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Learning Liveness Detection and Classification of Iris Images: A Detailed Survey

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Abstract - **Iris recognition is most often used for security related applications and mainly suffer from illegal attacks. So an iris recognition system that identifies the fake iris image are much needed. In this paper, we present a novel iris texture representation method called Hierarchical Visual Codebook (HVC) is proposed to encode the texture primitives of iris images and are used for identifying the fake and original iris images. Here we use the Bag-of-words models for statistical feature representation of iris for classification. For accurate and sparse representation of iris texture HVC make use of both locality-constrained linear coding and vocabulary tree. This helps in better visual representation of iris texture, Vector Quantization and the removal of coding errors.**

Index Terms- **Bag-of-Words models, Hierarchical Visual Codebook, iris liveness detection, race classification Support Vector Machine.**

I. INTRODUCTION

Iris recognition is a method of biometric identification that make uses mathematical pattern-recognition techniques on images of one or both of the irises of an individual's eyes, whose complex iris patterns are unique, stable, and can be seen from some distance. Iris texture is generally highly discriminative between eyes and stable over individual lifetime, which makes iris particularly suitable for personal identification.

The eye is a slightly asymmetrical globe, about an inch in diameter. The front part of the eye includes the sclera the white part, iris the pigmented part an annular part between the pupil which appearing black in an image and the white sclera. Iris has an extraordinary structure and provides many different characteristics such as coronas, stripes and freckles [1]. These visible characteristics, which are generally called the iris texture, are unique to each subject. Color of an eye focus on the color of the iris, which can be green, blue, or brown. In some cases it can be a combination of light brown, green and gold. Other components of an eye include optic nerve, sclerotic coat, lens, aqueous humour and vitreous humour.

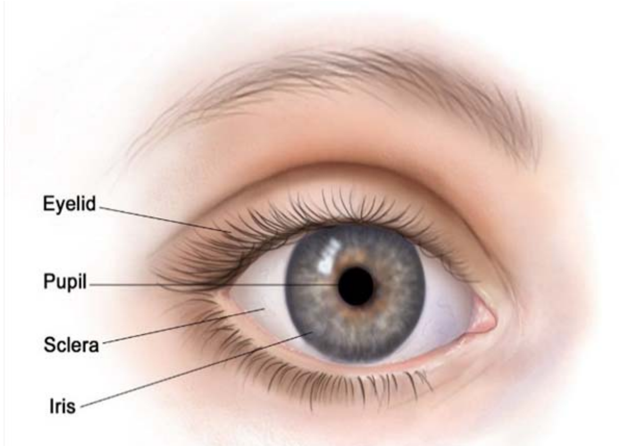


Figure 1. Eye Image

Iris recognition has become a hot research topic, is most often used for security related applications like national ID card, border control, banking, etc. The ring-shaped region of human eye is the iris, with rich texture information on infrared illumination. Iris texture is represented as a genotypic biometric pattern and stable during life so that iris recognition provides a reliable method for individual authentication. This paper propose a general framework to protect iris recognition systems from fake iris attacks. Here a novel pattern representation approach, named hierarchical visual codebook (HVC), is proposed for fake iris detection. Iris image classification aims to classify an iris image into three kinds of application ie. iris liveness detection, race classification, coarse-to-fine iris identification.

The paper later explains about the literature survey in the Section II. The Section III gives the descriptions of the methodology that have been used. Later in the Section IV there is the description of the dataset used. Finally in Section V we stops with the conclusion.

II. LITERATURE SURVEY

This paper defines a new scheme for iris recognition from an image sequence. First the quality of each image in the input sequence is assessed and a clear iris image is selected from such a sequence for subsequent recognition. A bank of spatial filters, whose seeds are suitable for iris recognition, is then used to capture local characteristics of the iris in order to produce discriminating texture features [1]. Using a nonparametric statistical method, extensive performance comparison of existing systems for iris recognition is conducted on a reasonably sized iris database. Here four basic module ie image quality assessment and selection, Pre-processing, feature extraction and matching included in an iris recognition algorithm.

