A Survey on Iris Recognition using Image Processing and Artificial Neural Networks

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Abstract–Iris recognition offers high accuracy in security applications such as banks, border control, defense and military etc. It is comparatively much more accurate compared to other biometric tests such as fingerprints, face recognition etc. Iris recognition generally consists of four stages namely iris localization, iris normalization, feature extraction and template matching. The process of localization means separating the section of the iris from the composite image of the eye. This paper presents a survey on automated iris recognition techniques. Such systems can prove to be highly useful and effective in automated iris recognition systems.

Keywords: Iris Recognition, Artificial Neural Networks, Accuracy, Sensitivity.

I. INTRODUCTION

There are several biometric based approaches used for security purposes such as face recognition, fingerprint recognition etc. However, iris recognition is one of the most effective techniques for security purposes which demand high accuracy. The following reasons make iris recognition more effective compared to previous techniques:

1) Extremely slow degradation of iris with age making iris image unaffected by temporal changes.

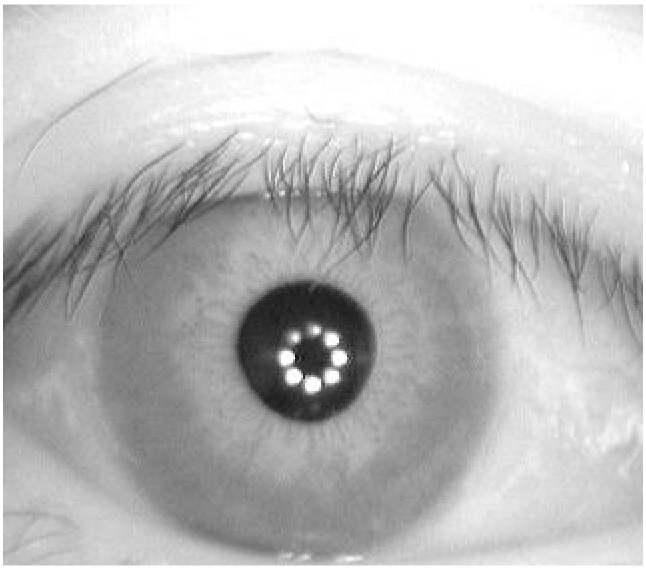
2) Immunity against local physical variations such as face or fingerprint.

Iris recognition is however challenging due to the fact that the first need for iris recognition is the separation of the iris from the composite eye image. Due to overlapping parts and reflections, it can be prone to errors. The next phase is deciding parameters based on which the matching of images can be matched. An image can be considered as a two dimensional spatial function. Images are made up of picture elements or pixels. However, the values of the pixels vary substantially with angle of capture, lighting effects and physical changes. Hence it is almost impossible to find a complete match of all the pixel values of the same iris for different captures. Hence it becomes a serious problem to get an accurate match between the stored images in the data base and the captured image. Hence parameters which do not exhibit variation need to be used for the matching purpose. Such parameters are often termed as features. Computing such features is called feature extraction. After the features are computed from a new image, it becomes necessary to design an automated system which can compare the stored and captured images with high accuracy. Errors can occur in two cases:

1) Authorized images are classified as unauthorized

2) Unauthorized images are classified as authorized.

It is a challenging task to attain high accuracy and reduce errors in classification. A typical composite image of the eye for iris recognition is shown in the figure below. [1]



II. SYSTEM MODEL

The generic system model can be understood using the basic four steps.

1) Extraction of Dataset: The dataset needs for be collected form an authentic source. One such source is the MMU database used in previous work [1].

2) Data Pre-Processing: The next step is preparing the images for analysis. This step comprises of removal of noise and disturbances from the image. Also segmentation or iris localization is needed to be performed in this regard. Several segmentation techniques can be used for the purpose such as edge based segmentation or threshold based segmentation. Some effective techniques such as the Daugman's algorithm can also be used for the purpose.

3) Feature Extraction: This step comprises of computing the relevant features or parameters of the image based on which the image template matching is to be performed.

4) Training a System: The next phase is designing an automated system with feature or parameter values of 2 categories which are authorized and unauthorized images. This is also the stage for pattern recognition.

5) Testing: Prior to actual execution, any system needs to be tested for its accuracy of classification. Hence, with previously available data, we test the system for its classification accuracy.

