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Software Implementation of Iris Recognition System using MATLAB

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ABSTRACT

The software implementation of iris recognition system introduces in this paper. This system intends to apply for high security required areas. The demand on security is increasing greatly in these years and biometric recognition gradually becomes a hot field of research. Iris recognition is a branch of biometric recognition method. In thesis, Iris recognition system consists of localization of the iris region and generation of data set of iris images followed by iris pattern recognition. In thesis, a fast algorithm is proposed for the localization of the inner and outer boundaries of the iris region. Located iris is extracted from an eye image, and, after normalization and enhancement, it is represented by a data set. Using this data set a Neural Network (NN) is used for the classification of iris patterns. The adaptive learning strategy is applied for training of the NN. The implementation of the system is developed with MATLAB. The results of simulations illustrate the effectiveness of the neural system in personal identification. Finally, the accuracy of iris recognition system is tested and evaluated with different iris images.

KEYWORDS: *Iris, Biometric, Neural Network, MATLAB*

I. INTRODUCTION

Biometrics technology plays important role in public security and information security domains. Using various physiological characteristics of human, such as face, facial thermo grams, fingerprint, iris image, retinal scans and hand geometry etc., biometrics accurately identify each individual and distinguishes one from another . Iris recognition is one of important biometric recognition approach in a human identification is becoming very active topic in research and practical application. Iris region is the part between the pupil and the white sclera. This field is sometimes called iris texture. The iris texture provides many minute characteristics such as freckles, coronas, stripes, furrows, crypts, etc. These visible characteristics are unique for each subject. The human iris is not changeable and is stable. From one year of age until death, the patterns of the iris are relatively constant over a person's lifetime [1-4]. Because of this uniqueness and stability, iris recognition is a reliable human identification technique.

Iris recognition consists of the iris capturing, pre-processing and recognition of the iris region in a digital eye image. Iris image preprocessing includes iris localization, normalization, and enhancement. In iris localization step, the determination of the inner and outer circles of the iris and the determination of the upper and lower bound of the eyelids are performed. In this research, the iris recognition system is developed using neutral network with MATLAB.

II. THE BACKGROUND THEORY OF BIOMETRIC TECHNOLOGY

It includes iris history and iris recognition system. The word biometric can be defined as "life - measure." It is used in security and access control applications to mean measurable physical characteristics of a person that can be checked on an automated basis. Security personnel look for biometric data that does not change over the course of the life; that is, they look for physical characteristics that stay constant and that are difficult to fake or change on purpose.

A. Biometric Technology

A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina [], and the one presented in this thesis, the iris. Biometric systems work by first capturing a sample of the feature, such as recording a digital sound signal for voice recognition, or taking a digital color image for face recognition. The sample is then transformed using some sort of mathematical function into a biometric template. The biometric template will provide a normalized, efficient and highly discriminating representation of the feature, which can then be objectively compared with other templates in order to determine identity. Most biometric systems allow two modes of operation. An enrolment mode for adding templates to a database, and an identification mode, where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates.

B. Different Types of Biometric Technologies
There are many types of biometric technologies as follow [].
- Body Odour
- DNA
- Ear Shape
- Facial Recognition
- Finger Scanning
- Hand Geometry
- Iris Recognition
- Keystroke
- Retinal Scan
- Personal Signature
- Vein Pattern
- Voice Recognition

C. Iris Theory
The iris is the plainly visible, colored ring that surrounds the pupil. It is a muscular structure that controls the amount of light entering the eye, with intricate details that can be measured, such as striations, pits, and furrows. The iris is not to be confused with the retina, which lines the inside of the back of the eye. The figure 1 shows human eye characteristics. No two irises are alike. There is no detailed correlation between the iris patterns of even identical twins, or the right and left eye of an individual. The amount of information that can be measured in a single iris is much greater than fingerprints, and the accuracy is greater than DNA.

III. IRIS RECOGNITION SYSTEM
The iris is the plainly visible, colored ring that surrounds the pupil. It is a muscular structure that controls the amount of light entering the eye, with intricate details that can be measured, such as striations, pits, and furrows. The iris is not to be confused with the retina, which lines the inside of eye of an individual. Fig 2.1 shows human eye characteristics. No two irises are alike. There is no detailed correlation between the iris patterns of even identical twins, or the right and left eye of an individual. The amount of information that can be measured in a single iris is much greater than fingerprints, and the accuracy is greater than DNA.

