



# MULTIMODAL OF FACE AND IRIS BASED ON LOCAL BINARY PATTERN AND GABOR-ZERNIKE MOMENTS

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**Abstract:** This paper presents the multimodal of face and iris based on the same feature extraction techniques for the both traits. For locating the iris, compute the next three neighbour-pixels from the pupil-circle in horizontal-right and horizontal-left, and if it found the value of those pixels are close to the sclera values (because it is close to the white color), then it will stop otherwise continue to the next pixels. The radius of the iris is obtained from the number of skipped-pixels. The iris is normalized by using the Rubber Sheet Normalization. The texture features of iris and face were extracted by using the Local Binary Pattern (LBP) and Gabor-Zernike Moments. Different classifications were used to evaluate the proposed system. The experiment was performed on the ORL and CASIA-Iris databases and the performance of the system is found to be satisfactory.

**Keywords:** LBP; ROI; Gabor; Zernike Moments; Classification

## I. INTRODUCTION

The biometric recognition means the analysis of the physical parts of human-body or the behaviour activities. The biometric recognition is one of the pattern recognition application and it becomes one of the most interest area for the researchers. Now a day, the biometric system is almost used by all the people, even to unlock the private mobile or to secure the files. The face and iris are physical biometric traits, and both of it have different features than the other, so the extraction of the texture features was proposed. In this paper, two traits were selected for the experiment face and iris. Face is the human-way to recognize each other. The face is one of the few physical biometrics trait that's can be recognise from a distance, so the face is used also in the surveillance system. The iris is looked like a ring inside the eye, and it control the intensity of light which is entering through the pupil. So, the radius of the iris is increasing and decreasing according to the illumination of light.

The multimodal of biometric system is to combine/fuse more than on trait of biometrics, for increasing the accuracy of the system [1]. Thus, the fusion of face and iris were proposed in this paper. The combine of Local Binary Pattern and Gabor-Zernike moments were performed for extracting the local and texture features of face and iris as well.

The rest of the paper is organized as follows, Section II describes the related work based on face and iris recognition systems. Section III contains the methodology of proposed system. Section IV explains the implementation and results. Section V the acknowledgement of the authors. at the end, the conclusion in section VI.

## II. RELATED WORK

S Noushath et al. [2] have proposed the multimodal biometrics based on face and palmprint. The fusion of this system was integrated at four different levels and the results were compared against each level. The wavelet is used for the image fusion at the sensor level. For the feature level fusion, normalization techniques were applied. For score level fusion, sum, max and min were used to combine the matching score.

G. Wang and Z. Ou [3] have extracted the feature of face by using the Gabor wavelet and they used 2000 face images as database. The achievement of their result is 94.4%. J. Naji et al. [4] have applied the Discrete Cosine Transform (DCT) for extracting the face features on the basis of face-skin. In [5] the authors have proposed the FisherFace for extracting the linear discriminate features. Noushath et al.[6] have extracted the features of palm and face by using LDA algorithm respectively. Ahmed et al. [7] have utilized the Gabor filter for extracting the discriminant features, then used Principal Component Analysis (PCA) to represent the data in class and Linear Discriminant Analysis (LDA) for discrimination the data between classes. Y. Fu et al. [8] extracted the energy features by Phase Congruency, and then applied ICA (Independence Component Analysis) for extract additional features of face.

C.M.Patil and S. Patilkulkarni [9] have extracted the iris features by using higher level of wavelet. Each level of decomposed images was proposed higher level wavelets for extracted the iris features and recognition process, and decomposed images into different scale levels by wavelets transform, furthermore each level is decomposed with varies resolution to obtain six level wavelets tree. The Euclidean distance is used to measure the closeness of match, and the recognition rate is 98.91%. And the same author's in later research [10] have used the Lifting wavelets transform to extract the iris features and it is improved the recognition rate to 99.97%.

M. D. Amiri et al. [11] combined the Angular and Radial partitioning (AP & RP) to increase the delicacy of extracted features, and extract the iris edges by using Canny operator and Gaussian mask, then two feature vectors are obtained based on AP & RP. Moreover, in matching stage the researches applied 1D DFT (Discrete Fourier Transform) to analysis the feature vectors, and then used the Manhattan metric to measure the closeness of feature vectors.

