Iris Recognition System: A Novel Approach For Biometric Authentication

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***Abstract*—The main issue of this decade is security. Nowadays, there are different authentication systems based on a password, card and biometric are present. Password and card based systems are the failure due to humans' poor judgment. The researchers suggest that the biometric is most secure and prominent solution for systems security. Among the biometric systems, iris-based biometric systems are more secured. In this proposed system, segmentation technique utilized shape, intensity and localization of the pupil and iris. The segmented region is converted into the rectangular region by normalization process. The use of Gray Level Cooccurrence Matrix (GLCM) and Hausdorff Dimension (HD) extracts the texture based features. The extracted features were classified by supervised SVM machine learning algorithm. The performance of the proposed system shows the robustness of the system.**

Keywords— BGM (Biometric GLCM, Graph Matching), Hausdorff Dimension, IRIS, SVM, Segmentation

I. INTRODUCTION

Safety is the most important thing for the systems nowadays. The authentication makes the system secure. The authentication systems are of three types i.e. password, card and biometric based. Password based systems are mostly used in bank, online accounts, email accounts etc. Card based systems are used in ATM, door authentication in companies. But the security of these systems can be easily broken because of human tendencies. So Biometric provides the strong security because of its uniqueness. There are different types of biometric systems like face recognition, fingerprint recognition voice pattern recognition, retina systems. Among all biometric systems, iris recognition system is best.

The iris recognition systems can be applicable to provide the authentication to banking, financial transactions and the system where security has prime importance.

Iris biometric authentication system is present in the processed system. The system consists of basic image processing blocks like image acquisition, preprocessing of the input image, feature extraction and authentication by machine learning approach.

The paper is organized as follow- In next section; different methods proposed by researchers are discussed with their pros, cons, methods and results. The proposed system is elaborated in section III. In qualitative and quantitative in section IV results have been discussed. The conclusion of the paper is in section V.

II. LITERATURE SURVEY

S. B. Kulkarni et al. [1], implemented the SVM machine learning approach along with GLCM and GLRLM feature extraction system. The proposed system achieved 75%.75.14% and 88.89% accuracy from GLCM, GLRLM and combination of GLCM and GLRLM respectively.

Amol M. Patil et al. [2] present texture feature extraction technique based on GLCM and Hausdorff Dimension technique. The process of matching of the iris is taken place by BGM algorithm. In this graph, topology is used to define feature vector of the iris. And the SVM classifier is used to classify the extracted feature vectors.

Seyed Mehendi et al. [3], proposed a biometric authentication system using graph matching technique. The system utilized about 60% images of the VARIA iris database. In preprocessing, the iris images were enhanced by histogram equalization, matched filter and some morphological processing. Finally, decision was made by SVM classifier.

Upasana Tiwari et al. [4], introduced person identification method which uses MMU and CASIA iris image database. In this system, the features are extracted using Gabor filter and reduced its dimensionality by PCA algorithm. An SVM classifier classifies the iris into authorized and unauthorized categories.

Hough transform is the approach used to segment the iris region. The features are extracted from extracted iris using Gabor filter. Supervised ANN and SVM classifier trained and classify the extracted features. It achieves the 83.65% and 90.25% respectively.

In 2015, P. Steffi Vanthana et al. [6] proposed iris detection system using GLCM and Hausdorff dimension. The segmentation of the iris is carried out by utilizing shape, intensity, and localization. The features were extracted using GLCM and Hausdorff dimension technique. This system uses a support vector machine classifier to distinguish between authenticated and unauthenticated person.

Sushilkumar S. Salve et al. [7], in 2016 proposed a novel approach to person identification system using iris. This approach uses a canny edge detector and Hough transform. The Daugman's rubber sheet model was used for normalized the iris segmented image. 1D log-Gabor filters extracted features from the normalized iris image and feature vector were trained and test with SVM and ANN classifier. This system gives an

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accuracy of 95.9% for RBF kernel, 94.6% for a polynomial kernel, and 92.5% for ANN.

III. PROPOSED SYSTEM

The robust approach for iris recognition is presented by proposed system. The proposed iris recognition system's diagram is shown in fig. 1.

