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Research Article

Novel Segmentation of Iris Images for Biometric Authentication Using Multi Feature Volumetric Measure

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Abstract: The aim of the research is to improve the efficiency of biometric authentication using different features of iris image. The biometric authentication and verification has become more popular where the authentication is more essential in many organizations. There are many approaches has been discussed to segment the iris image and to perform verification but suffers with the problem of accuracy in feature extraction and segmentation. To resolve such problems and to improve the efficiency of iris segmentation and recognition, we propose a novel segmentation algorithm which uses multi level filter which removes the eyelids and eyelash features and performs the edge detection to identify the inner and outer eye regions. Once the regions has been identified then, we compute various measures like the size of inner and outer eyes and extract the features of both and convert them in to feature vectors. The generated feature vectors are used to perform classification in biometric authentication approach. The multi feature volumetric measure is computed on the feature vector of each eye image where the feature vector has various features like the size of both inner and outer eyes, width and height, the original binary features, the number of binary ones and the number of pixels damaged by any form of disease and so on. Based on these features the MFVM is computed to classify the iris image towards a big data set of biometric features to perform authentication. The proposed method has improved the efficiency of iris segmentation and improved the efficiency of iris recognition based biometric authentication. Also the approach has reduced the time complexity and improved the efficiency also.

Keywords: Biometric authentication, iris recognition, iris segmentation, MFVM, multi level filtering

INTRODUCTION

The modern information technology has influenced the organizational authentication mechanism in high manner and the biometric recognition systems have been influenced by iris recognition in huge manner. There are many biometric authentication mechanism uses finger prints, palm prints, facial features, iris features. Among them the most influenced feature which affects the authentication system is the iris features. There are many iris recognition approaches has been discussed but suffers with the rest of the features like eyeglasses, eyelash and many more.

The general iris image which is captured using the camera has noise and distortion which has to be removed in order to extract the features of the iris. The iris has different portions like pupil, iris outer boundary, eye lash and many more. To extract the features of the iris, we have to identify the boundary of each component and have to be segmented to perform this task. While removing noise from the iris image the features of the iris has to be retained, so that to perform such task the selection of filter has to be efficient. The filters like Gabor could not be used because they do not remove the noise in efficient manner. So that the usage of multi level filter is essential which retain the features of the image. The multi level filter is one where the input image is passed through two stage filters which reduces the noise in most efficient manner.

To identify the boundary of each component of iris, the usage of edge detection mechanism is essential; the canny edge detection approach is most efficient and can be used to perform edge detection. Using the edge detected image, the segmentation has to be performed and the feature boundary has to be identified to measure the features of the iris component. Segmentation is the process of grouping similar pixels of the iris image based on the gray scale values of the pixel. The segmentation helps identifying the boundaries of the iris component and each components features can be extracted in most efficient manner.

The iris has various components and features like pupil, eyelash, iris and so on. The upper boundary and lower boundary, left and right boundary window of the iris has to be identified to compute the width and height of the iris component. If we could identify these values then the size of pupil can be inferred and computed. Using all these measures, we can compute the

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volumetric measure of the iris and also the iris features can be extracted and converted into a feature vector which can be used to perform classification.

From the above discussion, we are motivated to identify the exact features and using multiple feature of iris components to perform biometric authentication. The main objective of the research is to improve the efficiency of biometric authentication and reduce the false positive, false negative ratio of biometric authentication. Also the authentication approach has to reduce the time complexity of biometric authentication and increase the accuracy of authentication.

LITERATURE REVIEW

There are many approaches has been discussed for the development of iris recognition and segmentation process and we discuss few of them here around the problem of biometric authentication.

Tomasz *et al*. (2014) Selection of parameters in iris recognition systems, presents the detailed analysis of implementation issues occurred during preparation of the novel iris recognition system. First, we shortly describe the currently available acquisition systems and databases of iris images, which were used for our tests. Next, we concentrate on the feature extraction and coding with the execution time analysis. Results of the average execution time of loading the image, segmentation, normalization and feature encoding, are presented.

