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Fuzzy Mean and Variance Based Iris Recognition System

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***Abstract*– Iris recognition is a biometric approach for person authentication. In this research paper a unique method is proposed for applying moments to extract features of human iris. Moments are used to get properties of certain interesting area. It includes intensity of pixels, centroid, invariants of moments and orientation. Then next approach is to compute mean and variance, which are used with rule based fuzzy to get better classification rate. Here two phases of analysis have done which gives us valuable outcomes of proposed approach. Obtained average CCR is 86.6% in first test and 95% in second test.**

***Index Terms*– Biometrics Iris Recognition, Moments, Fuzzy Rules, Correct Classification Rate, Mean and Variance**

I. INTRODUCTION

IN today's digital world a wide range of reliable person identification requires like financial transaction and ATM banks, access control to buildings. Automated attendance system is also based on biometric authentication. Biometric authentication system is invented by the need of unique identification. Traditional way of authentication can be easily hacked. Passwords, pins and pattern matching are easily hacked by criminals. These types of authentication are not as safe as biometric authentication. Biometric characteristics can be divided in two terms:

- *Physiological Biometrics*
- *Behavioral Biometrics*

Behavioral biometrics is obtained by the way a person behaves. This can include a person's speech, walking patterns and key stroke.

A physiological characteristic is obtained by direct measurement of the body parts of human. Iris recognition, finger print and hand scans are most successful measurement for authentication.

The Iris is a thin, circular structure in the eye, responsible for controlling diameter and the size of the pupils. Iris is responsible for the amount of light that is reaching to retina. In response to the amount of light, muscles attached to the iris expand or contract the aperture at the center of the iris, known as the pupil shown in Fig. 1.

II. PREVIOUS WORK

Iris recognition is a robotic method of biometric identification that uses mathematical techniques on captured images of any person's eye. Not to be confused with other, less prevalent, ocular-based technologies, retina scanning and eye printing, iris recognition uses camera expertise with slight infrared illumination to acquire images of the detail rich, intricate structures of the iris externally visible at the front of the eye. Images should be detailed rich and should elaborate the structure of iris.

Various Iris Recognition System has been prepared for authentication in many countries to authenticate a person for example it is used as RAIC identity program in Restricted Area, passport free immigration. Most important example in India is Aadhaar. People are being enrolled in Aadhaar on the basis of iris pattern matching. Iris Recognition System is highly secure because iris is visible and external yet it is very safe. It is very safe and stable part of body. Iris Recognition system is a very high security system. Iris can't be same of two individuals. Even twins can't have same iris. A gray level image is obtained through a video camera to have intended portion of the image. Iris is the annular ring between the pupil and the sclera of the eye.

The structure of the iris remains fixed from one year to over the period. A typical iris recognition system shown in Fig. 2 involves following steps:

