Chinese Chess Recognition Algorithm Based on Computer Vision

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Abstract: This paper introduces the Chinese chess recognition algorithm based on computer vision and image processing. In order to simplify processing and enhance efficiency, the images of chessboard and chessman need preprocessing in advance. The steps of preprocessing include of transformation from color images to gray images, images filtering with mean filter or median filter, and binaryzation of the gray images. The edges of chessboard and chessman are able to be extracted from the binarized images by image segmentation. Then the location of center of chessman and the circle edge of chessman can be calculated with an advanced Hough transformation, which can ascertain the location of chessman in the chessboard and the size of each chessman. According to the features of chess images, main recognition method is to analyze the radial chess pixel statistical data with mathematical morphology. Because the values of pixel coordination in any angle of chessman can keep same and stable, the recognition algorithm should be with a good recognition rate from the experimental results. The advanced and modified recognition algorithm is proved to be practical and applicative by the experimentation of computer vision system in Chinese chess games provided in this paper.

Key Words: Chinese Chess, Chess Recognition, Recognition Algorithm, Computer Vision

1   INTRODUCTION

Chinese chess game is an important kind of computer games. Chess recognition is an essential foundation of automatic chess playing in the games. According to technologies of computer vision and pattern recognition, chess recognition algorithm is widely studied and researched for real situations of chess playing. In the paper, a serial of image processing techniques such as color space transform, threshold segmentation, morphological skeleton and Hough transformation are used to detect and locate the chesses in the chessboard. Through the features extracted from radial pixels are not varied in the condition of chess rotation with different directions, the chess recognition algorithm has overcome the random problem coursed by different chesses directions.

The real-time requirement of chess playing is very high, but the various pretreatment and Hough transformation with anti-noise ability must be spent much time for computing and calculating. Hence, there should be enough time to process the game initialization. However, in period of the game playing, the computation time becomes very important and tight. As a result, playing games can take the methods of subtraction of two frame images before and after to eliminate the redundant information, which also can ensure the accuracy of processing result and the

consumption of playing time. In this paper, algorithm initialization at the beginning and recognition methods in the game playing are two same important steps based on computer vision.

2   THE IMAGES PREPROCESSING OF CHESS RECOGNITION

2.1 Images Binaryzation

The image binaryzation is a common initial of image processing. Several ways of image binaryzation are compared to find the regulations and the effective factors by using of gray images with single chessman artificially cut from character chessboard as the experimental objects. The result is shown in the figure 1.

Fig. 1: Binaryzation of gray image

From the comparison above, several methods of binaryzation with different suitable conditions mainly depends on the quality of images.

In practice, the methods of binaryzation are chose according to the position of chessman in the images. When the chess position is located in the left and right ends of the image, binaryzation is the Otsu method, and the rest position with the fixed threshold method.

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2.2 Circle Edge and Chessman Center

Hough transformation is an effective method of detection of circle edge from images. But it needs to be advanced because the Hough transformation detects the image circle for a long time. The research in the paper adopts the method of extracting 3 points from radial and longitudinal directions.

On the condition of the clear images, more obvious features can get out as the key points. The experimental results are shown in the figure 2.
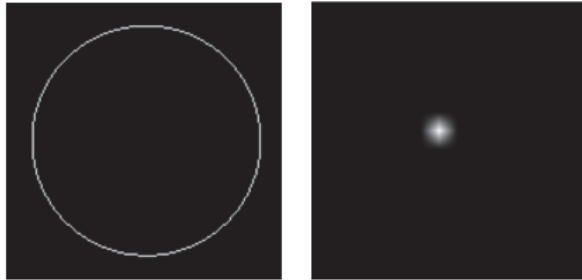

Fig. 2: Circle edge and center

However, it is not easy to accurately find out 3 points in the real process of image extraction. Considering the influence of image noises, the transformation with good robustness is used to find out more points, so as to ascertain the results correct entirely.

Because the chessboard initialization has a plenty of time, the images are processed by the traditional Hough transformation which can improve the correction and accuracy of the initial data. While playing chess games, the advanced Hough transformation is used in order to satisfy the time limitation with data correction and recognition speed.

2.3 Chessman Pixel Statistical Features

The pixel points are extracted from binaryzation image and are processed to compute the circle center with edge refinement. The chessman pixel statistical features are the pixel points in the circle domain around the position of center. The research takes the statistical radius which is 0.95 times to the radius of inner boundary of chessman. The experimental image is shown in the figure 3.

Fig.3: Chessman image

From the statistical data in the experimental results, the values of red chess and black chess are strictly and obviously different. So the features of images can be analyzed to detect chess colors finally. Then classification between red chess and black chess is benefited to enhance the recognition rate. Therefore, pixel statistical features are adopted to obtain the character recognition of chessman.

