Effect of Wavelet-transformed Iris Image Translation and Rotation on its Recognition Rate

by R. Rizal Isnanto

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An Experimental Approach using Haar Wavelet

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Abstract— **Iris can be used as a basic of biometrics system. Iris texture is unique for any person, it has a stable pattern of texture for along one's life, even for right or left-side of irises are different for everyone. Analysis for identification is based on this texture feature. Research objectives is to measure the effect of Wavelet-transformed iris image translation and rotation on its recognition rate. Circular Hough Transform is quite good in determining objects and to separate the circular iris from pupil and sclera, thus determining the object an be conducted accurately even though the translation process is carried out varying the input image. Iris characteristics generally have a uniform texture, so the recognition can be partially done with the proper results. Therefore, the image that is rotated with angle variations from 0^o up to 359^o can also still be recognized correctly.**

Keywords -- wavelets; translation; rotation; recognition rate; orthogonal; biothogonal.

I. INTRODUCTION

Iris can be used as a basic of biometrics system. Iris texture is unique for any person, it has a stable pattern of texture for along one's life, even for right or left-side of irises are different for everyone. Analysis for identification is based on this texture feature [30]. Several types of abnormalities in the iris can cause the iris pattern changed from the normal state, namely: inflammation, degeneration, abnormal growth, and tumor. Figure 1 shows the view of human eyes which iris included there.

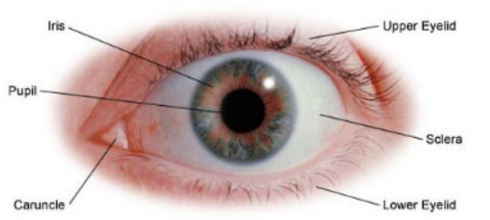

Figure 1. View of human eyes (courtesy of www.gcot.net)

Topics detailed in this research is the design of software systems based on extracting features of the iris texture. In this case there are several possible conditions when the iris data are acquired, those are: brightness and contrast of images, the presence of noise factors are caused by reflections, eyelashes, eyebrows, obstruction of the iris as it is covered in part by the petals, and so forth.

Having learned that the iris can be used as an organ of the biometric system with much greater accuracy, the feature extraction and iris recognition become more attractive. There are several advantages of digital image processing, in this case is its ability to distinguish which is almost the same intensity that the human eye cannot distinguish them.

The first problem is how to extract the iris feature. Here will be the process of feature extraction using Haar wavelet transform method and its recognition uses Euclidean distance (Euclidean Distance). Programming language used in this research is Matlab version 7.6.0 (R2008a).

The second issue is the subject of research itself, that is the iris. In iris data acquisition, there are some possibilities of imperfect iris captured because of translational as well as rotational effect due to digital camera movement or unstable eyes condition captured. Iris images used in this research are taken from The Chinese Academy of Sciences Institute of Automation (CASIA).

Therefore, in this research, an experimental approach has been done to measure the effect of wavelet-transformed iris image translation and rotation on its Recognition Rate.

II. RELATED WORKS

Before this research done, there are some research which also had been published before regarding to algorithm for iris identification and/or iris recognition.

Iris recognition using Independent Component Analysis (ICA) algorithm shows that the correct recognition rate (CRR) is 97,5 % which achieved in recognition using 6 (six) training images without any threshold and using all independent components [4].

While implementation of Principal Component Analysis (PCA) algorithm indicates that the correct recognition rate is 97,5% which achieved in recognition using 6 (six) training images [5].

For iris identification using Fourier Descriptors, it can be shown that the average classification accuracy achieved was 96.66%. It also shows that 40% of these cases exhibited a 100% accuracy. When noise was added to the images used for testing at an SNR of 10 db, the average accuracy dropped to 90.06%, then to 86% at 2db SNR. It is noticed that for some irises that were heavily distorted, such as part of the iris being covered, the classifier was giving unsatisfactory results. Fortunately, there were only few cases that fell under this category. [6]. In improved identification of iris and eyelash features, from the testing, it is shown that the iden tification rate is 95.25% [7].

In extraction of complex wavelet features for iris recognition complex wavelet, especially in identification mode, the CRR of the proposed algorithm was 99.83% and 98.15% on DB1 and DB2 respectively, whereas are 99.67% and 97.22% using the traditional Gabor filters method [8]. Otherwise, implementation of Haar wavelet, observing on 60 pictures, using a Pentium IV processor, and it resulted in an average of correct recognition of 93%, with an average computing time of 31s.[9]. Meanwhile, whwn using lifting wavelet, the algorithm was tested on 750 images using 6^{th} level coarse components, and an average correct recognition rate of 99.78%, 98.91% and 98.56% for Euclidean Distance Measure 1, 2 and Distance Threshold [10].