Iris recognition is the process of recognizing a person by analyzing the random pattern of the iris as shown Fig 1. The automated method of iris recognition is relatively young, existing in patent only since 1994. The iris is a muscle within the eye that regulates the size of the pupil, controlling the amount of light that enters the eye. It is the colored portion of the eye with coloring based on the amount of melatonin pigment within the muscle as shown in Figure 2.

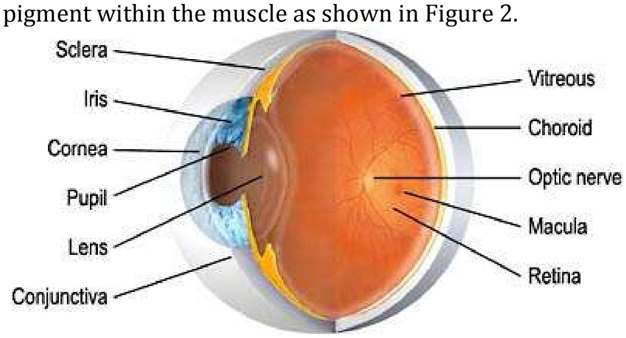

Figure1. Anatomy of the Eye [6]

Although the coloration and structure of the iris is genetically linked, the details of the patterns are not. The iris develops during prenatal growth through a process of tight forming and folding of the tissue membrane. Prior to birth, degeneration occurs, resulting in the pupil opening and the random, unique patterns of the iris. Although genetically identical, an individual's irides are unique and structurally distinct, which allows for it to be used for recognition purposes.

Before recognition of the iris takes place, the iris is located using landmark features. These landmark features and the distinct shape of the iris allow for imaging, feature isolation, and extraction. Localization of the iris is an important step in iris recognition because, if done improperly, resultant noise (e.g., eyelashes, reflections, pupils, and eyelids) in the image may lead to poor performance.

Figure2. Iris Structure

A. Typical Stage of Iris Recognition
This system presents an introduction to divergent aspects of pattern recognition. The operation of a pattern recognition system is presented as a series of consecutive processing stages in figure 5. Pattern recognition is an information-reduction process: the assignment of visual or logical patterns to classes based on the features of these patterns and their relationships.

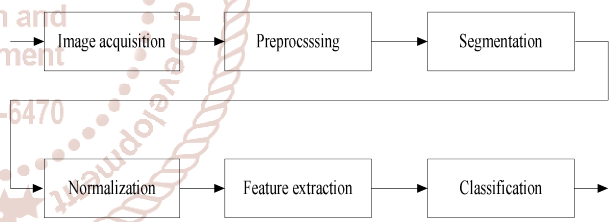

Figure5. Block Diagram Iris Recognition Process [7]

IV. THE PROPOSED IRIS RECOGNITION SYSTEM
In this work, the proposed iris recognition system using Artificial Neural Network is shown in Fig 6. The process for iris recognition system can be divided into the following different stages:
- Image acquisition
- Edge detection
- Localization
- Feature extraction
- Creating and training the neural networks

