A Comparative Analysis on Iris Recognition System and Its Techniques

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Abstract- *In recent days security requirements are continuously increasing and identification of person by using his/her biometric features isperfect solution. The most accurate and reliable method in biometric systems till date is iris recognition. Human iris exhibits distinct characteristic to spot or verify person. Iris recognition system (IRS) consists of image acquisition, preprocessing, segmentation, normalization, features extraction and matching. In IRS the accuracy primarily depends on the methods employed in segmentation and normalization..This paper covers the different methods of iris recognition and presents a comparative analysis with existing literature in the field.*

Keywords- Biometric recognition; Iris Recognition; Iris segmentation; FAR; FRR.

I. INTRODUCTION

In recent days as technology grows Online fraud has also grows. Whenever any person uses debit/credit cards, access computers, passes through any high security area such as airport, persons need to show or verify their identity. For such instances, person prove their identity by password, username, or identification traits. But such methods are non-secure. Password can be forgotten and identification traits may be lost. Thus, there is a requirement of reliable and secure identification application to person [1]. Basically a biometric authentication system is a pattern recognition system that determines personal identification on basis of specific physiological and/or behavioral characteristic influenced by the user.

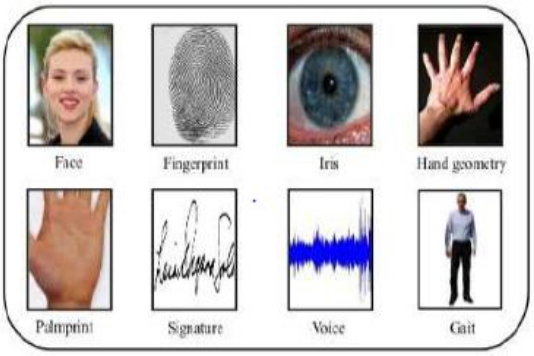


Fig. 1. Biometric Identification Methods [6]

Human physiological characteristics are associated with the body form like face recognition, iris recognition, hand geometry, palm fingerprint and DNA sequences. Behavioral characteristics are associated to the behavior of a person, such as gait, typing rhythm, voice and accent. Biometric identification method is best suited over traditional identification such passwords or any KEY based method, because there is not necessary to remember such KEY or carry a token whereas in biometric identification process person identity is verified using physical presence at the time of identification. Nowadays, various kinds of applications require secure and reliable verification method to authenticate the individual identity, and recognition of human on the basis of body characteristics became more and more interesting in emerging technology applications [2].

The identification and verification of individual can be done with eyes. In eyes the annular region is iris bounded with pupil and sclera (white portion of eye) on either side. The arrangement of iris visual surface is prepared amid the advancement of fetal and ends up plainly stable amid the initial two years of life. Iris of each individual is unique, though they may have similar fingerprints; even the irises of indistinguishable twins are special. What's more, the surface of iris is to a great degree hard to surgically alter. Further, it is genuinely easy to distinguish fake irises. An iris-acknowledgment calculation has at first restrict the inward and external limits of the iris (understudy and limbus) in a picture of an eye. Additionally, recognize the subroutines and expels eyelashes, eyelids and specular reflections that hinders the piece of iris. The arrangement of pixels containing only the iris is then researched to isolate a bit configuration encoding the information anticipated that would analyze among two iris images.

To extract a feature vector from localized image there is need to maintain light, contrast, focus and resolution for an image. Although, the initial iris-based recognition (IR) systems are much expensive and required considerable user participation whereas the new developed systems have become more user friendly and cost-effective [3]. In this research work, we present various techniques on iris recognition and its related work.

II. IRIS RECOGNITION

Iris recognition (IR) is a biometric recognition method that uses pattern recognition to identify and verify the images of iris[4]. The use of iris recognition system (IRS) is regularly increasing in various areas for security and access control in border areas etc. and due to its unique features like a furrow, rings, ridges, complex patterns and freckles [5]. The main advantage of iris recognition (IR) is speed for matching and gives accurate result in false matches related to iris and also protects not only internal but externally visible eye organ [6].