Meanwhile, in iris identification system using tree-structured wavelet algorithm, the experiment shows that 7 analyzed channels give the optimal result, with precision level 94.7% [12].

In research of automatic iris recognition technique based on divider dimension and Karhunen-Loeve Transform, it can concluded that the best identification accuracy of the divider dimension-based and KLT-based methods have False Acceptance Rate (FAR) of 3.67% and 0%, respectively [11]. It means that correct recognition rates are 96.33% and 100%, repectively.

In research of efficient iris recognition through improvement of feature extraction and subset selection, the highest acceptable classification accuracy percentage is arrived using Genetic Algorithm (GA) with Support Vector Machine (SVM) classifier, i.e. 97.81% [13].

From research on comparison analysis on recognition rate of iris [2], it can be concluded that The best recognition rate for the Haar wavelet is 84.375% which is occurred in the application of decomposition level 3. Meanwhile, the use of stored samples of the two images produces a greater level of recognition that is equal to 85.58% compared with the use of only one stored image which has a recognition rate of 81.20%. From these reasons, a research to find optimum decomposition level and number of data-stored is required to be done.

III. PROPOSED METHODOLOGY

Texture is an intuitively concept which describes about smoothness, coarseness, and regularity in a region ([1],[3]). In this research, there are two important processes. First, the feature extraction using Haar wavelet transform yields the energy measurement. The second process is the recognition stage using Euclidean Distance as a similarity measurement.

A. *Energy Measurement in Wavelet*

Energy measurement is used to calculate energies which are resulted of images as output of wavelet transform. These energies are input coefficients for Euclidean distance calculation.

In this research, energy can divided into 4 (four) features, those are:

1) Percentage of energy which is related to approximation value, E_a calculated based on percentage of sum-square of approximation coefficient values C_a which is divided by sum of all coefficients C (approximation coefficient plus detail coefficients).

$$E_a = \frac{\sum C_a^{\,2}}{\sum C^2} \times 100\% \qquad (1)$$

2) Percentage of energy which is related to detail values in horizontal direction, E_h calculated based on percentage of sum-square of detail coefficient values in horizontal direction C_h which is divided by sum of all coefficients C.

$$E_h = \frac{\sum C_h^{\,2}}{\sum C^2} \times 100\% \qquad (2)$$

3) Percentage of energy which is related to detail values in vertical direction, E_v calculated based on percentage of sum-square of detail coefficient values in vertical direction C_v which is divided by sum of all coefficients C.

$$E_v = \frac{\sum C_v^{\,2}}{\sum C^2} \times 100\% \qquad (3)$$

4. Percentage of energy which is related to detail values in diagonal direction, E_d calculated based on percentage of sum-square of detail coefficient values in diagonal direction C_d which is divided by sum of all coefficients C.

$$E_d = \frac{\sum C_d^{\,2}}{\sum C^2} \times 100\% \qquad (4)$$

B. *Normalized Euclidean Distance*

After passing through the process of feature extraction and the specific parameter values have been produced, then calculation of proximate distance (Euclidean distance) for image feature vectors [14]. The value of Euclidean distance which has a zero value, will indicates certain image. The value of input image feature vector which has similar value of specific image feature vector will have Euclidean distance of zero-approximated. For example, the value of input image feature vector $A_i = (A_1, A_2, ..., A_n)$ and *j*-th value of image feature vector is $B_j = (B_{1j}, B_{2j}, ..., B_{nj})$, then Euclidean distance between the value of image feature vector and *j*-th value of image feature vector can be determined as:

$$D(A,B) = \sqrt{\sum_{i=0}^{n} \frac{(|A_i - B_i|)^2}{A_i}} \qquad (5)$$

where:

$D(A,B)$ = Euclidean distance between iris *A* and *B*

A_i = Feature vector of iris *A*

B_i = Feature vector of iris *B*

Flow diagram for iris recognition can be shown in Figure 4.