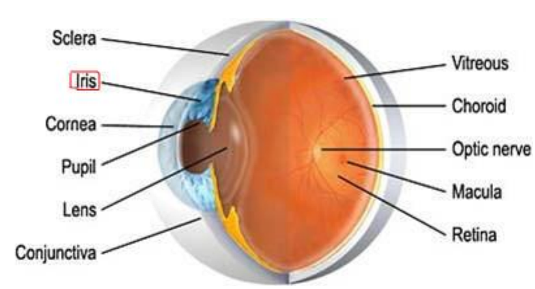

Fig. 1. Structure of human iris

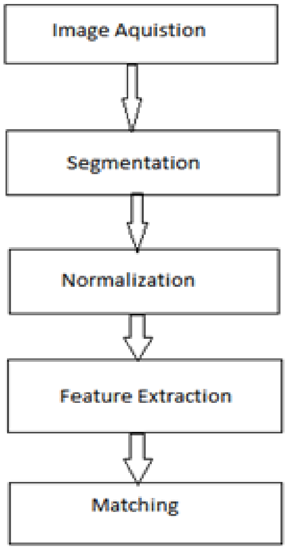

Fig. 2. Generalized iris recognition block diagram

The first step, image acquisition deals with capturing sequence of iris images from the subject using cameras and sensors. These images should clearly show the entire eye especially iris and pupil part, and then some preprocessing operation may be applied to enhance the quality of image e.g. histogram equalization, filtering noise removal etc. Next step of iris recognition is segmentation which is used to isolate iris portion from eyes. It is a technique used for locating the circular iris region. The inner and the outer boundaries of the iris are calculated. The better quality of iris segmentation depends on quality of eye image. The third step is to normalize the iris segmentation. The normalization process will produce iris regions of same constant dimension which will help the two iris images to have same characteristics features under different conditions to achieve the best recognition rate of an individual, the most prominent features of iris patterns are extracted in fourth step that is feature extraction. In this process only major features should be considered so that comparison between two templates can be achieved efficiently. In iris recognition system, the last step is the template matching of the significant features to find the best matching rate. Most of the authors [11], [12] have used hamming distances between two iris templates for matching.

The first general concept patent addressing iris recognition can be attributed to the work of Flom and Safir in the 1980s. They suggested the use of Iris as a biometric recognition technique. Flom and Safir asked John Daugman to develop Iris Recognition software. J. Daugman [2], [3] designed and patented the first complete, commercially available phase-based iris recognition system in 1994. Wildes, Boles and Sanchez-Reillo, has tried to do the same but in different manner. They use different Iris feature extraction method and pattern matching method. Wildes uses a diffused light source with low light level camera to capture image. For localization of iris and pupil boundary he uses Hough transform based on texture analysis. For feature extraction he employed Laplacian of Guassian filter at multiple scale to represent characteristics of the human iris. To match the templates Wildes applied a modified normalized correlation. Boles and Boashash [5] proposed a novel iris recognition algorithm based on zero crossing detection of the wavelet transform, this method has only obtained the limited results in the small samples, and this algorithm is sensitive to the grey value changes, thus recognition rate is lower.

The process starts with the image-feature extraction where three discrete i.e., (x, y) which corresponds to the pixel position, and z which corresponds to its intensity values has got extracted for each and every image pixel, which is followed by the application of a clustering algorithm which is the fuzzy K-means algorithm [6]. This has been used in order to classify each and every pixel and then generate the intermediate image. This correspondent image is then used by the edge-detector algorithm.

As it has additional homogeneous characteristics, this eases the tuning of the parameters which were needed by the edge-detector algorithm. The main advantage of this method is that, it provides a better segmentation for non co-operative iris recognition. The major drawback in this method is that thorough (extensive) search is needed in order to recognize the circle parameters of both the pupil as well as the iris boundaries. Most of the authors have calculated Hamming distance [12] between two iris templates. The Hamming distance algorithm employed also incorporates noise masking, so that only significant bits are used in calculating the Hamming distance between two iris templates.

III. PROPOSED METHODOLOGY

In this paper, an approach has been proposed based on moments of human iris. Image moments have been widely used for Iris Recognition for a very long time. Moments are capable of providing a representation of any object. Moments are scalar quantities used for hundreds of years to characterize a function and to capture its significant features.

The working flow of our proposed approach is shown in Fig. 3. The first step of our model is to capture iris of a human

