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Certain investigation on iris image recognition using hybrid approach of Fourier transform and Bernstein polynomials

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ABSTRACT

In the era of biometric research the recent developments in real time biometric world, iris recognition is considered as one of the most important approach used in person identification based biometric authentication. This approach is considered than the other biometric authentication methods such as behavioral biometrics which specially includes Keystroke, Speaker Recognition whereas the another side of biometric authentication is Physical biometrics which specially includes Fingerprint Recognition, Voice Recognition, Finger Geometry Recognition and Facial Recognition. From these considerations, the hybrid approach of Fourier transform and Bernstein polynomial for iris recognition has been proposed. The novelty of this proposed method results in improving the Accuracy, False Acceptance Rate (FAR), False Rejection Rate (FRR) and Equal Error Rate (EER) for the given iris image. In addition to this, Singular Value Decomposition (SVD) is used for iris image pre-processing. Circular Hough transform (CHT) and Canny edge detection (CED) are applied for iris image segmentation which segments the individual region of the input images. After the image is segmented, Fourier transform and Bernstein polynomial have been applied to extract the features from the segmented iris image, which is the most important step for obtaining the texture details, which are independent and uncorrelated even for identical pairs. Support Vector Machine (SVM) is used for image classification. Perhaps, Feature extraction and Classification of iris image are mainly based on the rich texture details present in iris image. Finally, our proposed system is applied on UBIRIS database and our research experiment provides better accuracy and recognition rates compared to the combined iris recognition techniques such as Fourier transform with SVM, Bernstein polynomial with SVM, Fourier transform with KSVM, Bernstein polynomial with KSVM and hybridization of Fourier and Bernstein polynomial with SVM.

1. Introduction

In many biometrics recognition techniques, verification and identification perform a major role [1] and it is the common factor for many recognition techniques. The verification [2] and identification in any captured image must depend on the biometric characteristics. To verify and identify the captured image against the biometric behavioral, it is necessary to take all image pixels into consideration during recognition progression.

From these considerations biometric recognitions are related to behavioral and physiological [3] characteristics of humans which are used for person verification and identification. There are different types of biometric such as iris, fingerprint, face, ear, and gait etc. The security applications include unique identity detection, border security, crime security, airport security and so on. These criterias are introduced by Jain and co-workers [1,4] for biometric recognition, in which iris boundary detection plays a vital role.

In this study, iris biometrics is focused because of its unique feature and also it is most reliable and accurate when compared with other biometrics traits. Iris differs in size, shape, color and patterns and it provides high confidence for recognizing person identity. Iris outer boundary and inner boundary have different characteristics for recognition process. Depending on these boundaries, numerous techniques which are slightly complex have been proposed earlier. In view of that, Circular Hough transform (CHT), Canny Edge Detection (CED), Fourier transform and Bernstein polynomial methods are considered for processing in iris image. In this paper, feature extraction of iris image was carried out using hybrid approach of Fourier transform and Bernstein polynomials. This system may execute and recognize the exact iris. In many cases, the biometric recognitions are randomly varied depending on the individualities such as uniqueness and measurable characteristics,

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distinctiveness to differentiate the people sufficiently, permanence and the characteristics of different lighting conditions. In this research, it is proved that the biometrics recognition techniques can easily verify and identify the captured image with respect to the proposed methods. Iris is circle in shape and the colored areas surrounding the pupil have some specific pattern with special characteristics such as freckles, coronas, stripes, zigzag collarette area etc. [5]. Compared to physiological and behavioral characteristics, iris patterns have a rich structure and contrast. Bertillon [6] reported the use of iris feature for person identification. In the place of high security, iris recognition is preferred for identification because iris structure is unique from one person to another person. Iris patterns are unique even for identical twins. Based on the above reason, countries like Germany, England, USA and Japan applied iris recognition for accessing bank accounts in ATM environments and hence the customer need not enter their PIN or passwords for access.

The roadmap of this paper is as follows. In this approach, noise in the iris image is removed using SVD algorithm. The iris image is segmented to detect several features by using the CED and CHT algorithms. Among the several features, the inner and outer boundary of the iris was selected. To capture the most important pattern in iris. Here, three methods are discussed for iris feature extraction such as Fourier transform followed by Bernstein polynomial and the final method is the hybrid appraoch of proposed Fourier transform and Bernstein polynomial (BPFT), which is explained in session 3. SVM, K-means algorithm and hybrid K-SVM were selected for the purpose of iris classification, which is explained in session 4. The experimental results are discussed in session 5. The conclusion is drawn in session 6. Finally the paper is concluded with the reference.

