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Ocular Detection for Biometric Recognition Using PCA

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Abstract

Ocular images processing is an important task in: i) biometrics system based on retina and/or sclera images, and ii) in clinical ophthalmology diagnosis of diseases like various vascular disorders. Ocular biometric has created vital progress over past decade among the all biometric trains. The white region of eye is sclera, which is exposed. The sclera is roofed by the thin clear wet layer referred as conjunctiva. Conjunctiva and episclera contains the blood vessels. Our aim is to segment the sclera patterns from the eye footage. This paper focuses on the detection of ocular region from the eye image, enhancement of blood vessels and feature extraction. The features extracted from ocular regions are used for biometric recognition. The experimental results provide significant improvement in the segmentation accuracy. For the implementation of this proposed work we use the Image Processing Toolbox under Matlab software.

Keywords: Ocular pattern, sclera and conjunctival vasculature, ocular detection, biometrics, iris segmentation, growing based segmentation; Gabor filter, PCA, Codification, Normalization, Image Processing.

Introduction

The general eye anatomy is presented in Fig.1. In this paper an approach is presented in which the vessel system of the retina and conjunctiva is automatically detected and classified for human identification/verification and ophthalmology diagnosis.
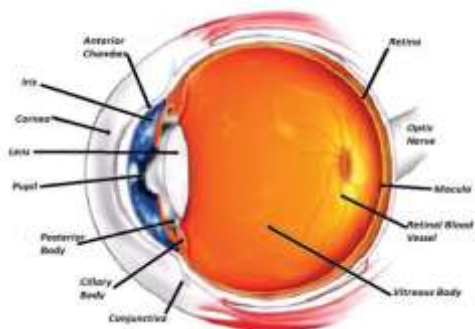

Fig.1 The eye anatomy

The retina is a thin layer of cells at the back of the eyeball of vertebrates. It is the part of the eye which converts light into nervous signals. It is lined with special photoreceptors which translate light into signals to the brain. The main features of a fundus retinal image were defined as the optic disc, fovea, and blood vessels. Every eye has its own totally unique pattern of blood vessels. The unique structure of the blood vessels in the retina has been used for biometric identification and ophthalmology diagnosis. The conjunctiva is a thin, clear, highly vascular and moist tissue that covers the outer surface of the eye (sclera). Conjunctival vessels can be observed on the visible part of the sclera. A biometric system is a pattern recognition system that recognizes a person on the basis of a feature vector derived from a specific physiological or behavioral characteristic that the person possesses. The problem of resolving the identity of a person can be categorized into two fundamentally distinct types of problems with different inherent complexities: (i) verification and (ii) identification.

We present a general framework for image processing of ocular images with a particular view on feature extraction. The method uses the set of geometrical and texture features and based on the information of the complex vessel structure of the retina and sclera. The feature extraction contains the image preprocessing, locating and segmentation of the region of interest (ROI). The image processing of ROI and the feature extraction are preceded, and then the feature vector is determined for the human recognition and ophthalmology diagnosis. In the proposed method we

implement ocular detection for biometric recognition using PCA.

In order to improve the effectiveness of ocular detection for biometric recognition, the PCA method is proposed. Ryszard present Automatic Feature Extraction from Ocular Images in 2012. A biometric system is a pattern recognition system that recognizes a person on the basis of a feature vector derived from a specific physiological or behavioral characteristic that the person possesses. The problem of resolving the identity of a person can be categorized into two fundamentally distinct types of problems with different inherent complexities. A new method for recognition retina vessel and conjunctiva vessel images was presented. This method based on geometrical and Gabor features.

Sachin Damon L. Woodard Shrinivas J. Pundlik Jamie R. Lyle Philip E. Miller in 2010. He presents Periocular Region Appearance Cues for Biometric Identification. He evaluates the utility of the Periocular region appearance cues for biometric identification. Even though Periocular region is considered to be a highly discriminative part of a face, its utility as an independent modality or as a soft biometric is still an open ended question. It is our goal to establish a performance metric for the Periocular region features so that their potential use in conjunction with iris or face can be evaluated.