Sayed *et al*. (2014) Improved Iris Recognition Using Eigen Values for Feature Extraction for Off Gaze Images, discusses various Iris recognition and identification schemes known to produce exceptional results with very less errors and at times no errors at all but are patented. Many prominent researchers have given their schemes for either recognition of an Iris from an image and then identifying it from a set of available database so as to know who it belongs to. The Gabor filter is a preferred algorithm for feature extraction of Iris image but it has certain limitations, hence Principal Component Analysis (PCA) is used to overcome the limitations of the Gabor filter and provide a solution which achieves better results which are encouraging and provide a better solution to Gabor filters for Off Gaze images.

Valérian and Stéphane (2014) Quality-driven and real-time iris recognition from close-up eye videos, deals with the computation of robust iris templates from video sequences. The main contribution is to propose: Optimal tracking and robust detection of the pupil Smart selection of iris images to be enrolled Multi-thread and quality-driven decomposition of tasks to reach real-time processing. The evaluation of the system was done on the multiple biometric grand challenge dataset. Especially, we conducted a systematic study regarding the fragile bit rate and the number of merged images, using classical criteria. We reached an equal error rate value of 0.2% that reflects high performance on this database with respect to previous studies.

Wei *et al*. (2013) Robust and Efficient Iris Recognition Based on Sparse Error Correction Model, is presented to improve the robustness and efficiency of the recognition system, each iris sample is separated into a few sectors and a Bayesian fusion-based Cumulative SCI (CSCI) approach is applied to validate the recognition results. Experimental results on CASIA-Iris V3 demonstrate the proposed method achieves excellent recognition performance both in robustness and efficiency.

Arora *et al*. (2012) Human Identification based on Iris Recognition for Distant Images, a new algorithm is proposed for iris recognition on distant images. The novelty of this algorithm includes recognition through iris patterns based on both the left and right eye of an individual so as to improve the recognition accuracy and computational efficiency. Experimental tests were performed using CASIA Iris Distance Database which a subset of CASIA V4 Database. The methodology found encouraging development in the field of Iris Recognition.

Bendale *et al*. (2012) Iris biometrics is widely used because of the highly discriminative characteristics found in iris. But designing an iris recognition system which is invariant to extrinsic factors such as illumination, noise, camera-to-eye distance is fairly challenging. This study proposes a novel iris recognition approach which takes into account the iris structure, illumination variation, occlusion, noise and rotational variance. A novel feature extraction technique exploiting the local iris features has been proposed. The proposed system uses two feature extraction techniques working over different blocks of an iris. The features are extracted from suitably modified pixel values which are enhanced to improve robustness of the technique. Relational measure is proposed that considers both radial and circumferential features which are combined with the proposed Block Local Binary Pattern (BLBP). The BLBP is applied in an unconventional block-wise manner adaptive to the iris structure. Finally, the scores are fused at score level.

Aditya and Phalguni (2013) Iris Recognition Using Consistent Corner Optical Flow, proposes an efficient iris based authentication system. Iris segmentation is done using an improved circular hough transform and robust integro-differential operator to detect inner and outer iris boundary, respectively. The segmented iris is normalized to polar coordinates and preprocessed using LGBP (Local Gradient Binary Pattern).

The corners features are extracted and matched using dissimilarity measure CIOF (Corners having Inconsistent Optical Flow). The proposed approach has been tested on publicly available CASIA 4.0 Interval and Lamp databases consisting of 2,639 and 16,212 images respectively.

Vanaja *et al*. (2011) Iris Biometric Recognition for Person Identification in Security Systems, focus on an efficient methodology for identification and verification for iris detection, even when the images have obstructions, visual noise and different levels of illuminations and we use the CASIA iris database it will also work for UBIRIS Iris database which has images captured from distance while moving a person. Efficiency is acquired from iris detection and recognition when its performance evaluation is accurate.

Pillai *et al*. (2011) in face recognition, indeed any image-based classification problem in general, representative features are first extracted from images typically via projection to a feature space. A classifier is then trained to make class assignment decisions using features obtained from a set of training images. One of the most popular dimensionality-reduction techniques used in computer vision is Principal Component Analysis (PCA). In face recognition, PCA-based approaches have led to the use of eigen pictures and eigen faces as features. Other approaches have used local facial features like the eyes, nose and mouth, or incorporated geometrical constraints on features through structural matching.