2. Literature review

There are various methods employed for iris recognition. Daugman [7] developed an algorithm for locating the iris, where limbic boundary followed by the pupil boundary is detected through integro-differential operators. Wildes [8] proposed a segmentation method by using the edge detection operator and Hough transform. Boles and Boashash [9] generated iris representation using zero crossing of the dyadic wavelet transform. Lim et al. [10] extracted high frequency information of the iris pattern using 2D Haar wavelet and used LVQ neural network for iris classification. Ma et al. [11] used Gabor filter to retrieve the iris pattern. Masek [12] proposed CED and CHT approach for iris segmentation. The same approach with the slight variation for iris segmentation was proposed by Ma et al. [13]. Poursaberi [14] generated binary code for representation of iris using Daubechies wavelet and used Euclidian distance for matching process. Weiqi and Binxiu [15] used surface matching technique for iris recognition.

Monro et al. [16] used discrete cosine transform for extraction of features from iris pattern. Ali et al. [17] proposed iris recognition system based on SVM. Chen and chu [18] proposed novel iris feature extraction and combined Probabilistic Neural Network (PNN) and Particle Swarm Optimization (PSO) classifier for iris recognition. Tieniu et al. [19] proposed a robust iris recognition using novel region growing method. Qi Wang et al. [20] proposed an iris recognition using 2D Gabor filter and Adaboost learning. Gabor filter is used to extract the iris features and Adaboost learning is used for classification. Shengnan et al. [21] developed a system for iris recognition, which consists of (a) active contour model for detection of inner boundary, (b) Scale Invariant Feature transform (SIFT) for extraction of set of features and (c) k-Nearest Neighbours (kNN) for iris matching. Rai and Yadav [22] implemented an iris recognition system in which they used combination of SVM and Hamming Distance approach. Saiyed Umer et al. [23] developed an iris recognition system which consist of preprocessing, feature extraction and classifier. They used restricted CHT algorithm for iris segmentation where a set of feature vector is formed through multi-scale morphologic technique and finally iris recognition system was built using SVM classifier. Bansal et al. [24] proposed iris based authentication system based on combined techniques of local principal independent components and Hanman classifier.

2.1. Overview of the proposed contribution of research

The proposed system describes about the five tier of processing scheme namely Image Acquisition, Image Preprocessing, Image Segmentation, Feature Extraction and Classification.

i. In image acquisition, the iris images from UBIRIS database are read and applied as the input image.
ii. Preprocessing work is based on the SVD algorithm which is widely used to remove the noise from the iris image.
iii. Images are segmented by using Canny Edge Detection methodology and Circular Hough transform. These are used to compute the iris center and radius.
iv. Finally, the feature extraction techniques namely *Fourier transform* and *Bernstein polynomials* are combined with the classification methods such as *SVM* and *KSVM* for extracting and classifying the features from the iris image. The result shows that the proposed methodology provides a highly robust iris recognition in a unique fashion. In the proposed hybrid approach of feature extraction and classification process, maximum accuracy along with FAR, FRR and ERR are obtained when applied in UBIRIS database.

3. Proposed methodology

3.1. Preprocessing by SVD matrix factorization

The iris recognition has been achieved by the following five main steps, such as Image Acquisition, Image Pre-Processing, Image Segmentation, Feature Extraction, Classification and Matching. The Block diagram of proposed iris recognition is shown in Fig. 1. Preprocessing of iris recognition is carried out to remove the noise from the acquired input image. Here, SVD algorithm is used to remove the noise present in the image which is widely used in data preprocessing and visualization. SVD filtering was introduced by Lee et al. which decomposes the whole image matrix into singular values and singular vectors [25]. In this paper, SVD is applied in the iris image to reduce the noise along with unwanted details and texture present in the iris image. SVD is a powerful matrix factorization method to get the useful information from the matrix obtained from the image. The singular matrix from SVD contains useful information rather than singular values when applied in face recognition [26], and hence considered as an effective tool for noise reduction [27]. Here, 'A' is a matrix which consists of $m \times n$ as shown in Eq. (1).

$$A_{m\times n} = U_{m\times m} \sum_{m\times n} V^{T}_{n\times n} \tag{1}$$

From the Eq. (1), $U_{m\times m} = [u_1, ..u_m]$ is $m \times m$ real unitary matrix, $V^{T}_{n\times n} = [v_1, .., v_n]^T$ is $n \times n$ real unitary matrix which is the transpose of $V_{n\times n}$, $\sum_{m\times n}$ represents $m \times n$ rectangular diagonal matrix with the non-negative real numbers on the diagonal. Once the SVD is applied in iris images, the de-noised iris image is obtained with the help of unitary matrix and rectangular matrix.

3.2. Iris segmentation

In this section, the de-noised output image is given as the input for iris segmentation to detect the edges of the image. Iris is