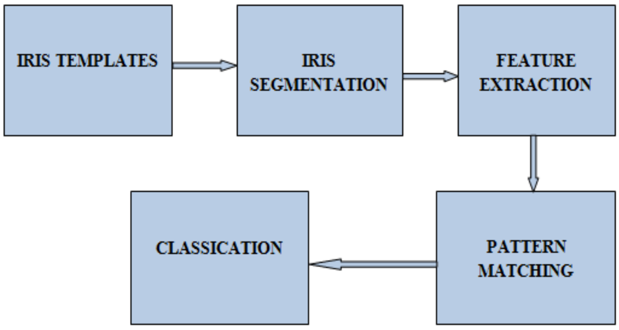


Fig. 2.1 Block diagram of generic system model

III. PREVIOUS WORK

In Ritesh Vyas et al. in [1] explained about Co-occurrence Features and Neural Network Classification used for Iris Recognition. The approach tried to utilize co-occurrence features to train a neural network and then test it with the remaining data. The ratio of training isto testing has been kept as 70:30. It was shown that the proposed system attains an accuracy of 97.83% which is comparatively higher compared to existing which use the same database. The MMU iris database was used in this approach.

Alaa S. Al-Waisy et al. in [2] proposed a biometric iris recognition system based on a deep learning and deep neural networks. The category of the neural network used was the deep neural network (DNN). The activation function used was the softmax function for the classification. The max-pool layer was responsible for the feature extraction stage. The trained deep learning network designed was termed as IrisConvNet whose architecture is based on a combination of Convolutional Neural Network (CNN) and Softmax classifier to classify iris images.

Kien Nguyen et al. in [3] proposed an Iris Recognition utilizing CNN Features and deep learning. It was shown that Iris recognition is however challenging due to the fact that the first need for iris recognition is the separation of the iris from the composite eye image. Due to overlapping parts and reflections, it can be prone to errors. The next phase is deciding parameters based on which the matching of images can be matched. It was shown that a cascading effect of convolutional neural networks (CNNs) is capable enough to extract varying image features.

Abhishek Gangwar et al. in [4] proposed the functional deep neural network called DeepIrisNet. It was shown that different neural architectures have different levels of classification accuracy. The increase in number of hidden layers or maxpool can significantly increase the classification accuracy. The approach used was a cascading thresholding effect of each layer’s output been fed to the next layer in the hidden layer. The accuracy was computed in terms of precision, recall and accuracy.

Nianfeng Liu et al. in [5] proposed a Convolutional neural network for iris recognition. The authors present two basic segmentation techniques which are termed as hierarchical convolutional neural networks (HCNNs) and multi-scale fully convolutional network (MFCNs). The techniques prove to be useful for both noisy and long distance image capturing cases. It is shown that the system identifies the pixels at a distance with ease and also optimizes the features extracted and the classifier values.

Shervin Minaee et al. in [6] the authors propose a new approach towards Iris Recognition, using scattering transform. This approach eases the computation of feature values and subsequent training. The transform helps in the computation of gray co-occurrence matrix features based on the scattering transform. Subsequently, the classifier is used to classify the images into authorized and unauthorized.

Kiran B.Rajaa et al. in [7] proposed a technique of sparse filtering. It was shown that the proposed system can work well for relatively larger distances with effective image retrieval. The sparse filtering used a median spatial filter for filtering out disturbances form the image. The proposed technique is found to exhibit more exact segmentation and accuracy of 85% with standard OSIRIS v4.1 dataset.

Chun-Wei Tan and Ajay Kumar in [8] proposed a technique using stabilized Iris encoding and Zernike moments phase features for iris recognition at relatively larger distances. . A nonlinear filtering or spatial pattern recognition approach is shown to be more effective compared to conventional linear models. An overall quality of the weight map is proposed. The approach used discards the bits which depict frequent mutations and retains the ones which don’t exhibit such a pattern. To achieve higher accuracy, a Zernike moment based phase encoding of iris features is proposed.

Daksha Yadav et al. in [9] evaluated the effect of Textured Contact Lenses on Iris Recognition and tried to nullify the detrimental effects. The paper analyzes the effect of contact lenses on classification accuracy. Real time data sets which are the IIIT-D Iris Contact Lens database and the ND-Contact Lens database, are prepared for experimentation. The performance of the system is evaluated in terms of accuracy and sensitivity and it is shown that the proposed system outperforms previously existing systems.

R Raghavendra et al. in [10] explored the concept of Combining Iris and Peri ocular Recognition using Light Field Camera. It is shown that better Iris Recognition mechanisms can help in better provisions of security against unauthorized intrusions. Using advanced methods like Artificial Intelligence for the recognition purpose, it can help in improved accuracy and better outcomes. It is important to segment out the iris from the entire eye image which needs special edge detection techniques. The Iris and Peri ocular combination helped in increasing classification accuracy.