In the previous work, the Local Binary Patter and Gabor-Zernike moments were proposed for extracting the face features and it were fused with the palmprint features. in this paper, we are extending the work to integrate the face with the iris based on the same feature extraction techniques.

### III. METHODOLOGY

The iris is located by using Neighbour-Pixels Value Algorithm (NPVA) and converted into rectangle images. The features of iris and face were extracted by using the Local Binary Pattern and the composite of Gabor and Zernike moments. The iris and face were fused in the feature level by using the arithmetic operator Fig.1. The accuracy of the system is evaluated by using different types of classification.

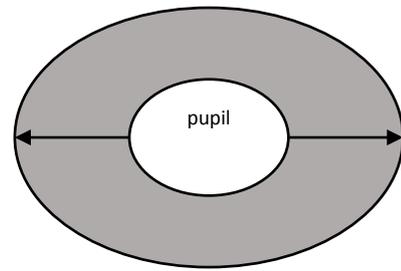


Figure.2. Direction of Computing the Iris Radius

After the localization of iris, the iris region is converted into rectangular shape by using the Rubber Sheet Normalization [13]. The dimensionality of iris images was resized to 64×384 and face images were resized to 32×32.

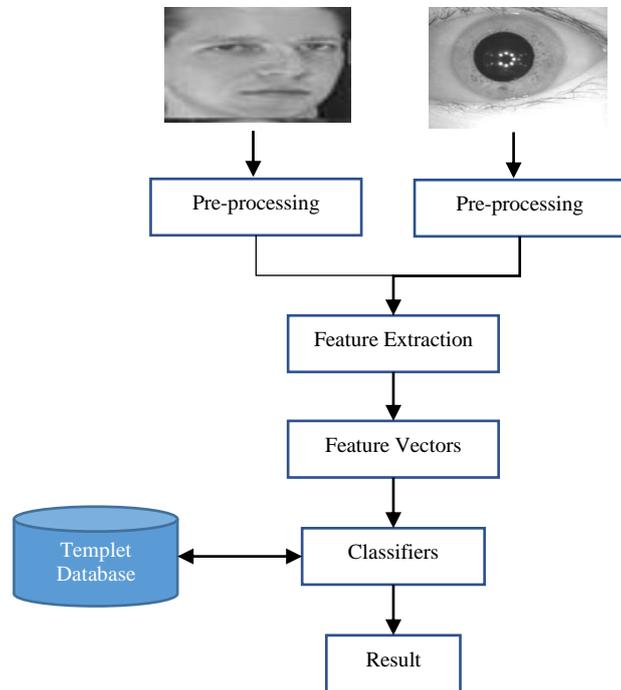


Figure.1. Multimodal of Face and Iris

#### A. Pre-processing

In this phase, the iris is located by applying the following algorithm: -

**Step.1.** Apply the Sobel edge detection to find the pupil boundary

**Step.2.** The Morphological Dilation is applied for enhancing the pupil boundary.

**Step.3.** Finding the circle, centre and radius of pupil by using Circular Hough Transform and its named as *imfindcircles* function which is available in MATLAB. The radius of pupil was set in the range of 30 and 60.

**Step.4.** Histogram Equalization is applied on the output of the pervious step.

**Step.5.** compute the next three neighbour-pixels from the boundary of pupil-circle in horizontal-right and if it found the value of those pixels value are more than 200 or close to sclera value (because it is close to the white colour), then it will stop otherwise continue to the next three pixels. The number of skipped-pixels is the radius of iris. In some cases, the centre of pupil and iris is not centralized, then it must compute the neighbour-pixels from the boundary of pupil-circle in horizontal-left as well (see Fig.2) for obtaining the proper centre and radius of iris.

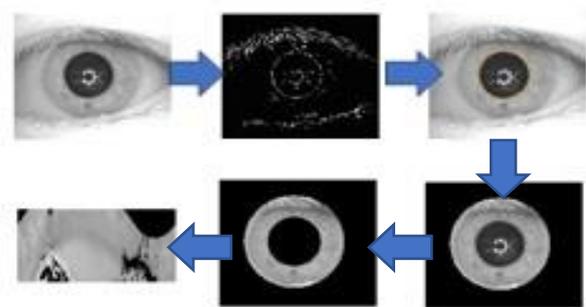


Figure.3. Segmentation and Normalization of Iris

#### B. Features Extraction

The texture features of iris and face were extracted by using the Gabor-Zernike moments [14] and the statistical of Local Binary Pattern [15]. The same feature extraction techniques were applied for the both traits (face and iris).