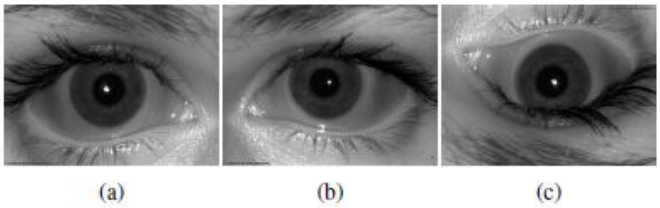


Fig. 2. (a) right iris image, (b) left iris image and (c) upside-down image made by rotating the first image by 180 degrees [23].

Steps of Iris Recognition System

The basic block diagram presented in figure 3 shows the functionality of IRS:

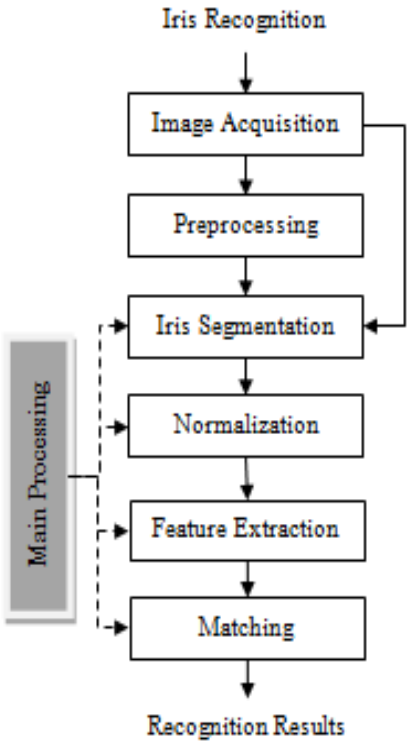


Fig. 3. Block Diagram of Iris Recognition (IR)

i) Image acquisition

In the initial stage of Iris- recognition system (IRS) is capturing an image from iris. And the image acquisition stage is much necessary for success of other recognition stages due to quality of images capture from iris [7]. The images database available such as CASIA lack in reflections of pupil and iris areas because in such available images infrared was used for imaging. In some images, if the visible light is used as amid imaging for those individuals whose iris is dim, a slight difference comes to presence amongst iris and pupil which makes it difficult to isolate these two regions in later stage.

ii) Pre-processing

To improve and simplify the later stage processing, a primary processing is performed on iris images. The preprocessing of iris image is the combination of image localization & normalization [8]. In this stage of preprocessing , to improve the outer boundary of iris that is not well recognized in normal conditions canny edge detection method is used and multiplicative function that can enhance the canny iris points also image contrast adjustment is performed to make its pixels brighter.

iii) Iris Segmentation

In this stage of iris segmentation, extracting the features that gives information related to iris pattern [9]. The basic idea behind is to remove unnecessary information of pupil segment and the outside part is iris (eyelids, sclera, skin). The progress of segmentation depends on the image quality of eye images.

In this step the boundary region of iris is identified and after that converts this segmented region into template in the normalization step [10]. The major reason for most iris recognition system failure is inaccurate segmentation [6].

iv) Normalization

In this stage of IRS, capture the iris of different person in different size and even for same eye the size may change due to illumination and other factors. The normalization will make iris regions, which have the same unvarying extents, with the goal that two photos of the same iris under divergent circumstance will have Characteristic highlights at the same spatial area [11].

v) Feature Extraction

In this stage of IRS, the important features of iris must be encoded so that process of comparisons between templates ends [11]. Many iris detection systems uses band pass decomposition of the iris image to make a biometric template. Iris provides abundant consistency in sequence. In general, eliminate noise from iris image with generation of iris code.

vi) Matching

In this stage, identification, one with many pattern; or verification, one with another pattern; compared and matched with iris code being saved in database [11].