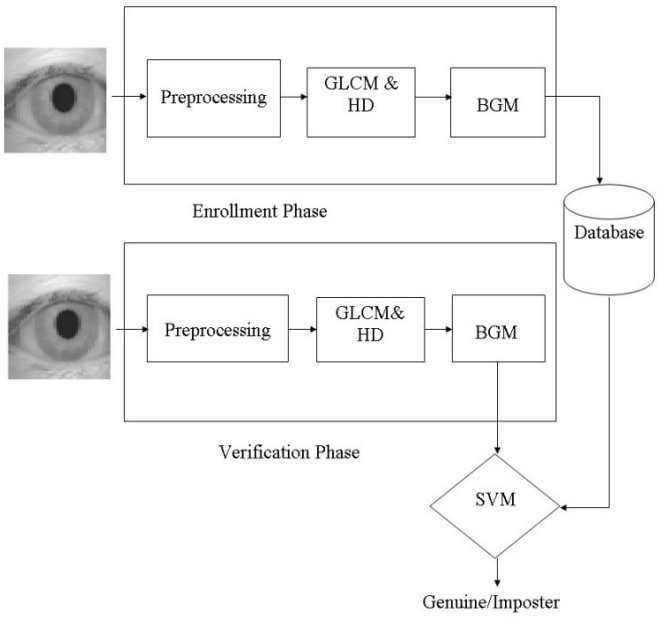

Fig. 1. Block diagram of iris recognition system

The proposed system broadly divided into two steps: Enrollment phase and verification phase. In enrollment phase, the iris image of the person has been enrolled while in recognition phase authentication is given to enrolled person by verifying his/her iris pattern or feature.

A. Image preprocessing and segmentation

First, the iris image is taken as an input to the system. The captured images are noisy, so it is important to remove the noise from the image to make it suitable for further processing. The median filter is used to remove the salt and pepper noise from the iris image.

The captured eye image consists of pupil, iris, and cilia. We are interested in iris part only, so segmentation of iris part from the eye image is a crucial task hence to localize the inner and outer part is essential. It is located by canny edge detection. In canny edge detection, the only vertical direction is considered because in vertical direction eyelids are suppressed. The iris and pupils are circular so circular Hough transforms is used. Hough transform has an advantage of higher computational time. Circular object can be extracted by using formula

$$x^2+y^2 - c^2 = 0 \quad (1)$$

The extracted iris part is different in size for different iris. For the global system, the size and shape of the iris image should be same in size. The normalization is the process which the circular intensities of iris part is converted into polar. Daugman's rubbersheet model is used for the normalization process. Iris point is remapped to the pair of polar coordinates which is represented by (r, θ) into a Cartesian coordinate (x, y) is given by

$$I(X(r,\theta), y(r,\theta)) \rightarrow I(r,\theta) \quad (2)$$

Where,

$$x(r,\theta) = (1-r)\, xp(\theta) + rxi(\theta)$$
$$y(r,\theta) = (1-r)\, yp(\theta) + ryi(\theta)$$

B. Feature extraction

In this paper, the feature extraction is carried by two feature extraction techniques. The feature extraction techniques are explained in detailed below.

1. Gray Level Co-occurrence Matrix (GLCM)

The image matrix by setting offset calculates the GLCM matrix. By the consideration of the distances and directions, the GLCM matrix is constructed. The texture features like energy, entropy, homogeneity, correlation, contrast, etc are extracted from the GLCM.

a. Contrast

It is used to calculate the local variations in GLCM matrix.

$$contrast = \sum_{i,j} |i-j|^2 p(i,j) \quad (3)$$

b. Homogeneity

Homogeneity measures of the closeness of the element distribution in GLCM to GLCM diagonals.

$$\text{Homogeneity} = \sum_{i,j} \frac{1}{1+(i-j)^2} p(i,j) \quad (4)$$

c. Energy

Energy is the measure of uniformity between the pixels.

$$\text{Energy} = \sum_{i,j} p(i,j)^2 \quad (5)$$

d. Entropy

The entropy of an image is a statistical measurement of the randomness of the pixel element.

$$\text{Entropy} = -\sum_{i,j} p(i,j)\, log(p(i,j)) \quad (6)$$

e. Correlation

Correlation between the pixels is a measure of linear dependency of the relative pixel.

$$\text{Correlation} = \sum_{i,j} \frac{(i,j)p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y} \quad (7)$$

2. *HAUSDORFF DIMENSION*

Hausdorff dimension (HD) is a feature extraction technique which extracts the roughness features from the image. The algorithm for HD is as shown in fig.2. The fractal dimension is counting the complexity of an image.

HD measures the features of iris image region and a set of features for each object in the binary image of the iris, which must be a logical array it can have any dimension.