Wright *et al*. (2009) we show that if sparsely in the recognition problem is properly harnessed, the choice of features is no longer critical. What is critical, however, is whether the number of features is sufficiently large and whether the sparse representation is correctly computed. Unconventional features such as down sampled images and random projections perform just as well as conventional features such as Eigen faces and Laplacian faces, as long as the dimension of the feature space surpasses certain threshold, predicted by the theory of sparse representation. This framework can handle errors due to occlusion and corruption uniformly by exploiting the fact that these errors are often sparse with respect to the standard (pixel) basis. The theory of sparse representation helps predict how much occlusion the recognition algorithm can handle and how to choose the training images to maximize robustness to occlusion. We conduct extensive experiments on publicly available databases to verify the efficacy of the proposed algorithm and corroborate the above claims.

Bowyer *et al*. (2008) the iris biometrics, providing appropriate context to evaluate more recent research. It relates to one of the four modules of an iris biometrics system: image acquisition, segmentation of the iris region, analysis and representation of the iris texture, or matching of iris representations. Section 8 discusses evaluations of iris biometrics technology and iris image databases.

Vatsa *et al*. (2008) these imaging conditions engender acquired noisy artifacts that lead to severely degraded images, making iris segmentation a major issue. Having observed that existing iris segmentation methods tend to fail in these challenging conditions, we present a segmentation method that can handle degraded images acquired in less constrained conditions. We offer the following contributions: to consider the sclera the most easily distinguishable part of the eye in degraded images, to propose a new type of feature that measures the proportion of sclera in each direction and is fundamental in segmenting the iris and to run the entire procedure in deterministically linear time in respect to the size of the image, making the procedure suitable for real-time applications.

Monro *et al*. (2007) The Biometric recognition offers a promising approach for security applications, with many advantages over the classical methods, like password, pin, keys etc. Some of the non-compensative properties of biometric traits are that they are based on, exactly what you are or what do you do, so that you don’t need to remember anything, it can’t be copied, stolen etc. Biometric identification technologies, including face recognition, fingerprint recognition, voice recognition, palm print recognition and so on, offers a new solution for personal identification and secure access. Among all biometric technologies, iris recognition is one of the best technology for person identification and security

Ahonen *et al*. (2006) for face recognition, Gabor features are effectively used. But, only a few approaches used Gabor phase features and they are performing worse than the Gabor magnitude features. To determine the potential of Gabor phase and its fusion with magnitude for face recognition, in this paper, we have proposed local Gabor XOR pattern operator, which encode Gabor phase. Then we introduce block-based Fisher’s linear discriminant for reduce dimensionality of proposed operator and at same time discriminative power also get enhanced. At last, by using BFLD we fuse Gabor phase and Gabor magnitude for face recognition. We evaluate our method for FERET database. Also, we perform comparative experimental studies of different local patterns.

Cui *et al*. (2004) the verification scenario, there are four possible outcomes. A true positive occurs when the system says that an unknown sample matches a particular person in the gallery and the match is correct. A false positive occurs when the system says that an unknown sample matches a particular person in the gallery and the match is not correct. A true negative occurs when the system says that the sample does not match any of the entries in the gallery and the sample in fact does not. A false negative occurs when the system says that the sample does not match any of the entries in the gallery, but the sample in fact does belong to someone in the gallery. Performance in an identification scenario is often summarized in a cumulative match characteristic curve.

All the above discussed approaches has the problem of identifying the exact features to perform authentication and iris recognition, we propose a novel approach to perform segmentation and recognition using multi variant volumetric feature estimation technique.

PROPOSED METHODOLOGY

The proposed multi feature volumetric estimation technique based segmentation and classification method has various stages namely Preprocessing, Multi Feature Detection, Segmentation, Multi Feature Volumetric Measure Computation, Iris Recognition. We discuss each of the functional components in detail in this section below.

Figure 1 shows the architecture of the proposed system and the functional components. The preprocessing block performs the noise removal and image enhancement operation. At the feature extraction, there are three stages like edge detection, pupil detection and boundary detection methods. At the third stage, the image is segmented to compute the multi feature volumetric measure using which the iris recognition is performed.

Preprocessing: The preprocessing operation is performed on the image acquisition performed by optical camera or any device. The image captured has noise present due to the acquisition and blurring which has to be removed to perform segmentation operation. But the edges of the image has to be retrained in such a way to identify the boundaries of iris objects, so that we use Gaussian filter which retains the image edges well and removes the noise from the image. Also the Gaussian filter enhances the contrast of the image which helps in boundary detection and pupil detection at the next stage of the process. The noise removed image is applied with histogram equalization technique which enhances the image still further to support the iris recognition process.