3 CHINESE CHESS RECOGNITION ALGORITHM
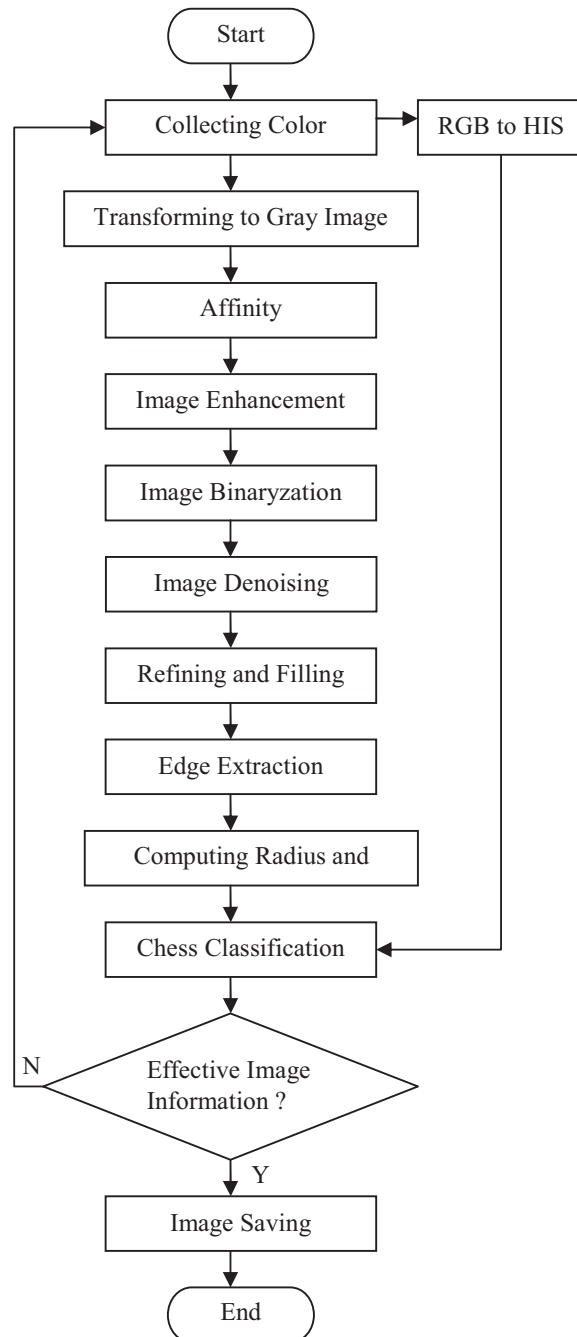
3.1 Initialization

Fig. 4: Workflow Chart of Initialization

The initialization has no limit of time at the beginning, which is the biggest advantage of it. At the same time, correction of initialization is decisively significant for the whole process of the chess game. It is necessary to ensure the correct initialization. According to enough condition of time, the initialization algorithm is designed as the figure 4.

3.2 Recognition of Chess Playing

Algorithm in the chess playing seems to be a duplication of initialization algorithm above with a certain extent. But it cannot repeat the initial process. Because it is lack of an important condition of initialization: the enough running time. The chess playing is required real-time entirely. In view of this reason, it is necessary to adjust and modify the algorithm above. The advanced method of removing redundant information makes the running time reduction. At the same time, the method is correct and effective in the chess playing. The algorithm is designed as shown in the figure 5.
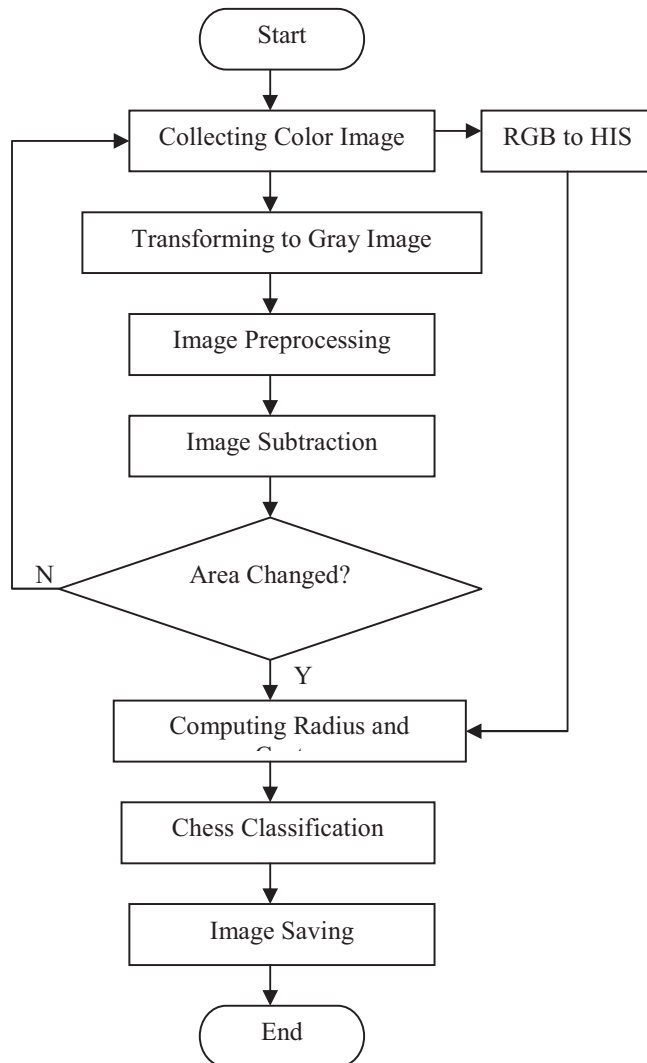
Fig. 5: Workflow Chart of Chess Playing

