Abstract—The aim of this study is evaluating the effect of irregular determination on the efficiency of hybrid iris recognition system. In this study, two phases of training and testing were done. The first phase of training and testing is performed on the images which determined before enhancement, while the second phase of training and testing is performed on the images which determined after enhancement. The accuracy of the system tested on CASIA-v4.0 interval database. Canny edge detection and Hough transform used to determine the irises. Histogram equalization method is used to enhance the images. Feature extraction performed by applying Gabor wavelet and Zernike moment on the images database. The results of recognition of the hybrid system in the first phase achieved accuracy about 96%. While the recognition of the second phase is equal to 60%. This accuracy is measured depending using 50 people, each person has 5 images used for training and 2 images used for testing.

Key words: Irregular, Gabor wavelet, Zernike moment, Hough transform, and Determination.

I. INTRODUCTION

Iris boundary determination is a critical step in the recognition system, because of the accuracy of this step governing of all the other steps subsequently. This step also named iris localization. It expects to separate the iris locale, along these lines it incorporates not just finding the roundabout inward and external limits of iris, yet in addition identifying the lower and upper eyelids. Iris localization will succeed according to the image quality [1]. Many researchers interested in the studying in both the iris segmentation schemes and recognition systems. In the following, the literature studies of iris segmentation are described:

A. Seyyed (2010): they proposed method used for segmentation of iris depending on efficient meter utilizing CASIA v 3.0 intervals. In the beginning, the medial filter is utilized to reduce the noise, and then the noise, and in the following step, the adjusted meter has been utilized for dividing the irises. The results show that about 98.20% of images were segmented correctly [2].

B. Koh et al. (2011): they proposed a method used for segmentation of iris depending on the efficient meter and Circular Hough Transform. The region between internal and external boundary when determined the noises treatment perform by applying Gaussian mistiness. The image pass through several steps the first step has binarized the image, the second step has performed the histogram achieve the pupil center. After that applying Canny edge detection and Hough transform to determine the pupil boundary. Hough transform applied again to determine the limbic border. The result shows that the ratio of correctly internal and external boundary detected is 99% when applied on 100-iris image gained from CASIA v 3.0 databases [3].

C. Nkole and Sulong (2012): they utilized circular Hough transform segmentation method for enhancing the iris image. The method utilized circular Hough transform. An enhanced iris segmentation algorithm using CHT. In this method the center of pupil and iris are concentric. The method beginning by performing the image threshold, then "8-neighborhood factors" are utilized to map the normal and perpendicular sector of the pupil ring. The two diverse points linked together to achieve the pupil center, where it represents the midpoint of the diverse points. On the other hand, the half-length between the diverse points represents the radius of the pupil. The center and radius of pupil were feed to circular Hough transform to determine the iris border. The results for testing 320-iris images show that 99.1% of the pupil and 98.1% of iris were correctly determined. The tested iris images gained from CASIA v 3.0-interval database [4].

D. Najafi and Ghofrani (2013): they utilized Canny edge detection for segmentation the iris. 3*3 binarization windows utilized. The mean pixel value of these values in the window is utilized to determine the threshold. In the suggested method, if any pixel greater-than specified threshold, the counter will be 1, otherwise 0. Circular Hough transform is achieved to map the edge. The center and radius of the rounded area and maximum number gained are utilized to detect the internal boundary and the center coordinate of iris. The external iris boundary then calculated by the same way to calculate the internal border. The result shows that the accuracy percent is 98.64% when applied on CASIA v 1.0 database [5].
E. Jayalakshmi and Sundaresan (2014): they suggested Fuzzy C-means and K-means algorithms utilized for iris segmentation. These algorithms were individually implemented and calculating the accuracy rates. CASIA v 1.0 database was utilized when the comparison between those two algorithms performed. The result shows that when applying algorithm of Fuzzy C-means the accuracy rate will be 98.20% and the few error rate with significant time. While when applying the K-means algorithm the accuracy rate will be, 84.98% and the much time consume [6].

F. Gupta and Kumar (2015): they suggest a technique used for handling the iris image (low-quality image) and several types of noises (iris obstructions and specular reflection). They beginning the implementation of this work by K-means clustering to produce the region of iris, then neglecting tiny blocks and noise. After that, the vertical Canny edge detection for iris region determining. Vertical circular Hough transform utilized to determine the iris boundary and delete the noise of upper eyelid and lower eyelash. The results show the accuracy the determination is 98.72% when utilizing CASIA v 4.0 interval databases [7].

II. PRACTICAL WORK

A. IRIS DETERMINATION
The localization of iris determines the area limited to the outside boundary of the sclera and the inside pupil boundary of eye image. The inside and outside iris boundary can drown like circles. The circles of understudy and external iris (limbic) limit recognized to restrict the iris, which is the part of these two circles. Likewise, an arrangement of preprocessing strategies utilized to manage impediments caused by eyelids, eyelashes, and reflections [8]. Therefore, the find pupil and iris centers are important steps in the iris localization [9]. The in the present work two of the main three segmentation stages is done. These three stages of the following [10]:

1) Determination inside iris boundary (the border between pupil and iris).
2) Determination outside iris boundary (the border between sclera and iris).
3) Determination the boundary between iris and eyelids.

Localization of an Iris represented the important step in recognition systems, The quality of eye image will success the localization [11]. The localization of iris determines the area between the outer boundary of the sclera and the inner boundary of the pupil from an eye image. Both of inner and outer boundary of iris can represent as circles [12 and 13]. Therefore, the find of the centers for pupil and iris are important steps in the iris localization. Canny edge detection and Hough transforms are the methods, which used to find all of Iris center in the present work, pupil center, iris radius and pupil radius. The accuracy of iris localization calculated by utilizing Equation (1).

\[
\text{Accuracy} = \frac{\text{No. of images localized correctly}}{\text{Total no. of images in database}} \times 100\% \quad (1)
\]

B. IMAGE ENHANCEMENT
Image enhancement is used as preprocessing step to enhance image quality without any effect on original image. Noise is removed and contrast is adjusted to produce better appearance quality for the desired image[14]. In this step, the eye image will improve through enhancing the contrast of the loaded image. The contrast enhancement is applied a histogram equalization enhancement method.