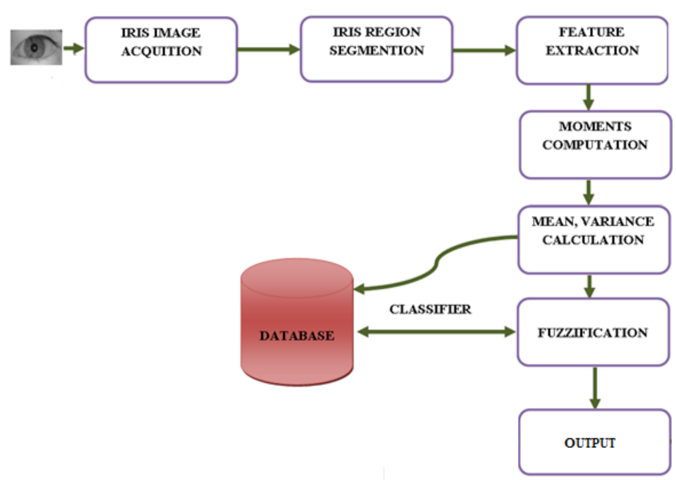

Fig. 3. Flow Diagram of Proposed Model

being, which has to be used for individual recognition. Once the gray scale image of the eye is obtained then the software tries to locate the iris within the image. Segmentation is the process of locating the iris part and excluding the artifacts. Iris is segmented from the image of eye to detect the edges. Canny is best edge detector as compared to Prewitt, Sobel and Robert so in this work canny is used to calculate edges. Moments calculation of a particular subject iris is the next process in this approach, then mean and variance are computed, shown in Table 1.

$$\text{Mean } (\mu) = \frac{\sum_{i=1}^{n} xi}{n} \quad (1)$$

$$\text{Variance } (v) = \frac{\sum (x-\mu)^2}{n} \quad (2)$$

Table 1: Each Subject Iris moments, mean variance value

Subject	Mean	Variance
1	0.0959	0.0007
2	0.0994	0.0016
3	0.0904	0.0005
4	0.0726	0.0007
5	0.0854	0.0008
6	0.0813	0.0005
7	0.0889	0.0012
8	0.1044	0.0013
9	0.0969	0.0007
10	0.0846	0.0018
11	0.0688	0.0002
12	0.0709	0.0006
13	0.0784	0.0006
14	0.0806	0.0014
15	0.062	0.0009

After calculating means and variance of each fuzzy rule are applied to get the better Correct Classification Rate.

Human beings make decision based on rules. Rules associate ideas and relate one event to another. We always follow if then conditions. Our decisions are also based on these rules. For ex if we want to go out we first check the weather. If weather will be nice we will go out if conditions are not suitable we will not go out. Fuzzy machines are also based on this nature.

They always follow the behaviors of human being; however, the decisions and the means of choosing that decision are replaced by fuzzy sets.

If X then A, if Y then B where A and B are all sets of X and Y.

A) Proposed Algorithm

1. Input Subject Iris, Repeat Step 1 to 7.
2. Convert Input Image[IM] into Gray Level[GL]
   GL(x,y)=IM(x,y)
3. Process Iris Region Segmentation.
4. Process Feature Extraction over the Gray Level Image.
5. Process Moments Calculation on step 4.
6. Compute Mean and Variance

   $$\text{Mean } (\mu) = \frac{\sum_{i=1}^{n} xi}{n}$$

   $$\text{Variance } (v) = \frac{\sum (x-\mu)^2}{n}$$
7. Store Data in Database
8. Apply Fuzzy Inference System to get better classification Rate
9. Output.
   [End Step 1 to 9]

IV. EXPERIMENT RESULTS

The proposed model is designed using MATLAB 7.5. Minimal dataset of 15 subject's iris is used. Result is classified into two phases:

- Without fuzzy
- With fuzzy

A) First Phase Analysis

In the first phase analysis, without fuzzy means that we are not considering rule based fuzzy for analysis. After feature extraction of inputted iris data, two parameters values have been computed i.e. mean and variance for each subject. Mean and variance for each subject is shown in Table 1.

The Fig. 2 and Fig. 3 show variations of mean and variance for each particular subject.

In first phase analysis, false match error has been calculated for each parameter of each subject and computed the correct classification rate (CCR) based on each parameters.

From table1, it is noticed that first parameter mean have zero false match error rate for each subject and the CCR is 100%. The second parameter variance, from table1 reveals the false match error rate 26.66%. So the correct classification rate for variance is 73.33%. So, from these two parameters analysis, the average CCR is 86.66%.