3.3 Chessman Recognition

Chessman recognition mainly takes two characteristics: saturation and text pixels. First, the circle center can be detected and calculated by Hough transformation. Then, the characters of red and black chessman can be processed and separated respectively. Finally, the text pixels' statistical characteristics can be divided into 32 pieces in two domains using the minimum distance classification method. The chessman recognition algorithm is shown in the figure 6 below.
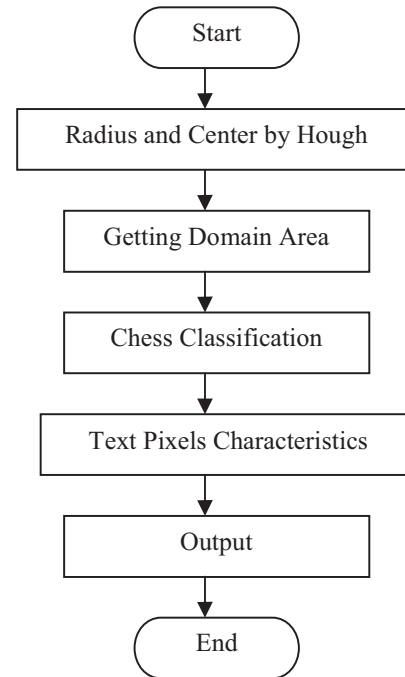
Fig. 6: Work Chart of Chess Recognition

4 EXPERIMENT AND RESULTS IN CHESS GAMES

4.1 Original Image

The original image is accessed as 24bit color, which is collected by camera. The image data is in BMP format or transformed into BMP format. This kind of image format is usually processed in this field. The basis images are treated to obtain some information. The original image of chessboard is shown in the figure 7 as an example.
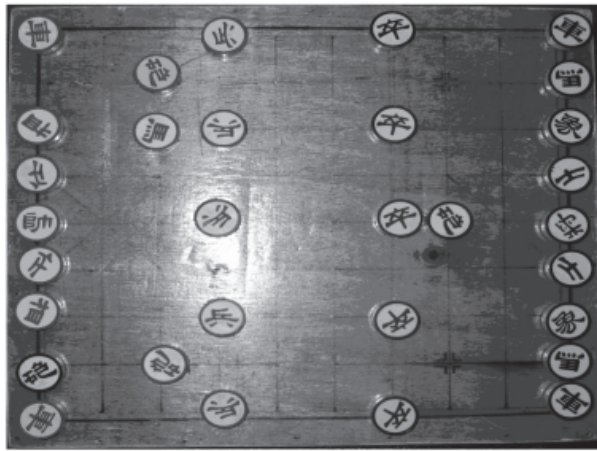
Fig. 7: Original image

4.2 Extraction of Circle Edge and Chess Center

The acquired image edge detection can be acquired only contains the image pieces circular boundary, so it can be for the Hough transforms for the center to create good conditions. By using Hough transform to obtain contains just the center of the image, and the image center is normalized. The gray image using Ostu two value processing method, statistical pixel to obtain refined result font details more obvious image, statistical results to refine gets better. The statistics of pixel can be obtained eigenvector pieces, so as to prepare for the recognition. Pixel single number as a feature vector, the 32 pieces of identification is not too big, but the chess pieces color image classification, can guarantee the correctness of recognition and higher.
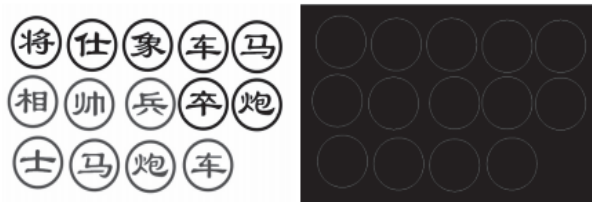

Fig. 8: Circle Edges and Circle Centers

4.3 Chess Recognition images

To identify the pawn, use the Hough transform to get the features and text pixels are two characteristics. The piece is divided into red, can be divided into 32 pieces in two domains using the minimum distance classification method.