##### 1) Local Binary Pattern

The Local Binary Pattern (LBP) is computed the 8-neighbour pixels against the centre pixel, if it is greater or equal to the value of centre pixel, then it will assign as one, otherwise it will be zero. The boundary pixels of the matrix are avoided because those pixels are not having 8-neighbour pixels.

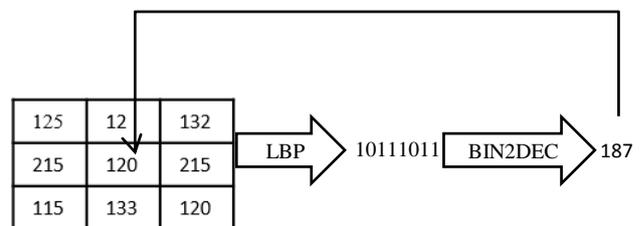


Figure.4. Example for Computing the Center Pixel of the Local Binary Pattern

The 8-neighbour pixels are converted into binary number and this number is converted into decimal number. The new decimal number is replaced with the centre pixel. The idea behind the Local Binary Pattern is to calculate the relation between the centre pixel and the 8-neighbours, so even if the illumination is changing the relation values will be the same. After that, the mean and standard deviation are computed for the LBP matrix. Therefore, the total number of LBP features for the face are 60 and the LBP features of iris are 124.

The mean equation: -

$$M = \frac{1}{N} \sum_{i=1}^N A_i \quad (1)$$

Where the standard deviation equation as following:

$$S = \sqrt{\frac{1}{N} \sum_{i=1}^N |A_i - M|^2} \quad (2)$$

## 2) Gabor-Zernike Moments

The second approach to extract the texture features of face and iris is the Gabor-Zernike moments. The face and iris images were divided into 40 sub-images by using the Gabor filter. The Zernike moments applied on the sub-images, the four features were selected from each sub-image. Thus, the total number of features are  $40 \times 4 = 160$ . The following equations are used for this experiment

$$G(x, y, \theta, \lambda, \varphi, \sigma, \gamma) = e^{-\left(\frac{x'^2 + y'^2}{2\sigma^2}\right)} e^{i\left(2\pi\frac{x'}{\lambda} + \theta\right)} \quad (3)$$

$$x' = x \cos(\theta) + y \sin(\theta)$$

$$y' = -x \sin(\theta) + y \cos(\theta)$$

Where,  $\lambda$  is the wavelet frequency,  $\theta$  means the direction.  $\sigma$  is represented the scale and  $\varphi$  = phase. The  $\gamma$  is represented the aspect ratio of the Gaussian.

Table 1 Total Number of Features

Biometrics Traits	LBP features	Enhancing features	Total No of Features	Total (after applying PCA tool)
Face	60	160	220	--
Iris	124	160	284	--
Multimodal	184	320	504	<b>63</b>

The texture features of face and iris were integrate/fuse at the feature level by using the arithmetic operator (see table.1). the Principal Component Analysis (PCA) tool was used for reducing the dimensionality of features.

## C. Classifications / Recognition

Different classifications were used to measure the accuracy of the feature extraction techniques and it compare with a different classification. The classification/recognition is to classify the features based on the training features. So, this process is to match the testing features against the training features and it determined the identity of the feature vector. The classification app learner in MATLAB was used in the proposed system. From the table.2, the classification time of the Weight KNN is 0.584s along with 97.9% as accuracy rate.

## D. Database

The AT&T face image database (the popular name of this database is known as "ORL") contains a group of face-images which were captured between April 1992 and April 1994 from 40 people [16]. Those images were taken with a different expression, illumination and with a different time as well. The dimensional of each face-image is fixed as  $92 \times 112$ .

CASIA-Iris-Interval Database was collected by the Chinese Academy of Sciences' Institute of Automation (CASIA) [16]. Iris images of CASIA-Iris-Interval were captured by close-up iris camera and this camera is designed a circular NIR LED array. Therefore, the CASIA-Iris-Interval images are well-suited for extracting the texture features. This Database is contained 2639 iris images from 249 subjects. In this experiment, 24 subjects with 8 samples  $8 \times 24 = 192$  subjects were selected from each standard database of ORL Database

and CASIA-Iris-Interval Database. The total number of images are  $8 \times 24 + 8 \times 24 = 384$ .