Algorithm:
Input: Input Iris Image Im.
Output: Preprocessed Image Pimg.

Step 1: Start
Step 2: Initialize Gaussian values Gv = {1.4/11.6, 3.6/11.6, 3.9/11.6, 3.6/11.6, 1.4/11.6}
Step 2: Apply Gaussian filter in the image:

$$\text{Im} = \int Im \times \int_{i=1}^{N} Gv$$

Step 3: Perform Histogram Equalization in the image Im
Step 4: Stop

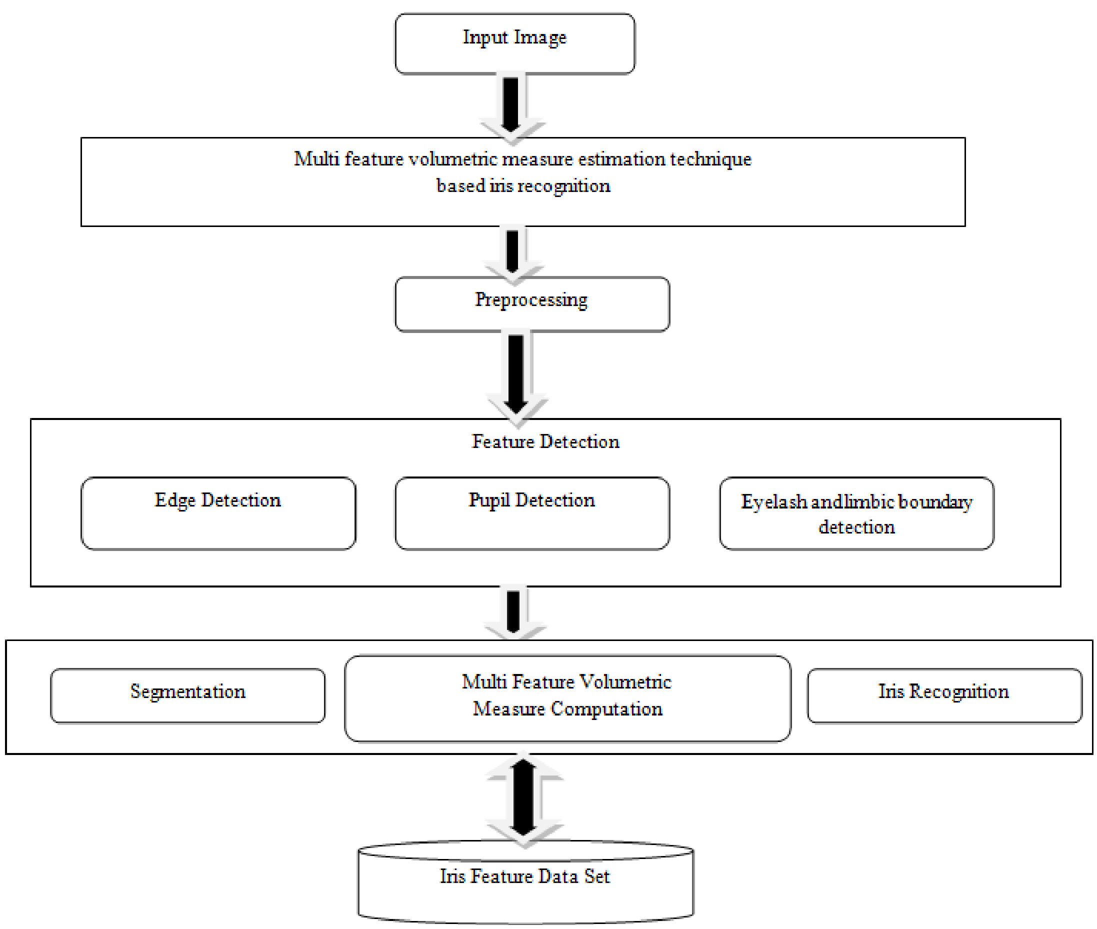

Fig. 1: Proposed system architecture

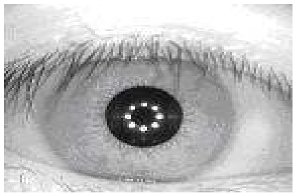

Fig. 2: Input original image

The preprocessing algorithm applies Gaussian filter to remove the noise from the input image and the method applies the histogram equalization technique which enhances the image quality (Fig. 2).