B) Second Phase Analysis

In second phase analysis we have used rule based fuzzy with these two parameters (Mean, Variance) for each subject. Second phase of analysis have four matching classification i.e Excellent(E), Good(G), Average(A) and Poor(P) on their values. We have kept the threshold value of 80%, after applying fuzzy on individual subject, if the output value of fuzzy is above the threshold, than it is considered to be excellent match and that subject comes under the category of recognizable. Second phase analysis focus only on excellent match. So analysis is done to find out excellent false match error rate (EFMER). Second phase analysis is sub classified into two parts:

- Analysis with same stored subjects
- Analysis with testing subjects

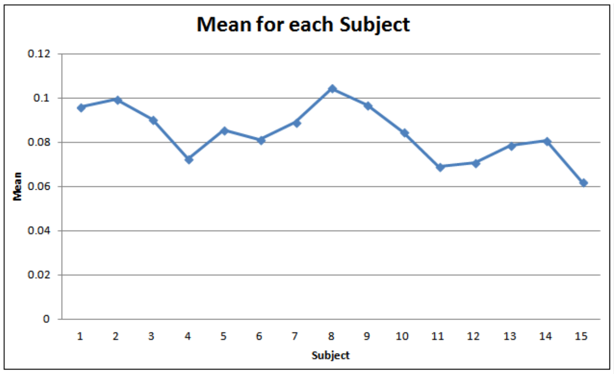

Fig. 2. Variations of Mean

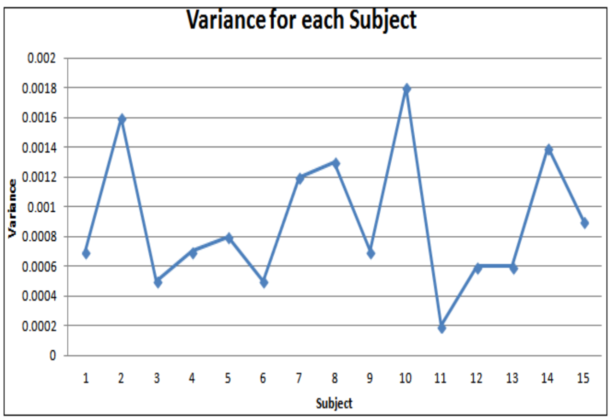

Fig. 3. Variations of Variance

1) Analysis with Same Stored Subjects

In first analysis that is with same stored images, 15 subjects dataset is used, out of which 10 subject parameter values are stored in the database and rest 5 subjects are taken for testing. In analysis with same stored images, 10 subject's parameters values are tested with itself. In this testing rule based fuzzy has been used for analysis. First 10 subject values have been saved in database, then each subject is inputted in designed model to find out False Match Error.

Table 2 shows the fuzzy outcomes of the first analysis, which are classified into four categories i.e. Excellent, Good, Average and Poor. Table 3 depicts the numeric values for the Table 2. This analysis focuses on excellent match category and computed the excellent false match error rate (EFMER). On the basis of EFMER correct classification rate is determined in this analysis. From Table 3 it has been found that subject 1 has false match with subject 9 and the false match error rate of excellent category is 10%. So the correct classification rate is 90%.

Table 2: Analysis with Same Stored Images

Subject	1	2	3	4	5	6	7	8	9	10
1	E	A	G	G	G	G	A	A	E	A
2	A	E	A	P	A	P	G	G	A	G
3	G	A	E	A	G	G	A	A	G	A
4	G	P	A	E	G	G	A	P	G	A
5	G	A	G	G	E	G	G	A	G	A
6	G	P	G	G	G	E	A	P	G	A
7	A	G	A	A	G	A	E	G	A	G
8	A	G	A	P	A	P	G	E	A	A
9	E	A	G	G	G	G	A	A	E	A
10	A	G	A	A	A	A	G	A	A	E

