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Iris matching by means of Machine Learning paradigms: A new approach to dissimilarity computation

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ABSTRACT

This paper presents a novel approach for iris dissimilarity computation based on Computer Vision and Machine Learning. First, iris images are processed using well-known image processing algorithms. Pixels of the output image are considered the input of the previously trained classifiers, obtaining the *a posteriori* probability for each of the considered class values. The main novelty of the presented work remains in the computation of the dissimilarity value of two iris images as the distance between the aforementioned *a posteriori* probabilities. Experimental results, based on the testing dataset given by the MICHE II Challenge organizers, indicate the appropriateness of the deployed method for the iris recognition task. Best results show a precision score above 90% even for iris images of new individuals.

1. Introduction

Biometric services are increasingly addressing the need for reliable authentication methods. They are required in everyday tasks such as micro-transactions, insurance entitlements and payments. Furthermore, the availability of these services in mobile platforms, which are ubiquitous and omnipresent, exalts the benefits of these technological solutions.

More precisely, iris recognition methods are essential for these applications due to the enormous number of discriminative features of the iris. As stated in [1], iris recognition can provide the basis for truly non-invasive biometric solutions as it is highly distinctive and stable regardless of the age of the user.

Even though, discriminative features are usually affected by the acquisition process of iris images and consequently adopted solutions are not always as precise as required. Therefore, user recognition processes require new technological approaches to overcome these limitations.

Aligned with the exposed needs, this paper presents a novel approach that combines image processing and classification to increase the accuracy of the recognition of iris images. The main contribution relies on the computation of the dissimilarity value that determines if a pair of iris images belongs to the same person or not. To sum up, the main concepts of the proposed approach are the following:

- Machine Learning and Computer Vision are combined for iris image classification: first, images are processed by means of diverse image processing algorithms in order to highlight the most discriminative features of the irises. Pixels of the processed image are directly considered the values of the feature vector and thus, the input of the classifiers.
- Computation of the dissimilarity value of two iris images as the distance between the two *a posteriori* probability vectors that are the output of the classification process.

MICHE dataset [2] is used to evaluate the performance of the proposed method. It contains iris images captured using three different mobile devices, two of which are mobile phones. Besides, this dataset has been proposed by the Mobile Iris Challenge Evaluation (MICHE-II), now part of the 23rd International Conference on Pattern Recognition (ICPR). This challenge is a new edition of the MICHE-I contest and its main objective is to collect novel and suitable techniques for iris recognition in images captured by mobile devices.

The rest of the paper is organized as follows: Section 2 presents the related work in the area of mobile biometric recognition and more precisely iris recognition using mobile devices. Section 3 describes the proposed approach and Section 4 summarizes the experimental setup. Section 5 gives the experimental results in order to show the suitability of our method for the presented challenge.

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Finally, in Section 6 conclusions of the work and the future work are presented.

2. Related work

Biometric recognition is the automated identification of individuals based on their behavioral and biological characteristics. As stated in [3] a biometric system is essentially a pattern-recognition system that recognizes an individual based on a feature vector derived from specific biological or behavioral characteristics.

There are several biometric recognition methods such as the ones presented in [4]; some of them are already implemented in real systems, while others are still under research.

Reliable automatic person identification has long been an attractive goal. For this purpose, as stated in [5,6,7], iris recognition is one of the major biometric recognition methods due to the reliability of iris patterns used in visual recognition of persons. The iris has the great advantage that its pattern variability among different persons is enormous and even more, it is stable over time.

Iris recognition systems consist mainly of four different steps [8]: image acquisition, image preprocessing, feature extraction and pattern classification. The phase-based method presented by Daugman [9] was one of the first commercial solutions. Later, some other authors such as [10] and [11] developed similar ideas.

The implementation of new modalities based on thermal imaging are considered possible future solutions for iris recognition systems [12]. More concretely, the fusion of the information obtained from images acquired using different types of sensors is being considered as one of the most challenging research directions for pattern recognition systems. For example, in [13] and [14], images from different sensors are combined to increase the accuracy of person's detection.

Another open issue in biometric recognition is the need of evolving the image acquisition step. Biometric identification devices must be designed for more intuitive, faster and lighter operations, and therefore, research is moving forward to the use on images captured from mobile devices. A complete study of these solutions is presented in [15].