Feature detection: The feature detection stage has various steps and starts with the edge detection. To perform edge detection, we used canny edge detector which retains the edge features in most efficient manner. The edge detected image is binarized to get the binary image of the preprocessed image. First we identify the pupil location and estimate the pupil center co-ordinate. Once the pupil coordinate has been identified then the boundary of pupil and iris limbic boundary also identified.

Pupil detection: The iris pupil is detected by binarized image, the input image is applied with canny edge detection and the edge detected image is used with binarization and identifies the location of iris pupil. We identify the center co-ordinate of the iris image by midpoint localization method and by using boundary detection and gray scale approximation method we identify the boundary of pupil.

Algorithm:
Input: Preprocessed image Pimg
Output: Pupil Co-ordinates

Step 1: Start
Step 2: Apply canny edge detection on Pimg
Step 3: Generate binary image
Step 4: Perform midpoint localization and gray scale approximation:

Midpoint mp =
$$\int_{i=1}^{N} \frac{Pi(x)}{(Pimg(width)/2)-T}, \frac{Pi(y)}{(Pimg(height)/2)-T}$$

Step 5: Identify boundary of pupil
Step 6: Stop

The above discussed algorithm performs identification of pupil region. First it applies the canny edge detection process and the edge detected image is converted into binary image. From the image, the midpoint of the image is identified and boundary of the pupil is identified.

Limbic detection: At this stage, the binarized image is used to identify the eyelash pixels and removed from the binary image. Then with the identified co-ordinates of iris pupil, we identify the boundary of limbic using identified pupil co-ordinates and perform gray value approximation till the limbic boundary detected. Detected limbic co-ordinates are stored to generate the feature vector of the input image.

Segmentation: The segmentation process is performed with the features detected and using these features we identify and extract the required features like Pupil feature, Limbic feature and so on. We identify the top and bottom boundaries of the limbic and right left corners of the limbic component also. Identified components are extracted to form the feature vector of the image.

Multi feature volumetric measure computation: The multi feature volumetric measure computation is performed using various values namely, pupil coordinates like mid point, boundary points, number of false pixels in the pupil region, the coordinates of limbic portion and so on. Using all these measures, we compute the multi feature volumetric measure which represents the overall components measure computed using number of binary pixels and other co-ordinate boundary measures.

Algorithm:
Input: Input Image Img, Coordinate of pupil
Output: MFVM

Step 1: Start
Step 2: Compute area of pupil region Apr:

$$\text{Apr} = \int (Pupil.r) \times Pupil.r) \times 3.14$$

Step 3: Compute Area of Limbic:

$$\text{Alr} = \int Area\ (Limbic.Inner, Limbic\ Outer)$$

Step 4: Generate Feature vector Fv:

Fv = {Apr, Alr, Pupil values, Limbic values}

Step 4: Stop

The above discussed algorithm computes the area of pupil region, area of limbic region and generate a feature vector with the values of pupil and limbic and there are computed.

Iris recognition: Iris recognition is performed based on the multi feature volumetric measure which is computed using the feature vector generated at the previous stage. The feature vector has various values about the components of iris image and based on the features and values available with the feature vector, we compute the multi feature volumetric measure. The volumetric measure shows the amount of volume occupied by the component feature from overall iris image which is computed for each component. There may be NaN pixel present in the pupil region which has to be accounted while computing the volumetric measure. Finally these measures are used to classify the input image towards the number of users. We compute the similarity of MFVM between all the training samples available in the training set and a single class will be selected based on the similarity of the features.

RESULTS AND DISCUSSION

The proposed multi feature volumetric measure based iris recognition and segmentation has been implemented and tested for its efficiency. The proposed method has produced efficient results in all the factors of iris segmentation and recognition.

Figure 3 shows the snapshot of the proposed method with input image selected which will be used to perform rest of the iris recognition.

Figure 4 shows the snapshot of the result produced by the proposed method. The second image shows the noise removed image and the third image shows the equalized image. The fourth image is the edge detected one which will be used to perform the feature detection process.

The fifth image shows the pupil identified image and its region is marked to extract the features of the image.

