Neurocomputing 120 (2013) 310–317

Contents lists available at ScienceDirect

Neurocomputing

journal homepage: www.elsevier.com/locate/neucom

Noncooperative bovine iris recognition via SIFT

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ARTICLE INFO

Article history:
Received 8 December 2011
Received in revised form
5 August 2012
Accepted 22 August 2012
Available online 10 April 2013

Keywords:
Iris recognition
SIFT
Active contour
Feature vocabulary
Noncooperative iris

ABSTRACT

Iris biometry has been widely used to recognize an individual in a natural and intuitive way. Conventional iris recognition systems transfer iris images to rectangle using polar coordinate after accurate segmentation, and have performed very well on accurate data. However, bovine iris images are usually irregular with respect to inactive participant, and the conventional methods cannot achieve high accuracy and true rotation invariance. In this paper, a new scheme is proposed based on scale invariant feature transform (SIFT) and bag-of-features. Firstly, region-based active contour is used to detect the inner boundary. Secondly, SIFT method is applied to detect the keypoints in the iris image, and points located in pupil region are removed. Then, feature vocabulary is constructed, and histogram representation for each iris image is generated. Finally, histogram distance is adopted for the matching test. Experimental results are provided to show the effectiveness and potential of developed noncooperative iris recognition.

1. Introduction

Biometric is a measureable physical characteristic which is much more reliable than passwords, such as face, fingerprint, hand geometry, iris, retinal, and vein. Biometric methods based on the pattern of the iris are believed to allow very high identification rate, and there has been an explosion of interest in iris biometrics in recent years [1]. The representative works in human iris recognition are presented by Daugman [2] and Ma et al. [3], and both iris recognition systems developed in their works have been commercialized in airport, bank and coal industry for security. Iris recognition technology has also been applied to animal individual identification. Suzaki et al. [4] introduced an iris recognition system for horse race, and Zhao et al. [5] applied bovine iris code to tracking and traceability system, which aims to ensure food security.

A typical iris recognition system usually includes some vital steps, such as iris segmentation, iris normalization, feature extraction, and matching test. For cooperative human iris images, the inner and outer boundaries are very close to concentric circles. Therefore, it is beneficial to transfer the segmented iris parts into rectangular area using polar coordinates [6–10].

Many different feature extraction techniques have been developed to analyze the iris. The most common and well-studied technique is to produce a binary representation using some filters. Daugman [6] proposed two-dimensional Gabor filter to extract the texture from the normalized iris image. Yao et al. [11] used modified Log-Gabor filters to generate the binary code, which was helpful to eliminate the impact of background brightness, while Ma et al. [7] employed a dyadic wavelet transform of a sequence of 1-D intensity signals around the inner part of the iris to create a binary iris code. Moreover, Monro et al. [8] applied 1-D DCT to the overlapping image patches to generate a binary iris code by calculating the differences between the DCT coefficients, while Sun et al. [12] convolved the gradient vector field of an iris image with a Gaussian filter to computer the local orientation at each pixel, and then quantized the angle into binary code. Other researchers used various wavelets to extract the feature pattern, but the output format was different. Boles and Boashash [13] treated the concentric circular bands as 1-D intensity signals, and zero-crossing representations were compared to identify the iris image. Ma et al. [3] used a variant of the Gabor filter at two different scales to analyze the iris texture and FLD (Fisher linear discriminant) to matching test. Also, Sun et al. [14] analyzed the iris features using local binary pattern (LBP), and compared the LBP histogram of the divided blocks to do the matching test.

As image rotation may influence the performance of iris recognition system, the conventional methods of iris recognition achieved approximate rotation invariance mainly by circularly shifting the binary patterns. With this circularly shifting, the complexity of these methods is increased, and the error rates may substantially increase while the rotation scale is beyond the certain scope. Several algorithms have been developed to achieve much more precise rotation invariance. Du et al. [15] used the grayscale-invariance local texture patterns to generate a one dimensional signature for each image, and then output the top n

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0925-2312/$ - see front matter
http://dx.doi.org/10.1016/j.neucom.2012.08.068

closest matches. The work in Huang et al. [16] developed a bank of non-separable orthogonal wavelet filters to capture the characteristics of the iris and Markov random fields to capture rotation invariant iris features. Proenca and Alexandre [17] designed an iris classification method that divides the normalized iris image into six regions, makes an independent feature extraction and comparison for each region, and combines each of the dissimilarity values through a classification rule. Yang et al. [43] proposed to select key points using 2D Gabor filter, and compare the two iris images by the mean of Euclidean distances between the corresponding key points.

