Pattern Recognition Letters 101 (2018) 44–51

Contents lists available at ScienceDirect

Pattern Recognition Letters

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

Optimized robust multi-sensor scheme for simultaneous video and image iris recognition

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ARTICLE INFO

Article history:
Received 8 May 2017
Available online 21 November 2017

Keywords:
Iris multi-sensor scheme
Image quality evaluation
Segmentation fusion

ABSTRACT

Today, recognition of people by the iris is widely used when secure identification of a person is needed. Iris biometric identification systems should be able to work with heterogeneous iris images captured by different types of iris sensors. However, stable iris recognition systems that are effective for all types of iris cameras are not readily available. These systems should also be able to work simultaneously with images and video frames. In this work, we present an optimized robust multi-sensor scheme with a strategy that combines video frame quality evaluation with robust fusion methods at segmentation level for simultaneous video and image iris recognition. As part of the proposed scheme, we presented a Modified Laplacian Pyramid-based fusion method at segmentation stage. Experimental results on the Casia-V3-Interval, Casia-V4-Thousand, Ubiris-V1 and MBGC-V2 databases show that the optimized robust scheme increases recognition accuracy, and is robust to different types of iris sensors and able to simultaneously work with video and images.

1. Introduction

At present, to recognize a person by the iris texture constitutes an important biometric application. Since the 1990s, iris texture has been used as a phenotypic feature to determine a person distinctiveness [1]. The success of a biometric application is related to a good iris texture image quality [2]. In this sense, it is important to pay attention to the main source of the image degradation quality such as the defocus and blur conditions. They occur when the point of view of an object is out from the depth of field of an image. To avoid this issue, in commercial applications the user must cooperate with the iris image acquisition system by approaching up to a certain distance (less than 14 inches) to be recognized [3].

Other existing problem is the time consuming during acquisition. Furthermore, just one user can be recognized and the user must interact with the system. One solution to the later issues is a video-based iris recognition system from one or multiple cameras (sensors). It allows a distance, quick multiple user image acquisition. However, it is important to note that acquire an optimal quality video is a challenging problem. This quality varies with the type of iris camera used to capture the image. The optical lens, illumination wavelength and the resolution are some parameters of the camera sensor, which determine the iris texture dissimilarities.

Some fusion approaches have shown that it is useful to combine the segmentation and the normalization information from multiple sources in contrast with combining outcomes of biometric feature extraction or comparison algorithms [4–7]. One example is the direct linear discriminant analysis (DLDA) combined with a wavelet transform to extract iris features. Their results showed that recognition performance increases dramatically [8]. Other work formed one average image based on different frames from an iris video, having noticed that signal-level fusion achieves comparable to any individual frame [9]. In our previous works [10], we faced the image degradation by image fusion techniques. These are proven methods to increase the iris image texture quality by obtaining a higher biometric information compared to an individual iris image texture. The results show a better recognition performance and reduction of error rates. On the other hand, other authors use the boundary curves information to evaluate two fusion algorithms using the Casia-V3-Interval database [5]. In [6] three automatic methods to segment the iris region were experimented. After the normalization step, the three segmentation outputs are combined into one image. Base on that, in our previous work we

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https://doi.org/10.1016/j.patrec.2017.11.012
0167-8655/