3. Proposed approach

As previously mentioned, the main objective of the presented approach is to determine the dissimilarity between two iris images in order to consider if they belong to the same person or not. To do that, this work combines the extraction of image features through the application of diverse Computer Vision algorithms with the use of Machine Learning techniques. There are two main phases: training phase where classifiers adapted to the concerning problem are built testing phase where two iris images are compared computing their dissimilarity value using the output of the classifiers.

During the training phase, classifiers (see Section 3.2 for more detailed information) are built using MICHE II dataset training images. First, images are processed using different image transformations and the pixels of the processed image are directly considered the input vector of the classifiers. Each image has associated a class that identifies the individual it belongs to. Taking into account this class, classifiers learn about the distinctive features of individual's iris images. Training process is totally blind for the user.

During the testing phase, as well as in the previous training phase, iris images are processed by pairs using different image processing algorithms to extract characteristics that are relevant for the identification of iris patterns. Afterwards, each pixel vector is classified to obtain the *a posteriori* probability vector used for the computation of the dissimilarity value. If this distance value stands under a predefined threshold, two images are considered of the same person.

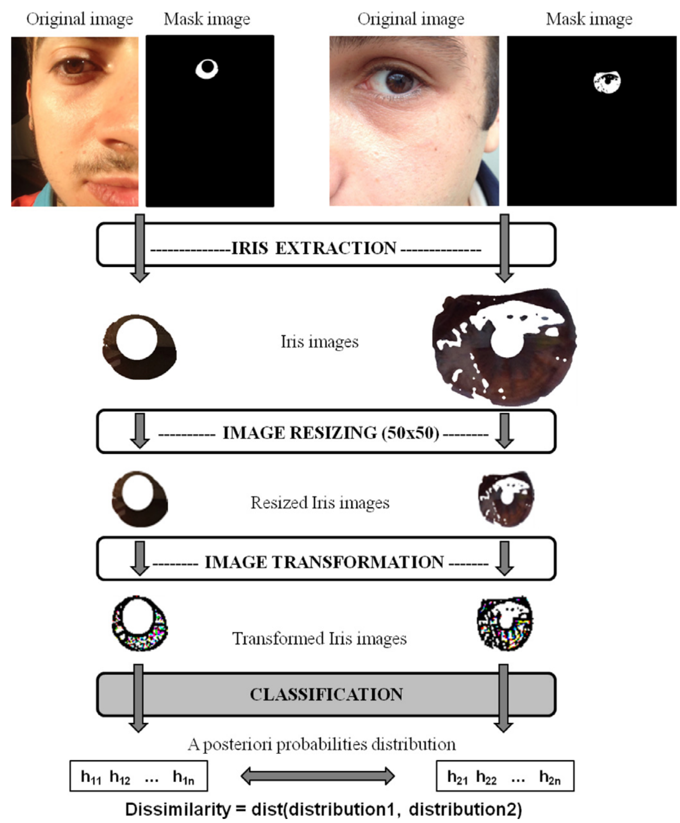

Fig. 1. Steps of the comparison of two iris images.

In more detail, the main steps of the testing process can be summarized as follows (see Fig. 1):

- Starting from a pair of given images and their masks, extract the images corresponding to the iris.
- In order to obtain the same number of attributes to be inserted in the classifiers, resize iris images to a fixed size (for instance, 50×50 pixel size).
- Apply the image transformation used in the learning phase of the classifiers to both images.
- Classify both images using the induced classifier, obtaining not only the winning class, but also the *a posteriori* probability distribution of all considered classes.
- Compute the dissimilarity between both iris images as the Manhattan distance of the two probability distributions.
- Determine if two iris images belong to the same person using a threshold value.

In the following sections a short revision of the image processing process, applied classifiers and dissimilarity computation is presented.

3.1. Image processing

A bank of filters with large variability is applied to highlight different characteristics of iris images (see some examples in Fig. 2). To achieve this, we have selected some of the most common transformations in order to show the benefits of the proposed approach making use of simple algorithms. Table 1 presents the transformations used as well as a brief description of each of them. It is worth to point out that any other Image Processing transformation could be used apart from the selected ones.