The remainder of this paper is organized as the following. At first, in Section II we illustrate the various components of our proposed technique to ocular detection. Further, in Section III we present some key experimental results and evaluate the performance of the proposed system. At the end we provide conclusion of the paper in Section IV and state some possible future work directions.

Proposed technique

This section illustrates the overall technique of our proposed ocular detection for biometric recognition using PCA. In this paper, we proposed an efficient analysis of ocular detection. Ocular detection is most accurate and reliable biometric identification system available in the current scenario. Ocular detection system captures an image of an individual's eye; the iris in the image is then meant for segmentation and normalized for feature extraction process. The performance of ocular detection systems highly depends on the segmentation process. Segmentation is used for the localization of the correct iris region in an eye and it should be done accurately and correctly to remove the eyelids, eyelashes,

reflection and pupil noises present in iris region. In our paper we are using PCA method for Ocular detection. This paper described ocular detection which is very useful in biometric recognition. Image denoising is used for eliminating noise which gives better result. The Specular reflection are observed and eliminated. A system is designed for enhancing and matching the conjunctival structure. These conjunctival structures are used in biometric recognition. Three are some parameters given below:

A. Ocular Normalization

Once the Ocular region is successfully segmented from a captured image, the next process is to fix the dimensions of the segmented image in order to allow for comparisons. There are various causes' inconsistencies between eye images. Some of them are due to pupil dilation, rotation of the camera, head tilt, and rotation of the eye within the eye ball and changing of the imaging distance. The most affected inconsistency is due to the variation in the light intensities and illumination causes pupil dilation resulting in stretching of the iris. In order to remove these inconsistencies, segmented image is normalized. The normalization process will produce iris regions, which have the same constant dimensions, so that two images of the same iris under different conditions will have the same characteristic features.

B. Ocular Localization

Without placing undue constraints on the human operator, image acquisition of the iris cannot be expected to yield an image containing only the iris. Rather, image acquisition will capture the iris as part of a larger image that also contains data derived from the immediately surrounding eye region. Therefore, prior to performing iris pattern matching, it is important to localize that portion of the acquired image that corresponds to an iris. In particular, it is necessary to localize that portion of the image derived from inside the limbus (the border between the sclera and the iris) and outside the pupil. Further, if the eyelids are occluding part of the iris, then only that portion of the image below the upper eyelid and above the lower eyelid should be included. Typically, the limbic boundary is imaged with high contrast, owing to the sharp change in eye pigmentation that it marks. The upper and lower portions of this boundary, however, can be occluded by the eyelids. The papillary boundary can be far less well defined.

C. Ocular segmentation

The first step of ocular detection system is to isolate the actual iris region from the captured digital eye. The iris region can be approximated by two circles, one for the iris/sclera boundary and another for interior of the iris/pupil boundary. The eyelids and eyelashes normally obstruct the upper and lower parts of the iris region. Specular light reflections can occur within the iris region corrupting the iris pattern and hence a technique is required to isolate and exclude these artifacts as well as locating the circular iris region.

D. Region Growing

Region growing segmentation is a direct construction of regions. Region growing techniques are generally better in noisy images where edges are extremely difficult to detect**.** The region based segmentation is partitioning of an image into similar or homogenous areas of connected pixels through the application of homogeneity or similarity criteria among candidate sets of pixels. Region growing is a simple region based image segmentation method. It is also classified as a pixel based image segmentation method since it involves the selection of initial seed points. This approach to segmentation examines neighboring pixels of initial seed points and determines whether the pixel neighbors should be added to the region. Firstly, an initial set of small areas are iteratively merged according to similarity constraints. It starts by choosing an arbitrary seed pixel and compare it with neighboring pixels. Then, the region is grown from the seed pixel by adding neighboring pixels that are similar, increasing the size of the region. When growth of one region stops, and then simply chooses another seed pixel which does not yet belong to any region and start again. The main advantages involved in the proposed method is that, the region growing methods can correctly separate the regions that have the same properties. Also, these methods can provide the original images which have clear edges with good segmentation results. The multiple criteria's can be chosen at the same time. It performs well with respect to noise.