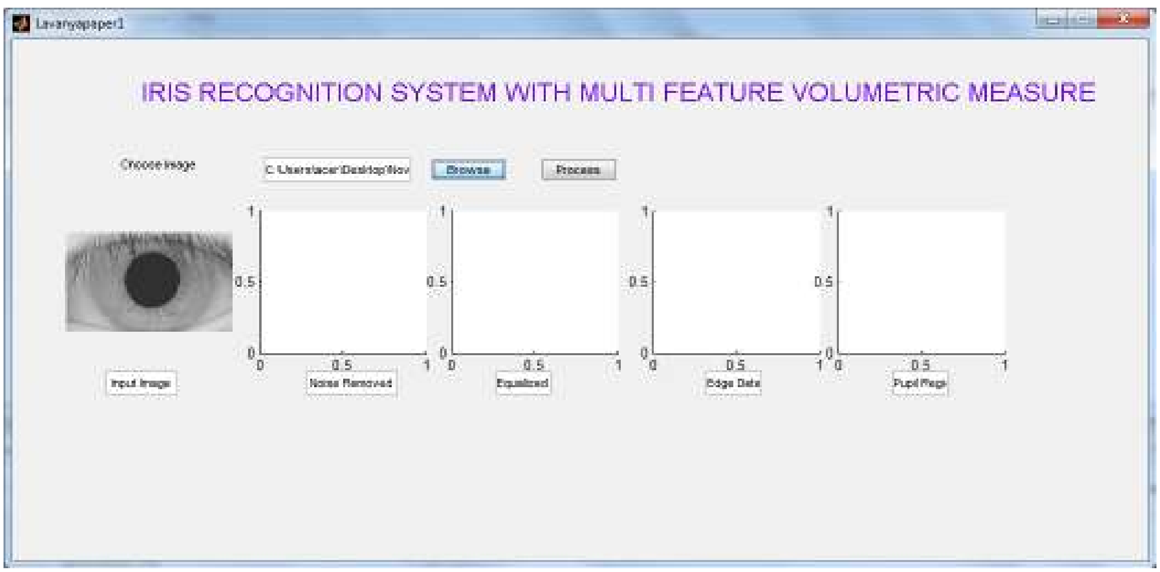

Fig. 3: Snapshot of input image given for the proposed method

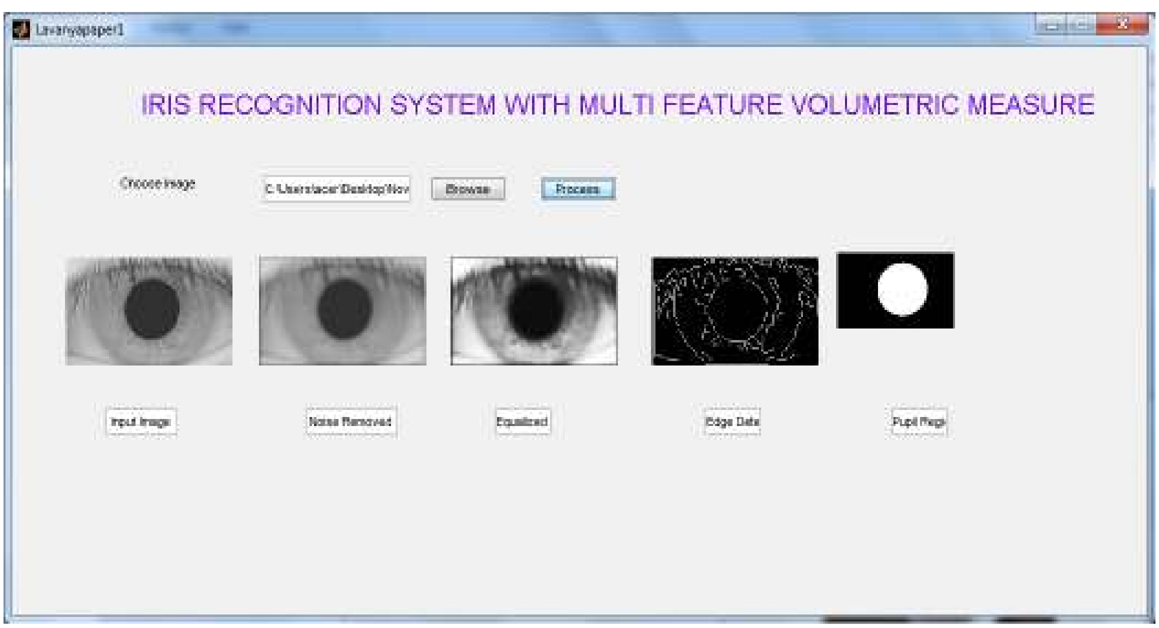

Fig. 4: Snapshot of result produced

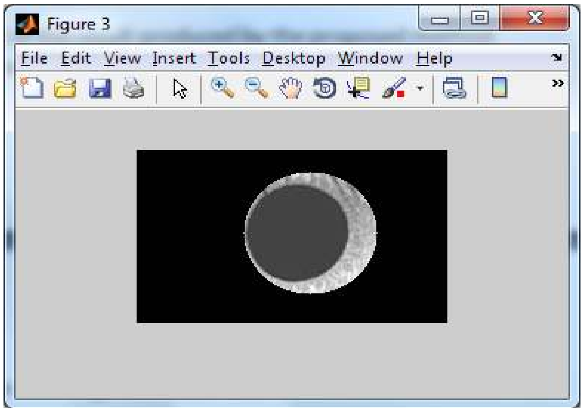

Fig. 5: Shows the snapshot of the feature identified by the proposed method

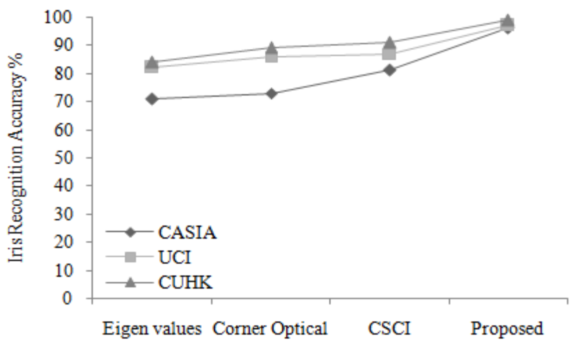

Fig. 6: Comparison of iris recognition accuracy

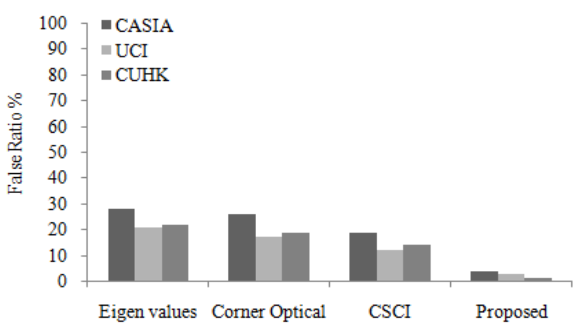

Fig. 7: Comparison of false positive ratio

Figure 5 shows the result proposed by the proposed method in segmentation process.

Figure. 6 shows the iris recognition accuracy produced by different methods and it shows clearly that the proposed method has produced efficient accuracy than other approaches.

Figure 7 shows the comparison of different methods on false positive ratio produced by different methods using various iris data sets and it shows that the proposed method has produced less false positive ratio than others.

Figure 8 shows the comparative result of time complexity produced by different methods on different data sets. It shows clearly that the proposed methods have achieved less time complexity in all the data sets.

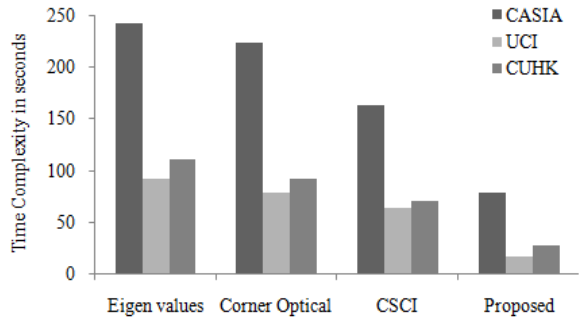

Fig. 8: Comparison of time complexity of different methods

CONCLUSION

We proposed a novel multi feature volumetric estimation technique based iris recognition system for biometric authentication mechanism. The proposed method, removes the noise from input image and equalized using histogram technique to improve the image quality. The improved image is applied with pupil detection and limbic detection and identified features are extracted using the gray feature estimation based segmentation technique. The extracted features are converted into feature vectors using which the classification is performed to perform the authentication. The proposed method has produced efficient results in recognition accuracy and time complexity than other methods and for future work in order to improve the recognition accuracy we would suggest to continue the proposed system in fuzzy logic or other algorithms of neural networks.

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