Another method propose an ordinal measures for iris feature representation with the aim of describing qualitative relationships among iris regions rather than detailed measurements of iris image structures. Such a representation may drop some specific information of the image, but it achieves a good trade-off between distinctiveness and robustness. Ordinal measures are central features of iris patterns and largely invariant to illumination changes. The compactness and low computational complexity of ordinal measures facilitate highly efficient iris recognition [2]. Ordinal measures describes a general concept for image analysis and many alternates can be derived for ordinal feature extraction. A multilobe differential filters is developed to obtain ordinal measures with flexible intralobe and interlobe parameters like location, distance, scale and orientation. This measure encrypt quality information of visual signal rather than its quantitative values. For iris recognition, the complete information related with an iris pattern can vary due to the change under different illumination settings. Ordinal measures among adjacent image pixels or regions that shows some stability with such changes and reflect the intrinsic properties of iris. In iris patterns, microstructures provides sharp intensity variations in iris images, which constitute several high contrast and stable ordinal relations between iris regions. Therefore, ordinal measures are capable of representing the distinctive and robust features of iris patterns.

Iris complex pattern can contain many unique features such as arching, ligaments, ridges, crypts, rings, corona, freckles, furrows and a zigzag collarette. Iris color is determined mainly by the density of melanin pigment in its forward layer and stroma, with blue irises from an absence of pigment. This paper clarifies how the algorithms execute and presents new facts on the statistical properties and singularity of iris patterns based on 9.1 million comparisons [3]. Here frequency analysis is used for detecting printed iris image.

. Fake iris detection is to detect a fake or forgery input iris image. A new method of detecting fake iris attack based on the Purkinje image is implemented by calculating the theoretical positions and distances of the Purkinje images based on the human eye and the performance of fake detection algorithm could be much enhanced by such information [4]. The FAR describes False Acceptance Rate for accepting forged iris as live one and FRR describes False Rejection Rate of rejecting live iris as fake one was 0.33%. A liveness detection scheme for iris based on quality related measures is presented. The novel anti-spoofing technique have a high potential as an effective protection scheme against direct attacks [5]. The potential of quality assessment is analysed to identify real and fake iris samples acquired from a high quality printed image. Quality assessment has been more often explored as a way to detect spoofing attacks. A similar strategy to the one proposed has already been used for spoofing detection on fingerprint based recognition systems, achieving remarkable good results. Furthermore, some quality based features have been used separately for liveness detection in traits such iris or face. Presented method is tested on an iris database where it has proven its high potential as a counter measure to prevent spoofing attacks.

In iris recognition systems detection of textured contact lens is an important problem in avoiding spoofing. A number of approaches are based on computing texture features from the iris image and training a classifier to differentiate the case of no textured lens versus textured lens [6]. Some iris biometrics systems also claim for detecting the presence of textured contact lenses to avoid a spoofing attempt. This paper has considered images obtained from more than one iris sensor. In practice the algorithms developed with image data from a sensor may be transferred to work with another sensor. In many applications, it is not realistic to assume that the algorithm have been developed using image data from every types of contact lenses. This paper proposes a potential textured lens detection algorithm and provides special attention to the potential issues with textured lens detection systems.

III. METHODOLOGY

In this paper we propose a novel iris pattern representation method namely hierarchical visual codebook (HVC) to encode the distinctive and robust texture primitives of genuine and fake iris images. This mainly includes four modules: iris image pre-processing, low level visual feature extraction, statistical iris image representation based on HVC model and iris image classification.

1. *Iris Image Pre-Processing*

In iris image pre-processing the segmentation of the valid iris texture regions from the original iris images and normalization of the ring-shape iris regions into a unified coordinate system is done.

2. *Low Level Visual Feature Extraction*

The low level feature extraction in iris image classification is used to obtain the common components of texture primitives across different iris images, to build a statistical representation. The purpose of Low level feature extraction in iris recognition is to find the unique local features specific to each subject. In this paper, we present a dense SIFT descriptors as the low level features for iris image classification. Firstly, the gradient information encoded in SIFT provides a generic description of local regions for all iris images. Secondly, the histogram derived. Thirdly, the SIFT descriptors are densely extracted from the normalized iris images. Finally, 913 SIFT descriptors can be obtained from each normalized iris image as the statistical texture features for iris image classification.

3. *Statistical Iris Image Representation Based On HVC Model*

Vocabulary Tree is the best solution for large-scale visual vocabulary and LLC is an effective visual coding method. So a novel visual texture representation called Hierarchical Visual Codebook (HVC) is proposed to inherit the advantages of both Vocabulary Tree and Locality-constrained Linear Coding. HVC method includes two phases ie. codebook learning phase and feature coding phase. These two phases are designed based on the characteristics of iris texture.