E. Gabor filter

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for edge detection. Frequency and orientation representations of Gabor filters are similar to those of the human visual system, and they have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. J. G. Daugman discovered that simple cells in the visual cortex of mammalian brains can be modeled by Gabor functions. Thus, image analysis by the Gabor functions is similar to perception in the human visual system. Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. The filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually.

Complex

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right) \exp\left(i\left(2\pi\frac{x'}{\lambda} + \psi\right)\right)$$

Real

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right) \cos\left(2\pi\frac{x'}{\lambda} + \psi\right)$$

Imaginary

$$g(x, y; \lambda, \theta, \psi, \sigma, \gamma) = \exp\left(-\frac{x'^2 + \gamma^2 y'^2}{2\sigma^2}\right) \sin\left(2\pi\frac{x'}{\lambda} + \psi\right)$$

Where

$$x' = x\cos\theta + y\sin\theta$$

And

$$y' = -x\sin\theta + y\cos\theta$$

In this equation, λ represents the wavelength of the sinusoidal factor, θ represents the orientation of the normal to the parallel stripes of a Gabor function, ψ is the phase offset, σ is the sigma/standard deviation of the Gaussian envelope and γ is the spatial aspect ratio, and specifies the ellipticity of the support of the Gabor function. Gabor filters are directly related to Gabor wavelets, since they can be designed for a number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of bi-orthogonal wavelets, which may be very time-consuming. Therefore, usually, a filter bank consisting of Gabor filters with various scales and rotations is created. The filters are convolved with the signal, resulting in a so-called Gabor space. This process is closely related to processes in the primary visual cortex. Jones and Palmer showed that the real part of the complex Gabor function is a good fit to the receptive field weight functions found in simple cells in a cat's striate cortex.

The Gabor space is very useful in image processing applications such as optical character recognition, ocular detection and fingerprint recognition. Relations between activations for a specific spatial location are very distinctive between objects in an image. Furthermore, important activations can be extracted from the Gabor space in order to create a sparse object representation. The main objectives of our approach are given below:

1. A biometric system is a pattern recognition system that recognizes a person on the basis of a feature vector derived from a specific physiological or behavioral characteristic that the person possesses. The problem of resolving the identity of a person can be categorized into two fundamentally distinct types of problems with different inherent complexities:

(i)   Verification and
(ii)   Identification.

2. In this method we tend to focus the tactic of mirror like reflection removal that is known as property of pixels. The proposed techniques consist of thresholding, dialation and interpolation. This technique avoids error in segmentation stage. This technique is quick and least damage to iris structure.

3. In this method we use median filter. The median filter provides wonderful result for eliminating the all type of noise. A median filter is utilized to denoise a color image, by applying it to each channel of the image.

4. The coarse sclera segmentation is the first step of segmentation process. In this NSI (Normalized Sclera Index) is estimated and then thresholding is used to calculate eyelids contour with the help of scatter plot.

5. In this method we use SURF. The Speeded-Up robust features (SURF) is use to calculate the points. These points referred to as ''interest points'' square measure distinguished structures like corners and T junctions on the image. The detector is used to find interest points that square measure depicted employing a feature descriptor.

6. PCA is the simplest of the true eigenvector-based multivariate analyses. Often, its operation can be thought of as revealing the internal structure of the data in a way that best explains the variance in the data. If a multivariate dataset is visualized as a set of coordinates in a high-dimensional data, PCA can supply the user with a lower-dimensional picture, a projection or "shadow" of this object when viewed from its most informative viewpoint. This is done by using only the first few principal components so that the dimensionality of the transformed data is reduced.

7. In our experiments, we have used different types of feature vectors with varying amount of information. Note that for PCA, only the gallery sets are used as training data.

8. The method proposed for the extraction of the ocular is mainly based on mathematical morphology along with principal component analysis (PCA). The input of the segmentation method is obtained through PCA. The purpose of using PCA is to achieve the grey-scale image that better represents the original RGB image.