The shape and color features are given below:

a. Mean:

Mean is a fraction of iris image taken for consideration to the total number of the iris image in the database.

$$\mu = \frac{1}{N}\sum_{i=0}^{N-1} X_i \quad (8)$$

b. Standard deviation:

Standard deviation is the measure of scattering of the measured values from the mean.

$$\sigma = \frac{1}{N}\sum_{i=0}^{N-1}(X-\mu)^2 \quad (9)$$

c. Area

Area is calculated as number of non-zero elements present in iris image

d. Perimeter

The perimeter is calculated as the distance between the two different boundaries pixel of an iris image.

e. Solidity

Solidity is a fraction of actual area of an iris image to the convex area.

$$Solidity = \frac{Area}{Convex\ Area} \quad (10)$$

f. Eccentricity

Eccentricity is the ratio of major axis to the minor axis of elliptical foci.

$$E = \frac{\sqrt{(a^2-b^2)}}{a} \quad (11)$$

Where, a, is the major axis and b is the minor axis of the equivalent ellipse representing the iris region.

C. Classification

The extracted features were classified using support vector machine (SVM) classifier. SVM is a supervised machine learning technique. In SVM the data features are classified into two group using hyperplane. In the proposed system, classification is carried out by linear kernel function and it is given by-

$$f(x) = w^T X + b \quad (12)$$

Where,

W is the normal vector to the hyperplane,
b is the offset of the hyperplane,
X is the training samples

IV. Result and Analysis

In this project given input image is segmented for localization, normalization and analyzed the feature vector. Each testing iris is matched against each stored database template at each level. A genuine and imposter matching is defined as the matching between iris features of training image and iris features of the test image.

In this system, 13 person's iris images are stored in the testing database. 3 images per persons hence total 30 images are stored in the training database. From the 13 people, 8 people are authorized and other 5 are unauthorized persons. The results of the system are evaluated in two ways qualitative and quantitative.

a. Qualitative analysis

It is non-statistical approach of the research where the results are analyzed by pictorial format. The results of each step of the proposed system is explained in Fig. 2