Jaishanker K. Pillai et al. in [11] proposed a technique for Noncontact biometrics such as face and iris have additional benefits over contact-based biometrics such as fingerprint and hand geometry. However, initial stages comprise of removal of noise and disturbances from the image. Also segmentation or iris localization is needed to be performed in this regard. Several segmentation techniques can be used for the purpose such as edge based segmentation or threshold based segmentation. The classification accuracy could be increased using non-contact biometrics.

Stefan Jenisch et al. in [12] proposed a cancelable biometric system to provide inherent security of iris recognition systems under the conditions that the attacker gets hold of iris templates. It uses block permutation and remapping of the iris texture as a strategy for template protection. Two situations are analyzed for the purpose which are

a) attacker got a hold on a single iris template and

b) scenario it is presumed that multiple templates of the same biometric characteristic are available to an attacker.

CT Chou et al. in [13] proposed a novel non-orthogonal technique for image segmentation, iris localization, feature extraction and final classification. It is shown that the proposed system attains higher accuracy compared to conventional orthogonal approaches. A dual-charge-coupled device camera was developed to capture four-spectral (red, green, blue, and near-infrared) for iris recognition is propsed in this approach.

AI Desoky et al. in [14] proposed a technique using fusion of templates for higher accuracy of classification. The approach uses a technique based on composite learning which is capable of rendering higher accuracy in the presence of noisy conditions. It is shown that values of the pixels vary substantially with angle of capture, lighting effects and physical changes. Hence it is almost impossible to find a complete match of all the pixel values of the same iris for different captures. Hence it becomes a serious problem to get an accurate match between the stored images in the data base and the captured image. The proposed fusion approach is shown to achieve higher results compared to conventional techniques.

KSS Kyaw et al. in [15] proposed a system based on statistical as well as texture based features for iris recognition. A comparative analysis of both the approaches have been shown in which it is found that in case of iris templates, statistical features outperform texture based features for final classification. The pre-processing has been done using noise removal with Gausssian filtering after which the 2-level features are compute.

IV. EVALUATION PARAMETERS

The evaluation of accuracy of classification is expressed in terms of accuracy and sensitivity. The following parameters are necessary for the classification.

1. True Positive (TP): It is indicative of the true or correct cases of the data to be in a particular class.
2. True Negative (TN): It is indicative of the true or correct cases of the data not to be in a particular class.
3. False Positive (FP): It is indicative of the false or incorrect cases of the data to be in a particular class.
4. False Negative (FN): It is indicative of the false or incorrect cases of the data not to be in a particular class.

Sensitivity (S_e): It is indicative the ratio in which a data set is categorized Mathematically it can be defined as:

$$S_e = \frac{TP}{TP + FN}$$

Accuracy (Ac): It is an indicative of the accuracy of classification of the algorithm for data classification,

Mathematically its defined as:

$$A_c = \frac{TP + TN}{TP + TN + FP + FN}$$

V. OUTCOMES OF THE REVIEW

The outcomes of the review infer that Iris Recognition is an important method that is used as a part of many security applications. Better Iris Recognition mechanisms can help in better provisions of security against unauthorized intrusions. Using advanced methods like Artificial Intelligence for the recognition purpose, it can help in improved accuracy and better outcomes. It is important to segment out the iris from the entire eye image which needs special edge detection techniques. The major classification governing factors are:

1) The number of features and the category of features are critical for accuracy. Co-occurrence features and

texture based features generally render moderate accuracy. [1], [3], [14]

2) The classification tool plays another important rule. Off late, the deep neural networks have become prevalent for classifications [3], [4], [5], [7]. Convolutional neural networks have also been effective for classification.

3) Clustering techniques can also be useful for finding the data set which can yield the most useful information.

4) Image pre-processing techniques such as Filtering can yield higher accuracy. [7], [11]

Moreover, due to differences in lighting, angle effects etc, any classifier should be able to find the significant parameters prior to final classification. The accuracy of the proposed systems vary between 70% to 90%. The aim should be to increase the accuracy beyond the previously existing techniques. For this purpose optimization and pre-processing tools such as PCS, or DT can be used.

VI. CONCLUSION

From the previous discussions, it can be concluded that highly classified and secure applications need reliable security systems to prevent unauthorized trespassing. Biometric security systems using face recognition or finger print recognition are unreliable. They render unreliability due to variation in pixels with respect to lighting, shadowing and angle effects. Iris on the other hand doesn't exhibit stark variation in pixels. The iris of the eye has been described as the ideal part of the human body for biometric identification for several reasons which are, it is an internal organ that is well protected against damage and wear by a highly transparent and sensitive membrane (the cornea). The paper presents a survey and taxonomy on iris recognition techniques.

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