C. IRIS NORMALIZATION
Normalization process refers to transform the localized iris region from polar coordinates to Cartesian coordinates. The iris radius (r) and angle (θ) used during the normalization stage to determine the rectangular size of the iris image, and can significantly appear the iris recognition rate. In the present study the two rectangular image parts of are used with equal size, marked using Iris BEE implementation, Depending on the value of the center of iris gained from iris localization it will take two parts left and right from the iris [15]. These two parts will be separated into two segments (a) and (b) as shown in the Figure (1). The mathematical representation of normalization process is explained in Equation (2)in the following below:

\[
I(x(r,\theta), y(r,\theta)) \rightarrow I(r, \theta) \\
x_n = x_{center} + r \sin(\theta) \\
y_n = y_{center} - r \cos(\theta) \\
r = \sqrt{(x_n)^2 + (y_n)^2} 
\]

Normalized image \((i,j) = I(x_n,y_n)\)

where: \((x_{center},y_{center})\) is the center coordinate of the iris image, \(I(x_n,y_n)\) is value for iris region and \(\theta\) is the angle \((0^\circ, 360^\circ)\).

Figure 1: Normalization Outcomes

III. FEATURE EXTRACTION
Features extractions means a decrease in the size of resources needed to characterize the image especially with high categories of data [16]. Two methods utilized in this work as the following:
A. **GABOR WAVELET**

John G. Daugman, a Professor of Cambridge University [17] suggested of iris recognition by using an exemplary and effective order, from through the implementation of a two-dimensional version of Gabor filters on the picture data. To extract information from image data by using a decomposition derived. A quad-rapture couple of Gabor filters using the analysis of a signal. With determining a real portion of a cosine and an imaginary portion by a sine modulated by a Gaussian [18]. Gabor wavelet defined as in equation (3).

\[
G(x, y) = e^{-\pi \frac{(x-x_1)^2 + (y-y_1)^2}{\alpha^2 + \beta^2}} * e^{-2\pi i (x-x_1) + y-y_1} \tag{3}
\]

where: \(x_1, y_1\) position in the photo, \(u, v\) specify modulation which has spatial frequency \(\omega = \sqrt{u^2 + v^2}\) and \(\alpha, \beta\) specify effective width, and length.

B. **ZERNIKE MOMENT**

Zernike moment computes a numeric magnitude at some distance from a referential points or axes. The definition of Zernike polynomials are a set of perpendicular polynomials, which known on the unit cylinder, moments are the projection of the photo function onto these perpendicular basis functions. The turning invariant feature of explaining a character [19]. In 1934 was the first suggestion for Zernike moment by Zernike [20]. Order \(p\) and repetition \(q\) of a picture for Zernike moments of with intensity \(f(r, \theta)\) defined as in Equation (4) [21]:

\[
Z(M_{pq}) = \lambda_{Z}(p, N) \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} R_{pq}(k_{it}) e^{-ip\theta_{it}} f(i, j) \tag{4}
\]

where:

\[
k_{it} = \sqrt{r_i^2 + c_i^2}
\]

\[
r_i = \frac{2i}{N-1} - 1 \quad \theta_{it} = \tan^{-1}\left(\frac{c_i}{r_i}\right) \quad c_i = \frac{2j}{N-1} - 1
\]

\[
R_{pq}(k_{it}) = \sum_{k=0}^{\frac{|p+q|}{2}} k! \left(\frac{p+q}{2} - k\right)! \left(\frac{p+q}{2} + 1 - k\right)! -2k
\]

C. **MATCHING**

The matching process published by a Euclidean distance measure between values of the feature vector of the tested image and saved vectors for training images.

IV. **RESULTS AND DISCUSSIONS**

A. **IMAGE ENHANCEMENT**

The result of this step is shown in Figure (2). In this figure, two iris images showed before and after enhancement. The results of this method are very acceptable because it increases the quality of the image.
On the other hand, the determination performed on the same images but before performing the enhancement stage. Four samples of these images are presented in Figure (4).

C. RESULTS OF NORMALIZATION

In iris normalization step, the iris image normalized into two segments, the results for two samples of images are shown in the Figure (5).

D. FEATURES EXTRACTION

In this stage, the system is tested on 100 images (i.e. 50 persons for each person 2 images) while the number of training image adoptive in this stage is (250 images for each person 5 images). The all training database in this trial is 350 images for training and testing. Two phases of training and testing are performed. In the first phase, the iris is determined before performing the enhancement stage, while in the second phase the images are enhanced and then determined. The results show, in the first phase the recognition rate is 96% while the second phase, the recognition rate is 60%.

V. CONCLUSION

A. The Wrong determination of iris images will affect normalization results. This is due to a non-uniform distance between the internal and external iris boundary.

B. The Wrong determination of iris images will affect the results of IRS due to the reduction in the determination accuracy.

C. The iris determination process plays an important role in evaluating the recognition accuracy of IRS.

D. Increase the number of images in the database will reduce the recognition rate. This is due to the irregular determination which will increase in this case.

E. After performing the enhancement process, the eyelid and eyelash will cause a confusing in determination process because it will be considered in the decision of the internal and external iris boundary.
The recognition time, will not change when the iris determination is correctly or wrongly evaluated because it is an independent variable in the iris size.

VI. REFERENCES


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