III. APPLICATION OF IRIS RECOGNITION (IR)

a) In computer login, iris can be used as live password.
b) Iris can also be used in ATM machines to biometrically authenticate bank accounts and withdraw money [12].
c) The application of iris can be used as entry password in highly secured areas as research laboratory, home, offices; where security is primary concern.
d) In mobile applications iris can be used as password, so that only authorized one can access the cell phone.

IV. Techniques of Iris Recognition

A. Watersheds Method:

Watershed image segmentation depends on the hypothesis of Mathematical morphology. Various methods have been proposed to process watersheds. The traditional thought for building the watershed is utilizing a topographical similarity, start by puncturing the provincial minima of the surface. At that point gradually submerge the picture into a lake. The water logically surges the bowls comparing to the different minima [12]. To keep the converging of two unique waters starting from two distinctive minima, we erect a dam between the two lines. Once the surface is completely drenched, the arrangement of the dams in this way assembled is the watershed of the picture. In one measurement, the area of the watershed is clear: it compares to the local maxima of the capacity. In two measurements, one can state in a casual way that the watershed is the arrangement of peak lines of the picture, exuding from the seat focuses. Watershed shape separate to beginning form. A watershed form is additionally a shut shape, yet it is precisely along the watershed edges, i.e., it is made out of watersheds. When we input an underlying physically depicted shape, we have to push (or consume) it to the close-by watershed edge to encourage the later computation. The technique enhances the catch go however it has disservice of over division.

B. Active contour models

Contour models (snakes) objective is to apply division procedure to a picture by doing distortion to the underlying form towards the limit of the question of intrigue. We do that by twisting an underlying shape to limiting the vitality work which characterized on forms there are two segments in this vitality: the potential vitality, which is little when the form is adjusted to edges of the picture, and the inside disfigurement vitality, which is little when the shape is smooth [12]. The two parts are form integrals regarding a parameter of the shape. An Active form can be parametrically spoken to by v(s) = (x(s), y(s)). Dynamic contour models (Snakes) can be spoken to by two models: area based models and edge-based models. The qualities of the picture decide the model we ought to pick. The fundamental favorable position of snakes' models is the capacity of snakes to give a straight portrayal of the protest shape amid the season of merging without including additional preparing. Be that as it may, what experimentally restricts the utilization of snakes is the need of the technique to have solid picture angles to have the capacity to drive the form.

C. Threshold Method:

Threshold in these calculations can be chosen physically as per from the earlier learning or naturally through picture data. Calculations can be additionally separated to edge-based ones, district based ones and cross breed ones Thresholds in the edge-based calculations are connected with the edge data. Structures are portrayed by edge focuses [12]. Regular edge discovery calculations, for example, vigilant edge identifier and Laplacian edge indicator can be grouped to this sort. Calculations attempt to discover edge pixels while wipe out the commotion impact. For instance, Canny edge locator utilizes the edge of slope size to locate the potential edge pixels and stifles them through the systems of the non - maximal concealment and hysterics shareholding. Consequently, it is important to apply post-handling like morphological operation to associate the breaks or dispose of the gaps. The technique can portion 3D picture with great exactness, however the disservice of this strategy is the trouble of the strategy to process the pictures of finished blob objects.

D. Daughman's Algorithm

Daugman uses an integral Differential operator [24] for segmenting the iris. Iris identification starts with finding an iris in a picture, outlining its internal and external limits at the pupil and sclera, identifying the upper and lower eyelid limits on the off chance that they block, and distinguishing and barring any superimposed eyelashes or reflections start the

cornea. This procedure could together be called as segmentation. The calculation is done twice, first to get the iris form at that point to get the pupil contour. It find both inner and the outer boundary of the iris area. [13].The equation is as follows

$$max\ (r, x_0, y_0) \left| G_\sigma \frac{(r) * \partial}{\partial r} \varphi \frac{I(x,y)}{2\pi r} ds \right|$$

Where x_0, y_0, r_0 are centre and radius of coarse circle ds is circular arc of radius r, I(x,y) is the image;

Gσ (r) is Gaussian function, Δr is radius range for searching for, and I(x,y) is original iris image.

