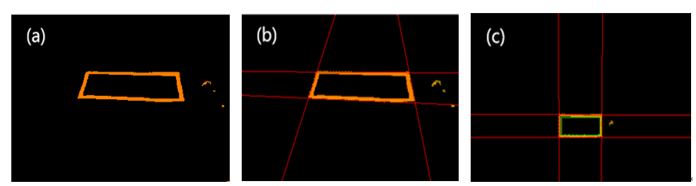

Fig. 2. (a)HSL threshold image; (b)Hough transform image; (c)Perspective transform image.

III. EXPERIMENT AND ANALYSIS

We summarize the experiment as follows:

Step 1: Segment the target image using the HSL threshold and determine the boundary of the target area.

Step 2: Use the Hough transform to extract four lines from the image.

Step 3: Calculate the coordinates of the four intersection points, solve the equation set about the perspective parameters, and obtain the perspective parameter vector.

Step 4: Apply the perspective parameters to all points in the image, then correct the image and obtain the front view.

Step 5: Use the OCR to identify the text in the image, and then compare the recognition results before and after correction.

Step 6: Record and analyze the accuracy of the recognition results.

The following [Fig. 3] distortion conditions occur easily during the shooting process. In particular, three-dimensional perspective distortion and geometric plane distortion are the main part. Fig. 3 contains three columns. The original image of the distorted sample is stored in the first column. The second column and the third column contain the perspective image and corrected image using OCR, respectively.

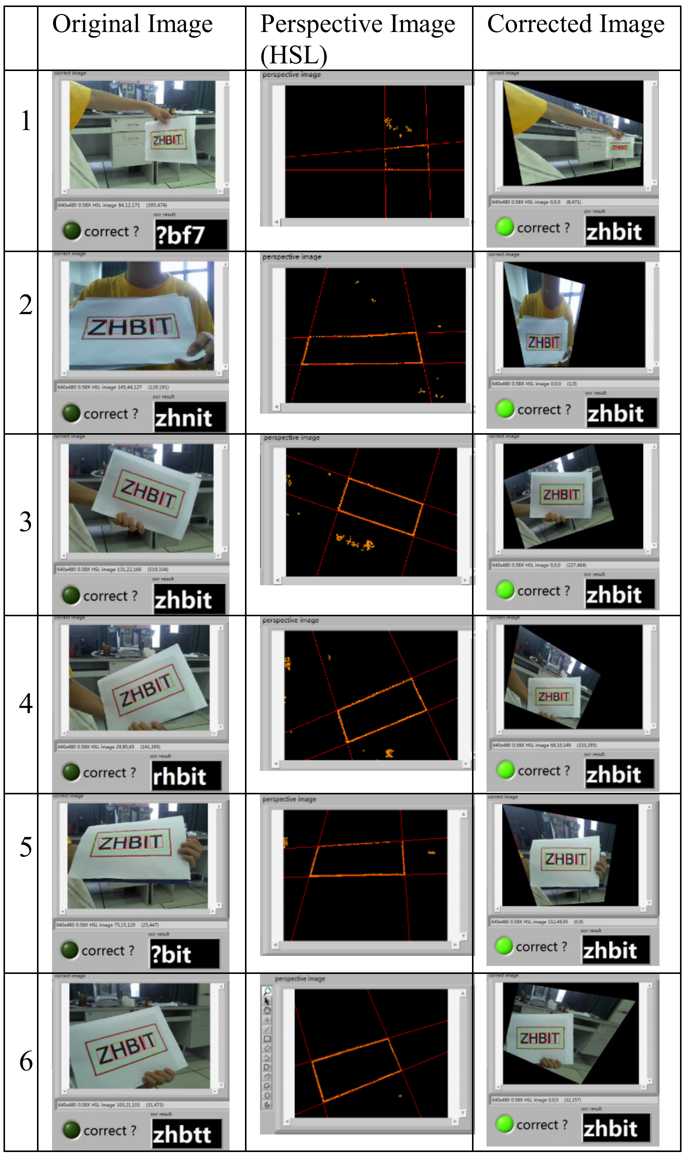

Fig. 3. Six typical experimental images and correction

From the experimental results, we found that before perspective image processing was completed, an error had already appeared during character recognition or even random code, and the distorted image greatly reduced the character recognition rate. By contrast, by applying our algorithm, we achieved a close-to-zero recognition error. The proposed method can manage a variety of perspective distortion, and effectively correct the distorted image.

The author captured 30 images including text, characters, architectures, and other objects from various angles. Additionally, this method was used for correction. The success rate of correction was up to 95%, and the accuracy of recognition after correction was 80% higher than that of the original image. The experiment in this paper was conducted using LabVIEW.

IV. CONCLUSION

A good target detection algorithm is very important for correcting perspective distorted images. In this paper, a correction method based on the improved Hough transform and perspective transform is proposed, which solved the problem of perspective distortion caused by different shooting angles.

This algorithm has wide applicability, and it can be applied to correct a variety of distorted images. A rectangular border is only one of the cases that can be corrected using this algorithm, which can be extended to circular, polygon, and contour images.

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