4. *Iris Image Classification*

Iris image classification becomes a standard pattern recognition problem and well established classifier such as SVM can be used to predict the class labels. SVM support supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis.

IV. DATASET DESCRIPTION

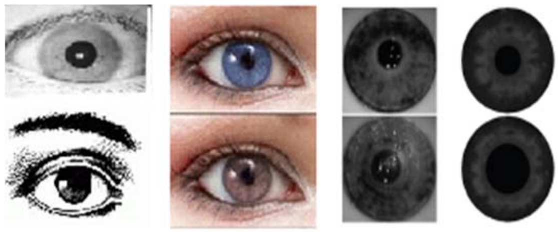
We mainly use three multi-race iris image dataset for the experiments. The dataset used are CASIA, ND, Clarkson.

The CASIA multi-race iris image database [7] was collected with a handheld iris device OKI irispass-h [8].It contains 2,400 iris images of 30 Chinese subjects and 30European subjects, i.e., 20 images/eye. Randomly selected 500 Asian iris images and 500 non-Asian iris images are used as the training set and all the remained iris images are used as the testing set.

ND-CrossSensor-Iris-2013 Dataset is a large iris image database and it has race label information for each image [10]. There are two iris devices (LG2200 and LG4000) used to collect ND-CrossSensor-Iris-2013 Dataset. To keep the balance between the iris images of Asian and non-Asian subjects, 8,188 iris images of 411 Asian subjects from CASIA-Iris-Lamp are added into the LG2200 and LG4000 dataset [11]. In each dataset, randomly selected 2,000 Asian iris images and 2,000 non-Asian iris images are used as the training set and all the remained iris images are used as the testing set.

The Q-FIRE database collected by Clarkson [12] has iris images captured at a distance and race label information is provided for each subject. However, this database does not have enough iris images of Asian subjects so we add some iris images in the CASIA-Iris-Distance [11] to constitute a subset of 63 Asian subjects with 1,244 iris images. Randomly selected 500 Asian iris images and 500 non-Asian iris images are used as the training set and all the remained iris images are used as the testing set.

The iris image captured from the cameras were taken. Some iris recognition system fails because of fake iris images generated by some attackers. Artificial iris patterns imprinted on contact lens, paper print, plastic plates and synth will generate special high frequency information that can be used to attack an iris recognition system.



(a) (b) (c) (d)

Figure 2. Fake iris images.(a) Print. (b)Contact lens.(c) Plastic. (d)Synth.

Print: The UPOL iris database contains high-quality iris images with abundant and clear iris texture. So one image of each class is randomly chosen and printed on paper using the Fuji Xerox C1110 printer as the counterfeit input of iris recognition systems. Five fake iris images are captured from each printed iris pattern to construct the Print dataset. There are totally 640 images in this dataset.

Contact: We collected 57 kinds of cosmetic contact lens with different texture patterns. There are totally 74 left and right eyes wearing these contact lens. Five fake iris images are captured from each eye to construct the Contact dataset.

Plastic: There are 40 iris images of different subjects from UPOL database printed on the cover of plastic eyeball models. Ten fake iris image are captured per sample. Therefore there are totally 400 fake iris images in the Plastic dataset.

Synth: We adopt the patch-based sampling method for synthesis, and both intensity and texture features are considered to select sampling patches with smooth transition boundaries. The Synth dataset includes 590 synthesized iris image prototype and their 2, 360 intra-class derivatives.

V. CONCLUSION

In this paper aims to learn and encode the most effective texture primitives of iris images for classification. The advantages of both vocabulary tree and locality constrained linear coding is integrated for a novel iris feature representation method called Hierarchical Visual Codebook (HVC) to encode the distinctive and robust texture primitives of iris images. HVC is an efficient solution to represent large scale and discriminant visual vocabulary of iris texture and an accurate texture analysis approach minimize visual coding errors using a hierarchical quantization strategy. In HVC method the number of unique features extracted is less. Therefore the computational load for HVC is very high and Response from the recognition system takes more time. So an approach that presents a very low degree of complexity, which makes it suitable for real-time applications, using some general image quality features extracted from one image to distinguish between legitimate and impostor samples can be applied.

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