The outer as well as the inner boundaries are referred to as limbic and pupil boundaries [14]. This method is based on linear search methods.

A. Histogram Equalization

Image can be enhanced using various operations such as increase in brightness, sharpening in image, blurring or noise removal. The most popular contrast enhancement technique is histogram equalization (HE) [15]. In HE, the histogram of image is shown by the occurrence of each intensity value. HE method utilized to build the dynamic scope of the histogram of an image. HE allots the intensity estimations of pixels in the information picture with the end goal that the yield picture contains a uniform distribution of intensities. It enhances differentiate and the objective of HE is to get a uniform histogram. This method can be utilized on an entire picture or just on a part of an image.

B. BI- Histogram Equalization

The Brightness Preserving Bi-Histogram Equalization (BBHE) method was proposed to overcome the drawbacks of HE. In BBHE segment the image into two sub-images, by utilizing the picture mean graylevel, and after that apply the HE technique on each of the sub pictures [15]. In bi-histogram equalization the histogram of the picture is isolated into two sub histograms in light of the mean estimation of the histogram of the original image, the sub-histograms are adjusted autonomously utilizing refined histogram leveling, which gives flatter histogram.

C. Contrast-Limited Adaptive Histogram Equalization (CLAHE)

CLAHE is different from ordinary AHE as it limits the contrast. This feature is also applicable to global HE, which gives rise to CLAHE [16]. It is mostly used in enhancement of low contrast retinal image. In case of CLAHE, a transformation function derived from contrast limited procedure to each neighborhood pixel.

V. LITERATURE REVIEW

Hu et al. [17] proposed new Improving color iris segmentation using a model selection technique. For this improve the reliability and accuracy of iris segmentation in the color eye images, i.e., in particular for the eye images captured with the static and mobile devices. The method is a combination of different segmentation model. To begin with analysis of an iris segmentation framework. It uses three different models to demonstrate that improvements can be achieved by selecting among the outcomes generated by three models. Then, use of model selection method that outlines the optimal segmentation based on a ring-shaped region around outer segmentation boundary identified by each model. Authors adapted the histogram of oriented gradients (HOG) as the features extracted from ring-shaped region and then train a SVM (support vector machine)-based classifier, which offers the selection decision.

Tossy et al. [18] proposed a method RANSAC (Random Sample Consensus) for fitting ellipse around non circular iris boundaries. The boundary of iris can easily and accurately be locate by proposed method rather than Hough transform. The performance of proposed algorithm is evaluated on WVU iris database [25] and is better from Daugman's iris recognition system.

Aparna G et al. [19] in this paper presented the feature extraction of iris recognition using Haar transform, PCA, Block sum algorithm with hybrid algorithm. We have applied these transforms on the iris images for finding out the recognition rate and accuracy. Results of this experiment have shown that the accuracy in recognition using hybrid algorithm is better than block sum, PCA and Haar transform. Also Hybrid classifier i.e. combination of ANN (Artificial Neural Network) and FAR / FRR are used for matching either image is accepted or rejected. FAR and FRR in percentage with respective various methods as shown in above graph. Thus proposed algorithm provides better accuracy and recognition rate than comparative algorithms.