Evaluation and results

To verify the effectiveness (qualities and robustness) of the proposed ocular detection, we conduct several experiments with this procedure on several images. In this work we load an image and apply the different technique on loaded image in the Image Processing Toolbox under the Matlab Software. Below steps of our proposed work is given:

Phase 1: Firstly we develop a particular GUI for this implementation. After that we develop a code for the loading the ocular image file in the Matlab database.

Phase 2: Develop a code for the filter technique using Gabor filter and edge detection using canny edge detector and after that apply on the image.

Phase 3: Develop a code for the algorithm with PCA for the segmentation and normalization. When code is develop then apply on the image for ocular region detection.

Phase 4: After that we develop code for the ocular detection.
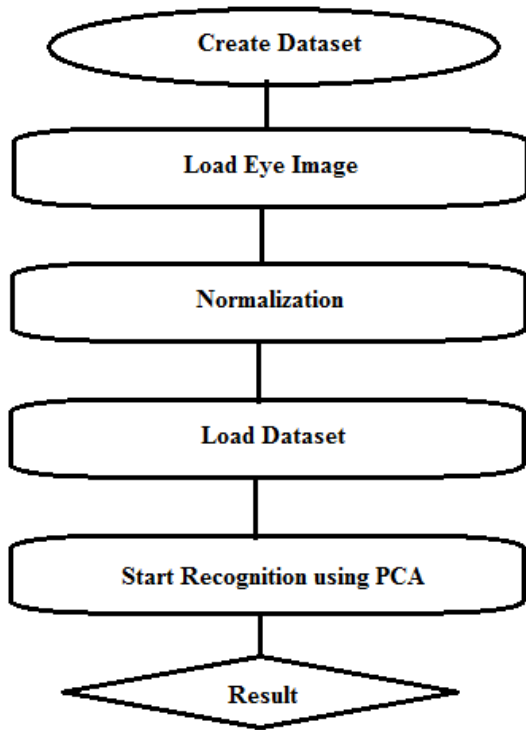
Flow Chart of proposed method

Fig.4 Edge Image

Fig.5 Iris Detected Image

Fig.6 Binary Image

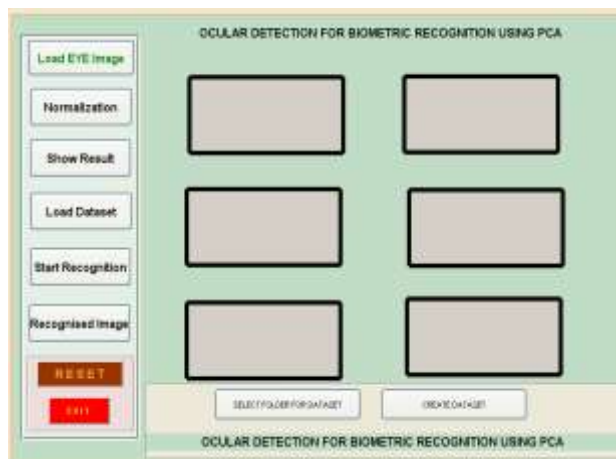*Fig.7 Segmented Image*

Fig.2 Main Figure Window

Fig.8 Tracked Image

Fig.3 Original Image

Fig.9 Recognized Image

Conclusion and future scope

In this paper, we present ocular detection for biometric recognition using PCA. Ocular detection is most accurate and reliable biometric identification system. This paper described ocular detection which is very useful in biometric recognition. Image denoising is used for eliminating noise which gives better result. The Specular reflection are observed and eliminated. A system is designed for enhancing and matching the conjunctival structure. This conjunctival structure is used in biometric recognition, which is also known as ocular biometric system. The experiments presented in the paper demonstrate that at its best, the Periocular region holds a lot of promise as a novel modality for identifying humans with a potential of influencing other established modalities based on iris and face. At the very least, the results suggest a potential for using Periocular region as a soft biometric. Future work includes evaluation of more Periocular features, comparison of Periocular based recognition performance to a commercial face recognition algorithm, exploration of how the capture conditions and the image quality such as uncontrolled lighting, or subjects wearing cosmetics affect the Periocular skin texture and color, among others.

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