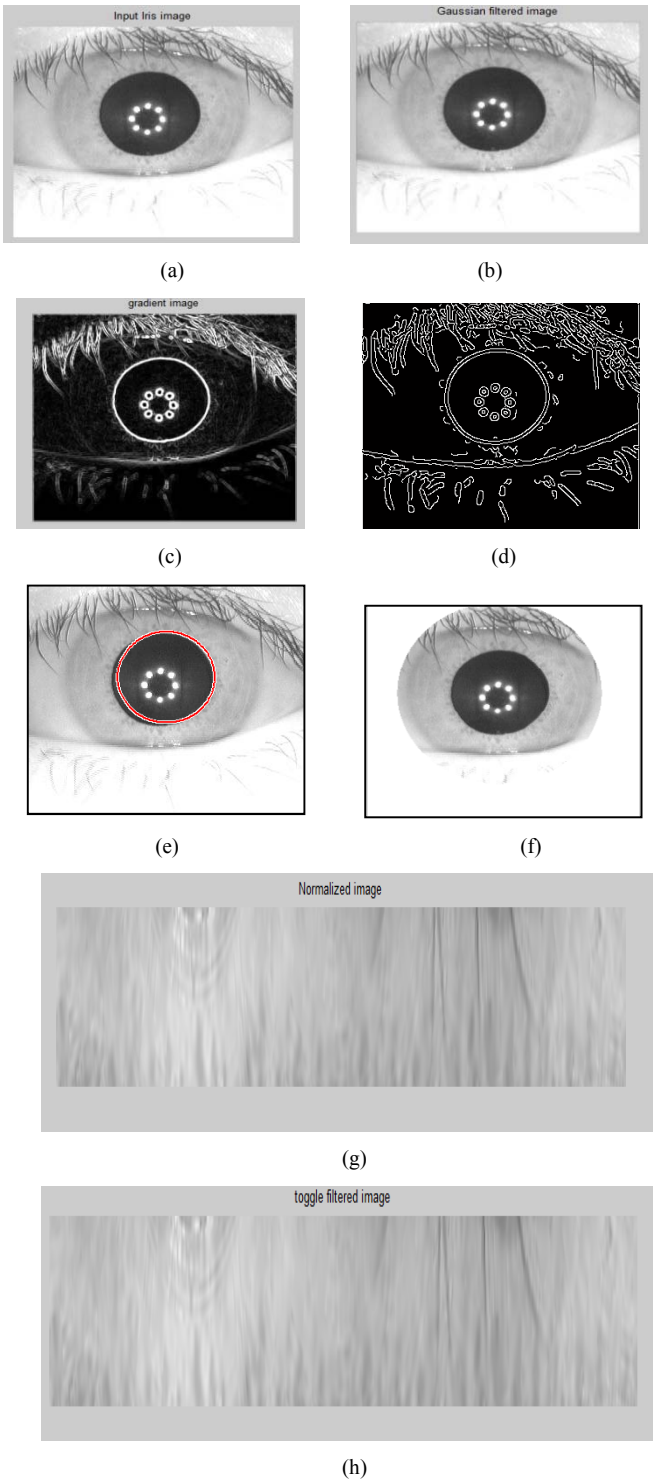

Fig. 2. Qualitative analysis:(a) Input Image from CASIA database (b) Gaussian filter output (c) Gradient image (d) Canny Edge detection output (e) Pupil detection (f) Iris detection (g) Normalized image of Daugman's rubbersheet Model output (h) Toggle filter output

b. Quantitative analysis

The proposed system is tested on 13 images. The expected results and systems results are tabulated in Table 1.

TABLE I. QUALITATIVE ANALYSIS

Sr. No	Test image	Expected Result	Actual Result
1	001_2_4.bmp	A	UA
2	002_2_4.bmp	A	A
3	003_2_4.bmp	A	A
4	004_2_4.bmp	A	A
5	005_2_4.bmp	A	A
6	006_2_4.bmp	A	A
7	007_2_2.bmp	A	A
8	007_2_4.bmp	A	A
9	008_2_3.bmp	UA	UA
10	008_2_4.bmp	UA	UA
11	009_2_4.bmp	UA	UA
12	010_2_3.bmp	UA	UA
13	010_2_4.bmp	UA	UA

Table I shows the quantitative analysis of the proposed system. In this table, A represent the authenticated and UA represent Un-Authenticated person. For evaluation of the proposed algorithm, 8 authenticated and 5 un-authenticated persons are taken as an input. The respective results are tabulated in Table II.

The results of the proposed system are calculated in terms of sensitivity specificity and accuracy which is defines in Eq. 13, Eq. 14 and Eq. 15 respectively.

$$Sensitivity = \frac{TP}{(TP + FN)} \quad (13)$$

$$Specificity = \frac{TN}{FP + TN} \quad (14)$$

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (15)$$

From Table 1, the performance parameters are calculated and tabulated in Table 2.

TABLE II. RESULTS IN TERMS OF SENSITIVITY, SPECIFICITY AND ACCURACY

Database	TP	TN	FP	FN	Sensitivity	Specificity	Accuracy
CASIA	7	5	0	1	87.50%	100%	93.75%

Finally, the results of proposed system are compared with the method explained by Asim Ali Khan et al. [5] and it is presented in TABLE III.

TABLE III. COMPARISION OF ACCURACY OF PROPOSED SYSTEM WITH SYSTEM PROPOSED BY [5]

Methodology	Accuracy (%)
Artificial Neural Network	83.65
Support Vector Machine[5]	90.25
Proposed System[5]	93.75

The comparative analyses of the proposed system with existing methods are tabulated in Fig.3.

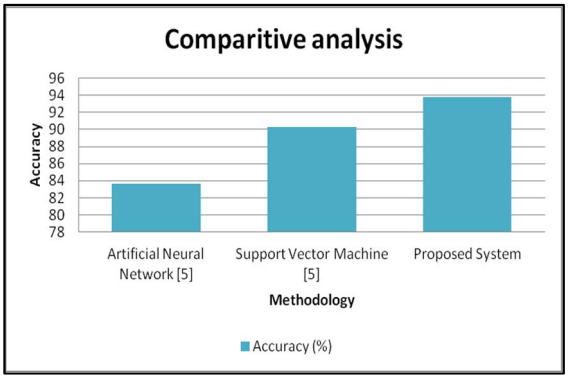

Fig. 3. Comparitive analysis of proposed system with existing methods

From the comparative analysis, it is observed that, the proposed system is working robustly with high accuracy.

V. CONCLUSION

In biometrics, the iris is one of the users friendly because without the individual contact the characteristics of a person easily find out and also provide security and authentication in an efficient manner. The proposed method involves the biometrics details is extracted by using two technique such as GLCM (Gray Scale Co-occurrence Matrix) and Hausdorff Dimension (HD). From GLCM texture features like energy, contrast, entropy, Correlation Coefficient, homogeneity is extracted. Finally, SVM is used to classify whether the person is authorized or unauthorized. The proposed system achieved the accuracy of 93.75%.

In future work, this limitation can be addressed by multimodal biometrics system to combine both the biometric characteristics derived from one or modalities such as Palm print and iris which give a high level of security and different secure applications.

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