Because of the easy to distinguish, so you can choose to distinguish within the scope of their respective color, because the images as the ideal image, it can directly distinguish. The recognition rate can reach 100%.

After processing, the classification will have greater choice, using the minimum distance method can achieve correct classification of chess. The experimental results show that, the recognition rate of the proposed

method achieves above 95%. To improve the image quality, the recognition rate will be further improved.

Fig. 9: Ideal Chessman Recognition

5 CONCLUSION

The research in the paper mainly complete Chinese chess recognition algorithm and experiment the relevant results. The whole process is divided into two steps of game initialization and game playing. Using the Hough transformation can get two obvious features of red-black color and pixel statistical character. According the two features above, the chessman can be classified into 32 pieces in two domains by the minimum distance. Finally the ideal results show that chess recognition rate could reach more than 95%. The advanced and modified methods and skills are proved to be practical and applicative by the experimentation of Chinese chess recognition algorithm provided in the paper.

References

[1] Chen Bo-Nian, Liu Pang-Feng, Hsu Shun-Chin. Aggregating consistent endgame knowledge in Chinese Chess, KNOWLEDGE-BASED SYSTEMS, Vol.34, SI, 34-42, 2012.

[2] Su Pan, Wang Xizhao, Li Yan. Modeling Chess Strategy by Classifier Based on Imbalance Learning and Application in Computer Chinese Chess, Journal of Computer Research and Development, Vol. 48(5), 841-847, 2011.

[3] Jun Tao, 3D modeling of small object based on the projector-camera system, Kybernetes, Vol.41, No.9, 1269-1276, 2012.

[4] Zhang Xiao-chuan, Chen Lian-chang, Li Zu-shu. Research on Computer Game System of Chinese Chess by Introducing Intention, Journal of Chongqing University of Technology (Natural Science), Vol.24, No.10, P: 68-73, 2010.

[5] Tian Cui-hua, Song Xing-liang, Zhu Shun-zhi, Kong Li-xin. Research on the Chinese chess computer game algorithm, Information Technology, Vol.12, P: 5-9, 2011.

[6] Jun Tao, Development and application of functionally gradient materials, International conference on industrial control and electronics engineering, 1022-1025, 2012.

[7] Zhang Bin, Xu Yan-qun. Adaptive Genetic Algorithm Application in the Chess Game System, Computer Program Skill and Maintenance, 122-124, 2012.

[8] Fang HR. Rule-tolerant verification algorithms for completeness of Chinese-chess endgame databases,

COMPUTERS AND GAMES, vol. 3846, proceedings, 129-144, 2006.

[9] Jun Tao, Design and visualization of optical feedback laser based on computer vision, International conference on industrial control and electronics engineering, 1030-1032, 2012.

[10] Wang Quanyu, Liu Siyin. Chinese chess based on Jabber, TECHNOLOGIES FOR E-LEARNING AND DIGITAL ENTERTAINMENT, PROCEEDINGS, Vol. 3942, No.4, 706-710, 2006.

[11] Li Bi-Yi, Chen Chun-Hua, Su Kuo-Lan, Guo Jr-Hung. Development of the searching algorithm based Chinese chess game, ICIC Express Letters, Vol. 6, 245-253, 2012.

[12] Jun Tao, Face reconstruction based on camera-projector system, International conference on industrial control and electronics engineering, 1026-1029, 2012.

[13] He Yulin, Wang Xizhao, Fu Tingting. A combined position evaluation function in Chinese chess computer game, Lecture Notes in Computer Science, v 7420, p 31-50, 2013.

[14] Liu Yanli, Zhang Heng, Fu Ping. A hybrid game-tree search algorithm for playing chess, Journal of Computational Information Systems, v 8, n 14, p 5803-5811, July 15, 2012.

[15] Ban Yameng, Zhao Yuepeng. Algorithm research on online game of Chinese chess, Proceedings - 2012 International Conference on Computer Science and Service System, CSSS 2012, p 1659-1661, 2012.