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Original Research Article

A novel phase-intensive local pattern for periocular recognition under visible spectrum

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ABSTRACT

The article proposes a novel multi-scale local feature based on the periocular recognition technique which is capable of extracting high-dimensional subtle features existent in the iris region as well as low-dimensional gross features in the periphery skin region of the iris. A set of filter banks of different scales is employed to exploit the phase-intensive patterns in visible spectrum periocular image of a subject captured from a distance in partial non-cooperative scenario. The proposed technique is verified with experiments on near-infrared illumination databases like BATH and CASIA-IrisV3-Lamp. Experiments have been further extended to images from visible spectrum ocular databases like UBIRISv2 and low-resolution eye regions extracted from FERETv4 face database to establish that the proposed feature performs comparably better than existing local features. To find the robustness of the proposed approach, the low resolution visible spectrum images of mentioned databases are converted to grayscale images. The proposed approach yields unique patterns from these grayscale images. The ability to find coarse-to-fine features in multi-scale and different phases is accountable for the improved robustness of the proposed approach.

1. Introduction

Token-based and knowledge-based authentication are two principal modes of personal access that evolved with the advent of automated secured systems. For token-based authentication, a user needs to possess a unique token like swap-card, ATM card to prove his authenticity to a system. For a knowledge-based authentication, a user needs to know a unique piece of information like password or PIN to prove his authenticity. Both the token and knowledge are prone to proofing attack. Further, a user can easily forward the token or the knowledge to unauthorized user(s) to access the system which leads to compromising the security of the system. In contrast to these two modes of authentication, a biometric system authenticates a user through his/her trait which the user uniquely bears. Fig. 1 illustrates a working model of a biometric system, which comprises three sequential modules: sensor and preprocessing module, local feature extraction module, and matching module. When a new user comes, the sensor and preprocessing module enrols the subject by capturing his trait, extracts the region of interest, processes the region to make it suitable for use, and stores the processed region (template) in database. When a returning

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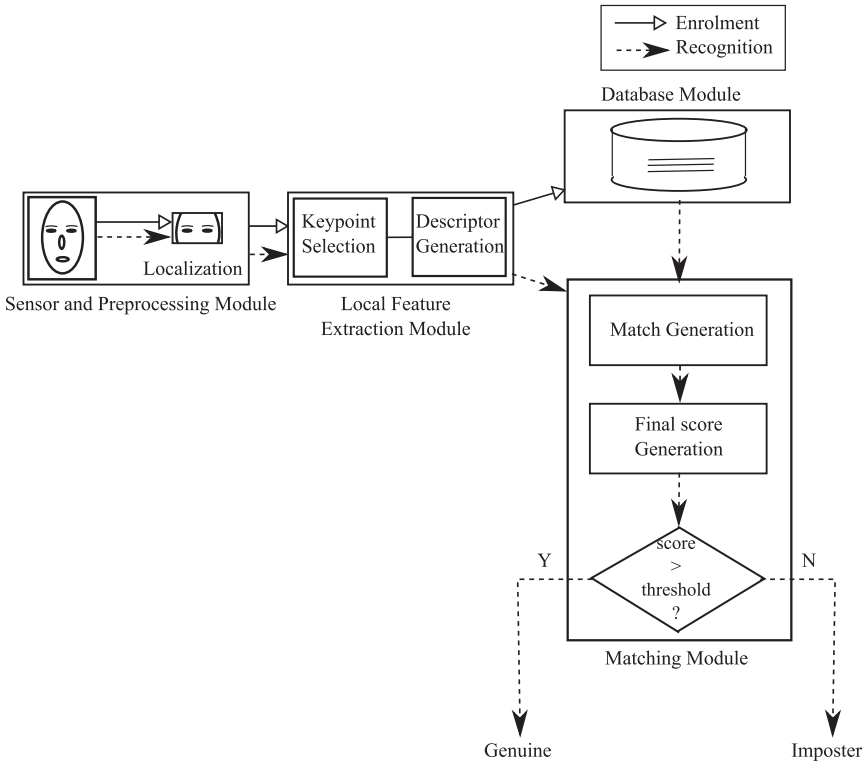

Fig. 1 – Working model of ocular biometric system.

user triggers a live query giving his identity information and a biometric print to validate the claimed identity, the system matches the print with the print stored in the database corresponding to only the subject claims himself to be, and not with all prints in the whole database. If the matching score is higher than a pre-chosen threshold, the system authenticates the subject, else marks the live subject as imposter. This mode of authentication is termed as verification. In contrast, for identification mode, the user only gives his biometric print to the subject and does not claim his identity. The biometric system matches the live print with all prints stored in database and generates scores for each match. The system identifies the subject to be the user with whose stored print the live query yields highest match score. It is evident that identification systems are more time-consuming as well as more prone to false decisions than verification systems. Hence the feature extraction technique and matching method used in a biometric system should be very robust and accurate to work in identification mode. Literature record comparative success of local features over failure of global feature toward working in this scenario.

It is also an important concern to choose a proper biometric trait for robust and accurate performance of a biometric authentication system. Physical traits are the traits that human possess in biological parts of the body like face, ocular region, lip, ear, fingerprint, palmprint, knuckle, etc. Behavioral traits are traits that human express uniquely through behavior like gait, signature, etc. Particularly it is noticed that face is the most-feature dense region in the human body which has made it a primitive candidate for natural way of recognition. Automated biometric recognition systems developed earlier also established that the region around the ocular portion of the human face is highly unique for recognition purpose. Typically there are skin portion and eye portion that constitute the ocular region, named as periocular (periphery of ocular) region. Fig. 2 depicts the important features existent in the periocular region of a subject. Three primary contributors to make periocular region unique for every person are: (a) flowery pattern in the iris region, (b) blood vessels in the sclera region, and (c) texture in the skin region around the eye. Iris pattern has high dimensional subtle features which can be extracted from near-infrared (NIR) images, and not prominent in visual spectrum (VS) images. Rather uniqueness of blood vessels and skin texture are low dimensional gross features that are prominent in VS images. Eye images obtained in VS are not suitable for recognition through iris features as high dimensional features are missing in VS. However some subtle pattern exists in VS eye image that can be extracted and employed for recognition. This article attempts to describe a

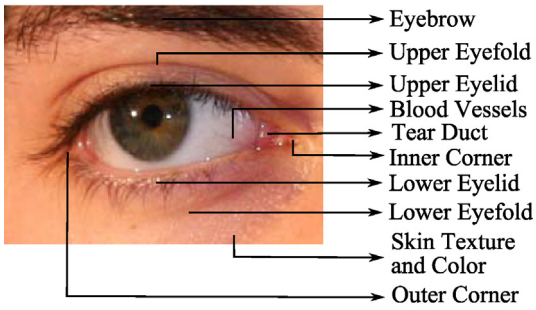

Fig. 2 – Important features from a periocular image.