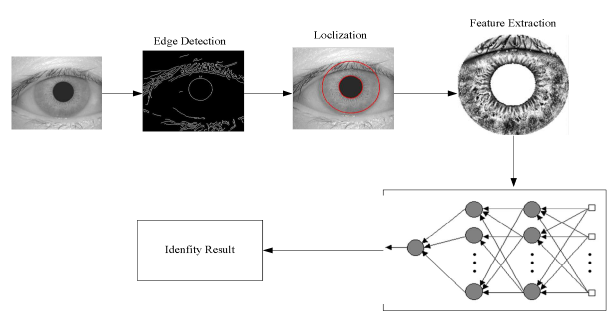

Figure6. Block diagram of software implementation of iris recognition process

A. Image Acquisition
The iris recognition system includes iris image acquisition and iris recognition. The iris image acquisition includes the lighting system, the positioning system, and the physical capture system. In iris acquisition, the iris image in the input sequence must be clear and sharp. Clarity of the iris's minute characteristics and sharpness of the boundary between the pupil and the iris, and the boundary between the iris and the sclera affects the quality of the iris image. A high quality image must be selected for iris recognition. However, the eye pictures are taken while trying to maintain appropriate settings such as lighting and distance to camera, the light spot from the camera cannot be removed from the image. The preprocessing is difficult to detect the iris area from those pictures. Therefore, CASIA iris [5] database is used in this thesis. The CASIA [8] database used a special camera in the infrared spectrum of light, not visible by the human eye. In CASIA, each iris class is composed of seven samples taken in two sessions, three in the first session and four in the second. Images are 320x280 pixels gray scale taken by a digital optical sensor designed by NLPR (National Laboratory of Pattern Recognition Chinese Academy of Sciences). There are 108 classes or irises in a total of 756 iris images. The train data set is taken 5 kinds of irises from CASIA database. Fig 7 shows the example of train data set three iris images are collected in each type. The train data set contains 3x5 = 15 images in train folder. After collection of train set, the program has to be preprocessing. In the preprocessing stage, the images are transformed from RGB to gray level and from unsigned integer eight bit or double precision thus facilitating the manipulation of the images in subsequent steps in Fig 8.

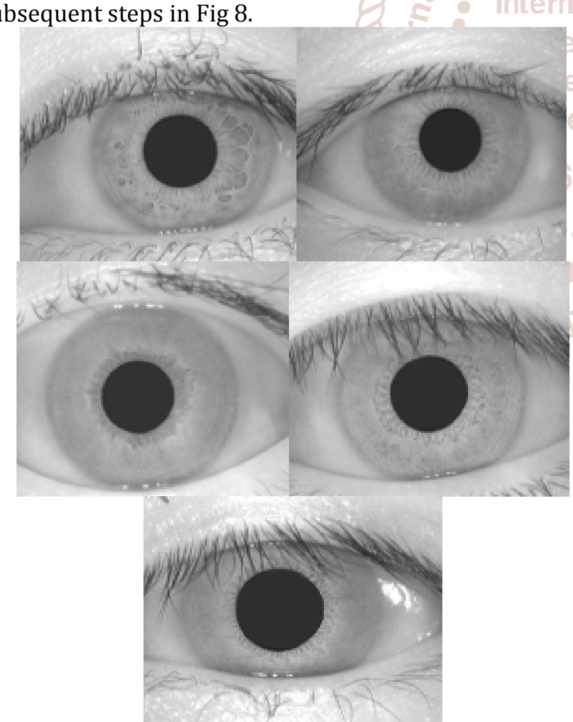

Figure7. Example of Iris Train Data Set

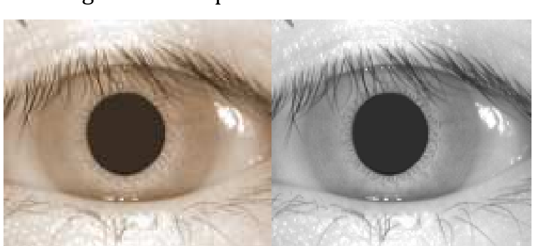

Figure8. RGB Image and Gray Scale Images

B. Edge Detection
Canny edge operator is chosen to extract the clear edge of iris and pupil area. Some other operators are Robert, Prewitt, and sobel. By analyzing the output edge images, the canny image is found that as the best operator for the pupil detection as shown in Fig 9.

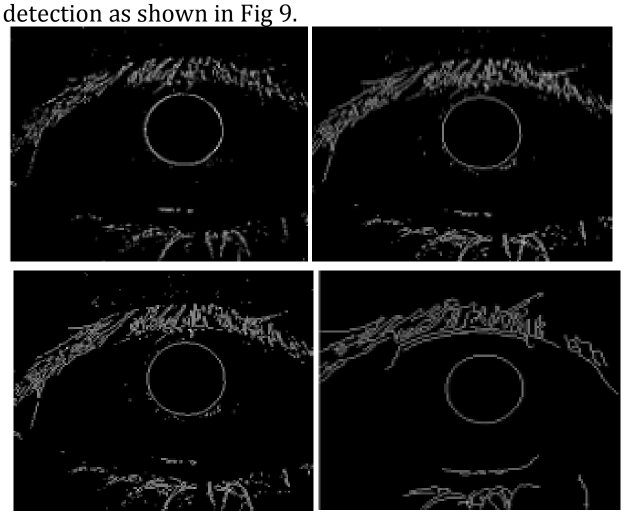

Figure9. Edge Detection Methods for Sample Eye (a) Robert (b) Prewitt (c) Sobel (d) Canny

C. Iris Localization
By utilizing the eye image, the boundary between the pupil and the iris is detected after the position of the eye in the given image is localized. After the center and the radius of the pupil are extracted, the right and the left radius of the iris are searched based on these data. For this part, the following sequences are conducted.