## IV. RESULTS AND DISCUSSION

This experiment was developed by using the MATLAB 2016a. the laptop configurations are Lenovo i7 CPU processor 2.50 GHz (8 CPU), the operating system is a Windows 10. 8 GB of RAM. The classification learner app which is built in the MATLAB 2016a was used for the classification purpose.

From the below table.1, five classifications were obtained 100% as recognition rate and the best classification with the respect of time is the Linear Discriminant (LD). The classifier time for LD is 3.1149s. The minimum time was obtained from Weight KNN which is 0.58476s and the accuracy is 97.9%. The Complex tree classification was failed for this experiment which is achieved at max 52.1%. however, after applied the PCA tool for reducing the dimensionality of feature vector, the time of classifier was reduced as well but the accuracy is decreased by 1% on LD and SVM. For 63 features, the accuracy of LD, Leaner SVM, Quadratic SVM, Cubic SVM, Fine Gaussian SVM, Medium Gaussian SVM, Coarse Gaussian SVM, Fine KNN and Ensemble (Subspace Discriminant) are 99%.

Table 2 Result of Multimodal based on Face and Iris

Classification	No of features	Time	Accuracy
Complex tree	all	9.7904	36.5%
	63 PCA on	2.3844	52.1%
<b>Linear Discriminant</b>	<b>All</b>	<b>3.1149</b>	<b>100%</b>
	63 PCA on	1.6607	99%
<b>Linear SVM</b>	<b>All</b>	<b>25.612</b>	<b>100%</b>
	63 PCA on	14.765	99%
<b>Quadratic SVM</b>	<b>All</b>	<b>19.434</b>	<b>100%</b>
	63 PCA on	16.891	99%
<b>Cubic SVM</b>	<b>All</b>	<b>19.089</b>	<b>100%</b>
	63 PCA on	17.653	99%
<b>Fine Gaussian SVM</b>	<b>All</b>	<b>13.57</b>	<b>100%</b>
	63 PCA on	15.084	99%
Medium Gaussian SVM	All	16.387	97.9%
	63 PCA on	16.56	99%
Coarse Gaussian SVM	All	16.218	99%
	63 PCA on	16.585	99%
Fine KNN	All	1.7229	99%
	63 PCA on	1.1614	99%
Medium KNN	All	0.7445	83.3%
	63 PCA on	1.1023	77.1%
Cosine KNN	All	0.68445	92.7%
	63 PCA on	1.1109	97.9%
Cubic KNN	All	1.1784	88.5%
	63 PCA on	1.1891	68.8%
Weighted KNN	All	<b>0.58476</b>	97.9%
	63 PCA on	1.1522	94.8%
Ensemble (Boosted Trees)	All	37.768	74%
	63 PCA on	11.633	91.7%
Ensemble (Bagged Trees)	All	5.3393	97.9%
	63 PCA on	3.8354	95.8%
Ensemble (Subspace Discriminant)	All	11.031	99%
	63 PCA on	3.803	99%
Ensemble (Subspace KNN)	All	2.9749	97.9%
	63 PCA on	3.0245	96.9%

Note: - the accuracy rate in the classification learner app is changing in some cases due to the random samples selection for training and testing, the approximate change is not exceeded 1%.

## V. CONCLUSION

This paper presents the multimodal biometrics based on face and iris. The iris was located by proposing the Neighbour-

Pixels Value Algorithm (NPVA). The iris images are converted into rectangle images by using the Rubber Sheet Normalization. For enhancing the ROI of iris, the Histogram Equalization was applied. The face images were resized into 32×32 and ROI of iris images are resized into 36×384. For extracting the texture features of face and iris, the Local Binary Pattern and the Gabor Zernike Moments were used. The main approach of this experiment, same features extraction techniques were used for the both traits (face and iris). The total number of features are 504 and it is reduced to 63 by using the Principal Component Analysis (PCA). The ORL and CASIA-Iris databases were used for this experiment. The accuracy and time of classification for the proposed system are a satisfactory as compare to the existing system.

#### ACKNOWLEDGMENT

This work is sponsored by SAP DRS-I (No: F.3-52/2011), UGC New Delhi, India.

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