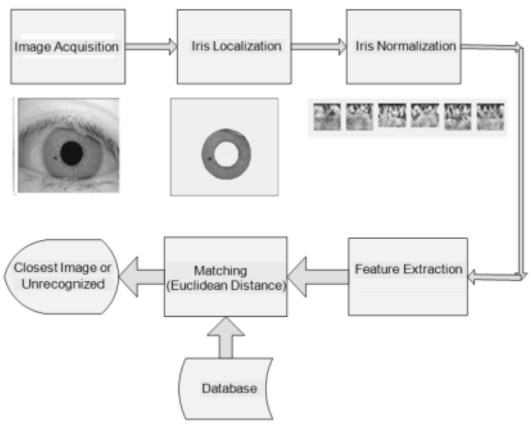

Figure 2. Flow diagram for iris recognition system using feature (i.e. wavelet) extraction method

IV. Results and Discussion

A. *Effect of Iris Image Translation on its Recognition Rate*

Recognition requires the invariance on both translation and rotation. Iris image as the input is recognized as a circular object. To recognize objects such as circles, the Circular Hough Transform is used. In this section, the input of one individual is tested with a variety on shift (translation) during image capture. Figure 3 shows an image in database, while Figure 4 (a-f) are translated images varied on the individual's iris taken at 6 (six) at different times. Testing is done by looking at the recognition of five test images. If the result shows that recognition refers to the training image according to Figure 3, it can be said that the recognition is invariant in translational aspect of input images.

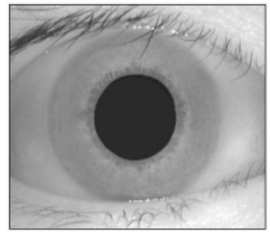

Figure 3. Training image for translation test (077_2_1.bmp).

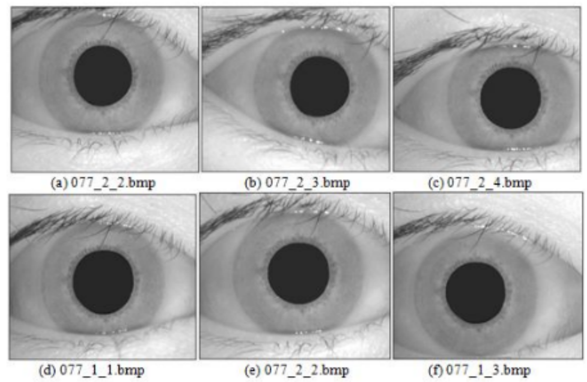

Figure 4. Image for translation-testing.

Test results on the six images in variation of decomposition level 1 to 3 by the number of trained image stored in database is 1, shows that all recognition result is 'Correct'. Based on the test sample and the previous recognition test which showed the diversity of the iris position (which means also the translational parameters are varied), it can be concluded that feature extraction with the Circular Hough Transform is able to overcome the problem of diversity on the translation of the iris input.

B. *Effect of Iris Image Rotation on its Recognition Rate*

In addition to testing of the aspect of translation diversity, it is also conducted a test of aspect of rotational diversity, with a variation of angle between 0^o up to 360^0. Image sample tested is **077_2_1.bmp** eye image. Figure 5 shows examples of various angles of rotation for the image.

Tests performed on the database 5, the decomposition level 3 ,using wavelet transform Haar. Test results on 20 variations of angles in range of 0^0-359^0, the system can still recognize the 'correct' iris. This shows that Haar wavelet transform can recognize the input iris which is rotation-indpendence. This fact also reinforces the conclusion of [15] that iris recognition can be done partially from a certain area of the iris. Iris feature extraction can be done from any angle of rotation, and this suggests that the texture of the iris for a single individual is uniform in all parts of the iris.

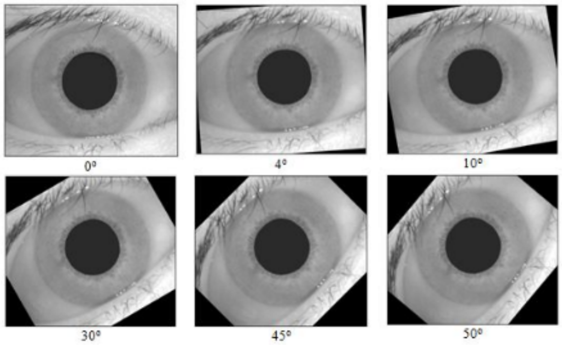

Figure 5. Samples of images for rotational-testing

V. CONCLUSIONS

From Results and Discussion, it can be concluded some important points as follows. *Firstly*, Circular Hough Transform is quite good in determining objects and to separate the circular iris from pupil and sclera, thus determining the object can be conducted accurately even though the translation process is carried out varying the input image. *Secondly*, wavelet transform, i.e. Haar is robust-proofed to translation invariant for extracting the iris image. *Thirdly*, iris characteristics generally have a uniform texture, so the recognition can be partially done with the proper results. Therefore, the image that is rotated with angle variations from 0^o up to 359^o can also still be recognized correctly. This infers that Haar wavelet is, again, robust-proofed to rotation invariant for extracting the iris image.

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