Naglaa F. [20] in this paper, a quick iris confinement calculation, while protecting the precision contrasted with alternate methodologies. Thresholding is utilized as the initial

step rather than comprehensive inquiry of a three-dimensional parameter space for countless pixels. The proposed versatile thresholding framework has been utilized to beat the shifting light conditions. To ensure a satisfactory exactness, the proposed calculation fine stage utilized the known Daugman'sintegro differential operator. It has been applied into two segments, and in a specific area according to database. In this searched a center parameter in a neighborhood of 10x10 pixels around initial center. The impact of errors in iris boundary is low at matching stage where as pupil boundary problem result in FRR. The proposed approach gives high processing speed and acceptable accuracy in compare to other methodologies.

Kanchan S.et al. [21] in this proposed system, the person is authenticated using his own unique retina pattern. Though, the number of images used to evaluate the performance of the proposed system is not more, the performance of the system and the results are interesting. The GLCM (Gray Level Co-occurrence Matrix), Gabor and LBP (Local Binary Pattern) texture features are considered separately. For classification, we have used SVM classifier. For the performance evaluation of DRIVE and HRF standard image dataset, iris recognition process is carried out by using blood vessel segmentation. Though the GLCM and Gabor features when considered separately, does not give promising results, the combined results shows more accuracy. The system has shown the outstanding performance using LBP features.

Shin et al. [22] propose to use eyelash distribution and specular reflection points as features to determine the eye orientation. They use the standard deviations of the pixel values in search regions positioned on the left and right sides of the pupil to identify the presence of eyelashes and specular reflection points, and determine if the analyzed search region corresponds to that of the tear duct or the outer eye corner (the lateral canthus). The authors operate on visible-light eye images rather than near-IR images.

VI. PERFORMANCE MEASUREMENT

In this section discuss about performance parameter of iris recognition system and also shows iris image comparison on different enhancement methods as well.

A. FAR (False Acceptance Rate):

A FAR is the measure of the probability that biometric security framework will incorrectly accept an access attempt by an unauthorized user [26].

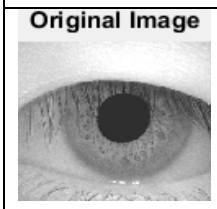
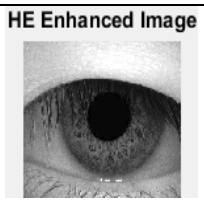
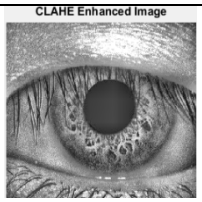
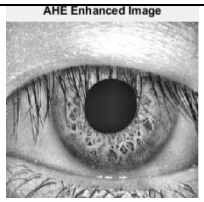
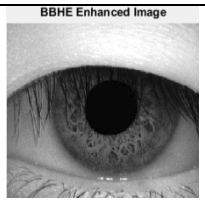
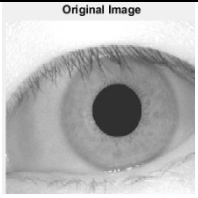
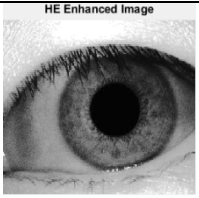
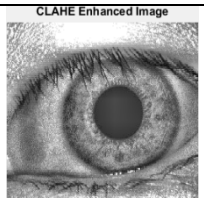
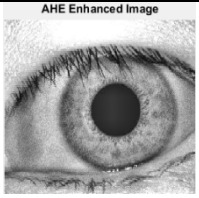
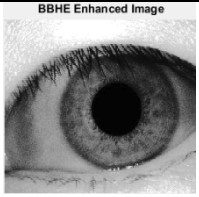
$$FAR(\%) = \frac{No.ofincidentsoffalseacceptance}{totalNo.ofsamples} x100$$