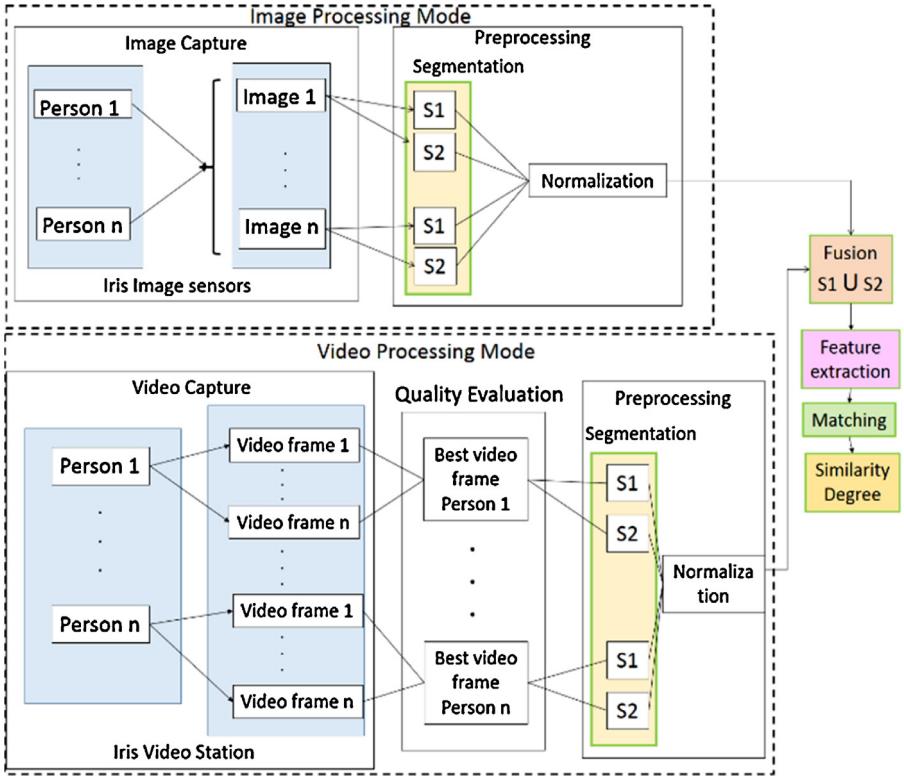

Fig. 1. Scheme of the proposed system.

compared seven fusion methods and fused normalized iris templates using the principal component analysis (PCA) method [10]. We demonstrated experimentally that the recognition accuracy for representative algorithms increases efficacy in diverse benchmark iris databases. The comparison presented in [10], shows that PCA method has the best performance on images taken under unconstraint conditions.

In recent years, some efforts of iris biometric community have focused on the problem of the acquisition of iris images from multiple sensors (cross sensor). In [10] we experimented robust fusion methods from iris verification scheme under cross sensor conditions. In [11] an optimization model of coupled feature selection for cross-sensor iris recognition was presented. In [12] the concept of heterogeneous iris recognition. The cross-sensor iris images and cross-quality were discussed. Nevertheless stable iris recognition systems that are effective for all types of iris cameras are not readily available.

In this work, we proposed an iris recognition multi-sensor scheme. The novelty of our proposal is the strategy of combining video frames quality evaluation and a robust fusion method at segmentation level for simultaneously video and image iris recognition. As part of the proposed scheme, at segmentation level, we present a Modified Laplacian Pyramid based fusion method.

The remainder of this paper is organized as follows: Section 2 presents the proposed scheme for image and video iris verification including a new fusion method and describes the experimental design; Section 3 presents the results and discussion of the experimental evaluation; finally, Section 4 concludes this work.

2. Image and video iris verification scheme

In this work, we present a new scheme of an iris verification system (Fig. 1), which is able to identify a person by simultaneous capture of eye images or video frames from different sensors. The novelty of our proposal lies in the combination of a series of steps that involve processes of simultaneous capture of eye images and video, the evaluation of their quality, segmentation and their fusion using a new robust method. This scheme ensures no dependence on the type of captures used (iris images or iris video sequences).

Iris segmentation refers to the task of automatically locating the annular region delimited between the pupillary and limbic boundaries of the iris in a given image. Recent results show that iris segmentation under non-cooperative environment still a very challenging problem [13,14]. Iris recognition in a non-cooperative environment refers to automatically recognition at-a-distance and dealing with several factors that deteriorate the quality of an iris image when it is captured, such as occlusions, blur, off-axis, specular reflections and poor illumination, among others.

Because there is not a segmentation method that is robust to all possible capture scenarios of iris images, in recent years, some authors have focused on the fusion at segmentation level with the aim to improve accuracy of an iris recognition system. The segmentation fusion combines the information of several independent segmentations from a same image. This merged segmentation contains more information than each independent image.

2.1. Image processing mode

This mode uses iris images as inputs (Fig. 1). The process begins when a subject approach to a capture device and the system acquires one or more iris images using the same type of sensor or multiple sensors simultaneously. Secondly, the system uses at least two segmentation algorithms to localize and extract the inner and outer iris boundaries. In this work as an experiment two state-of-the-art algorithms were used. These algorithms were selected from the results of the evaluations performed by us in previous works [10]. Then it normalizes the segmentation outputs by a coordinate transformation using the classical Daugman's algorithm [1], where