Recently, using gradient-orientation-based feature descriptor, such as scale invariant feature transform (SIFT) [18], histogram of gradient (HOG) [19], and speed up robust features (SURF) [20] is a trend in object recognition [21–28]. While the captured iris images are less-than-ideal due to individual activities and other factors, and it is difficult to get the accurate iris inner and outer boundaries using conventional method, Belcher and Du [29] proposed a region-based SIFT approach to noncooperative human iris recognition. Instead of accurate segmentation and polar transformation in conventional iris recognition system, they divided the annular iris area into three regions: left, right and bottom. Then, they got the SIFT keypoints of the iris image in these three regions for classification.

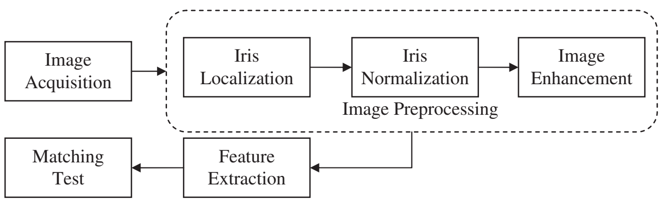

Fig. 1. Framework of conventional iris recognition.

There are significant differences between human iris and bovine iris. Normally, human iris images can be captured clearly and cooperatively with human active participation. Conversely, bovine iris images are usually noncooperative captured due to the cattle inactive participation. Scale variance and rotation variance exist in bovine iris images, and the outer boundary of bovine iris is difficult to be detected. Therefore, a method that performs well on noncooperative bovine iris database is desired. Considering that SIFT descriptor achieves a higher performance over SURF descriptor in rotation situation [30], we propose a new scheme based on SIFT and bag-of-features [31,32] to noncooperative bovine iris recognition. In the new scheme, we use the region-based active contour model to segment the iris inner boundary, and SIFT to detect the keypoints. After removing these keypoints located in the inner boundary, bag-of-features is adopted to classify iris images.

The remainder of the paper is organized as follows. In Section 2, a new iris recognition framework based on SIFT is introduced. The procedure of the recognition method is presented in Section 3. The experimental results are provided in Section 4, and the paper is concluded in Section 5.

2. Framework

Conventional iris recognition framework consists of image acquisition, iris segmentation, iris normalization, iris enhancement,

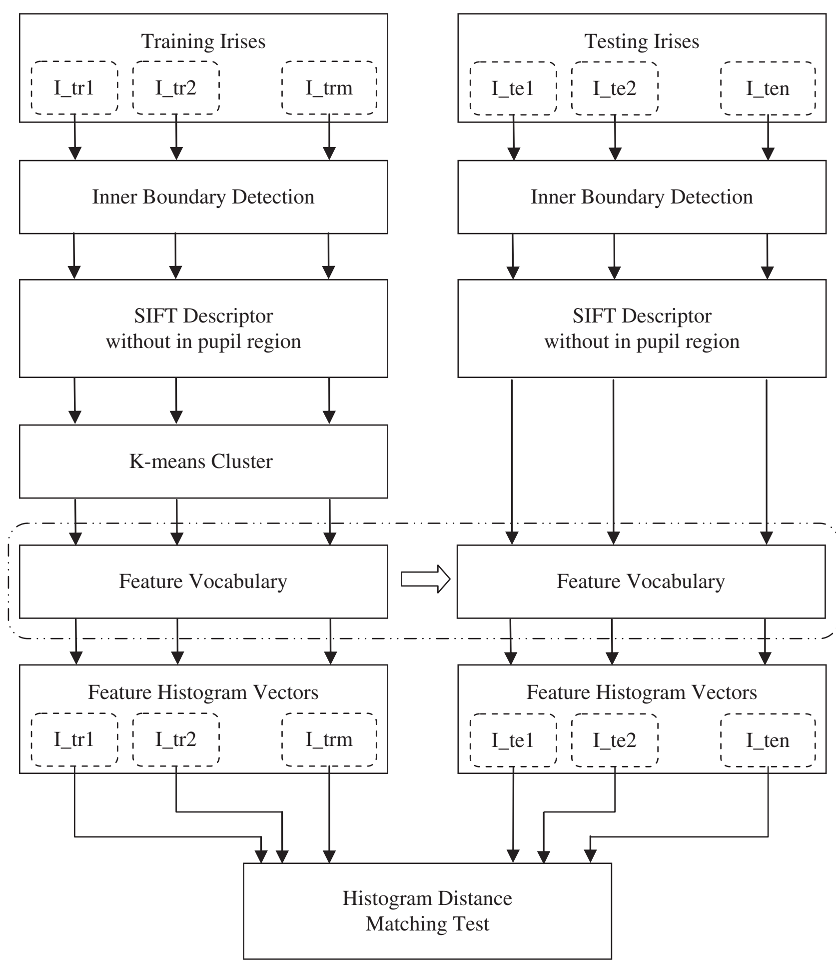

Fig. 2. Framework of proposed iris recognition.