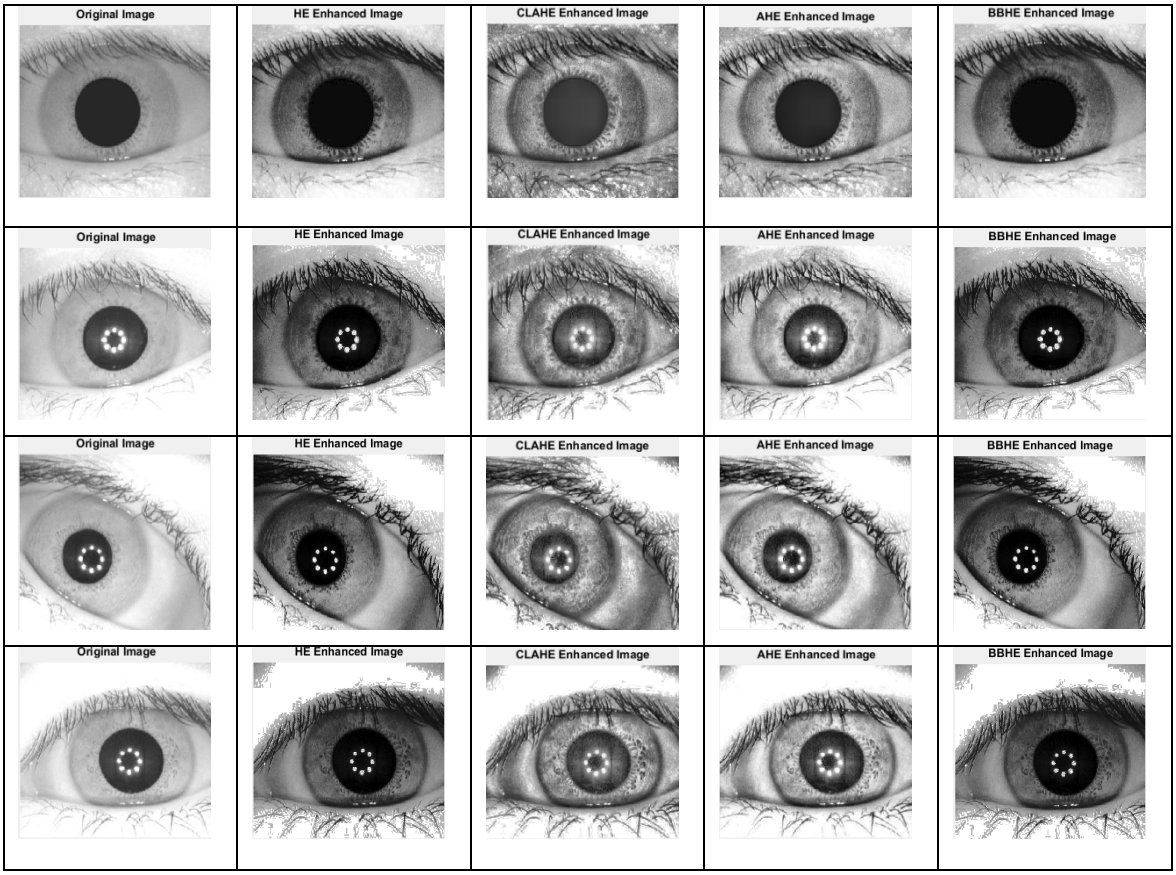
B. FRR (False Rejection Rate):

A FRR is the measure of the probability that biometric security framework will incorrectly reject an access attempt by an unauthorized user [26].

$$FRR(\%) = \frac{No.ofincidentsoffalseRejection}{totalNo.ofsamples} x100$$

Table 1: Comparison of Iris Image on Different Enhancement Methods

Iris Image	Histogram Equalization (HE)	CLAHE	Adaptive Histogram Equalization (AHE)	BBHE
				
				



VII. CONCLUSION

Iris recognition has gained a greater attention due to its uniqueness, stability over the years and difficulty in forging the Iris. The physiological and behavioralcharacteristics of every person are unique. Iris recognition is most method for visual recognition of person. In this paper a comparative study on iris recognition using different enhanced method is present. Also the review of various existing methods proposed by different researcher in iris recognition.The Iris recognition system is one of the best secure methods of authentication.

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