Table 3: Analysis with Same Stored Images with Numeric Value

Subject	1	2	3	4	5	6	7	8	9	10
1	86.537011	63.04915	70.02496	73.63383	75.12993	66.46445	65.31929	63.7646	85.74213	58.58854
2	63.049145	86.53701	57.91904	53.57898	60.45909	54.29288	69.54811	74.23244	63.43628	73.82072
3	70.024959	57.91904	86.53701	64.71516	67.25354	80.08814	63.27575	57.83758	69.66433	58.20353
4	73.633831	53.57898	64.71516	86.53701	73.2691	68.16911	61.00708	54.64958	73.34682	57.63003
5	75.129927	60.45909	67.25354	73.2691	86.53701	67.53697	69.12936	62.00031	74.80392	64.21398
6	66.464448	54.29288	80.08814	68.16911	67.53697	86.53701	60.54942	54.32079	66.13668	59.19356
7	65.319287	69.54811	63.27575	61.00708	69.12936	60.54942	86.53701	75.05446	64.95349	68.79335
8	63.764602	74.23244	57.83758	54.64958	62.00031	54.32079	75.05446	86.53701	64.13017	65.30301
9	85.742133	63.43628	69.66433	73.34682	74.80392	66.13668	64.95349	64.13017	86.53701	58.22536
10	58.58854	73.82072	58.20353	57.63003	64.21398	59.19356	68.79335	65.30301	58.22536	86.53701

Table 4: Analysis of Different Images with Stored Images

Subject	11	12	13	14	15
1	P	G	G	A	A
2	P	P	P	G	P
3	P	G	G	A	P
4	A	G	G	A	G
5	P	G	G	A	G
6	A	G	G	A	A
7	P	A	A	G	A
8	P	P	P	G	A
9	P	G	G	A	A
10	P	P	A	G	P

Table 5: Analysis of Different Images with Stored Images Numeric Value

Subject	11	12	13	14	15
1	49.79369	67.73519	71.03041	59.71922	61.3445
2	45.7265	51.46714	54.50225	71.38932	52.13165
3	53.96768	68.65015	72.15485	58.22147	54.70792
4	58.84108	77.16732	75.43928	62.07414	69.15717
5	52.54054	67.12139	70.42257	65.63149	68.4389
6	57.41245	72.33212	75.60648	62.16654	58.03228
7	49.603	57.95531	61.34479	74.75958	61.9276
8	44.98088	52.00163	55.00473	71.67629	56.12971
9	49.49796	67.44688	70.64365	59.36823	61.12868
10	50.05725	55.54499	59.06904	72.77606	55.23633

2) Analysis with Testing Subjects

Here 10 subject parameter values are used in the database and 5 different subject parameter values are used to test with the stored database using rule based fuzzy. Output of the fuzzy for this analysis is shown in Table 4 and their corresponding numeric value is shown in Table 5.

From the Table 4 it is found that error rate of excellent match is 0% and correct classification rate is 100%. In second phase analysis the average classification rate is 95%.
Table 6 shows the classification rate of both phase analysis and average classification rate (ACR) for both phase analysis.

Table 6: Classification Rate of both phases

Analysis	CCR	ACR
1st Phase Analysis 1. mean 2. variance	 100% 73.33%	 86.66%
2nd Phase Analysis 1. 1st Analysis 2. 2nd Analysis	 90% 100%	 95%

V. CONCLUSION

Iris plays a vital role in biometric security systems, as it is physiological trait of biometric. Large scale of research has been proposed by researchers in this field. This approach is to identify an individual based on moments of iris using fuzzy. Analysis has been done in two ways. From both analyses it is concluded that average classification rate of first analysis is 86.66% and average classification rate of second phase analysis is 95%. Excellent match category is considered in second phase analysis, which can be expanded to other categories for analysis in future. Another challenge for our proposed approach is lack of dataset, which can be improved with creation of own database.

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