D. Feature Extraction
In order to provide the compact features for accurate recognition of individuals, the most discriminating information present in an iris pattern must be extracted. Only the significant features of the iris must be encoded so that the neural network can be classify well.

The feature is extracted by limiting 6x6 matrixes which is divided the iris pattern for 6 rows and 6 columns. The summation of the pixel values for each region is calculated and recorded for each iris image. They are saved in train feature vector set. The selected vectors with is checked by the following table. Fig 10 is the flowchart of feature extraction system.

E. Neural Network Creation and Training Process
After the features are saved in the file, the neural network is created and trained with supervised learning. The target vector is initialized with the relevant 1, 0 matrix. Logic 1 is set for the recognized person position, and logic 0 is set for other places. In the training part, goal is set to 0.01 of mean square error, and number of epoch is set to 1000. After training process, network can be used for recognition parts. The neural network training function is to apply according to the below MATLAB code and the Fig 11.of flow chart.

F. Graphical User Interface (GUI)
GUIDE, the MATLAB Graphical User Interface development environment, provides a set of tools for creating graphical user interface (GUIs). These tools greatly simplify the process of designing and building GUIs. The GUIDE tools can be used to lay out the GUI. Using the GUIDE Layout Editor, a

GUI can be laid easily by clicking and dragging GUI components, such as panels, buttons, text fields, sliders, menus, and so on into the layout area.

V. SIMULATION RESULTS

MATLAB programming is used for the development and simulation of iiris recognition which has many stages such as iris recognition, localization is an important step to isolate the iris region. Edge detection method has been described to remove the pupil region from eye images. After localization, feature extraction method and adaptive histogram equalization method have been described. Then, the selective feature vectors is used for classification of neural network and the GUI software implementation is provided for an identify person.

After the development of iris recongin system, the performance of the proposal system and some tests are carried out. The results for the system are explained in detail. The proposed system for the identification includes two operations modes: training process and identification process. These processes are called recognition system using GUI software implementation.

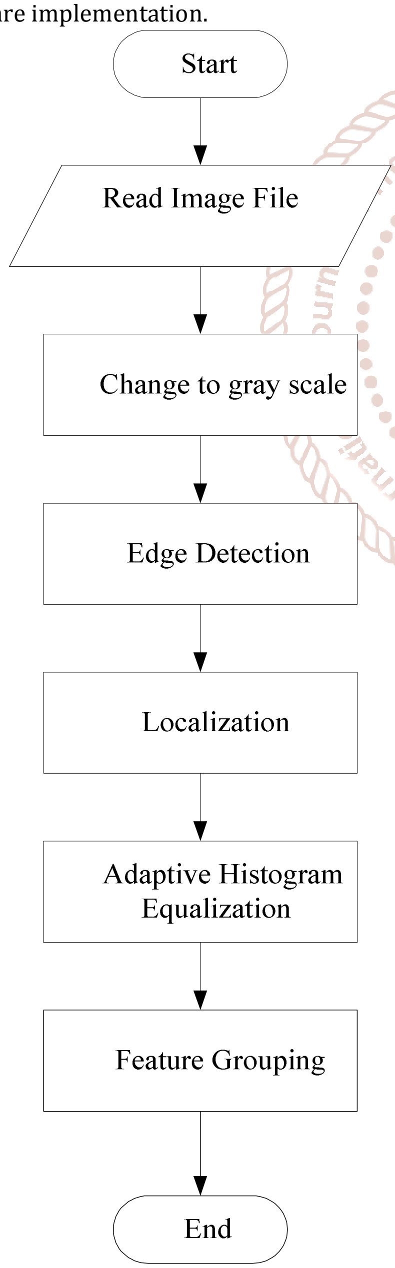

Figure10. Flow Chart for Feature Extraction Program

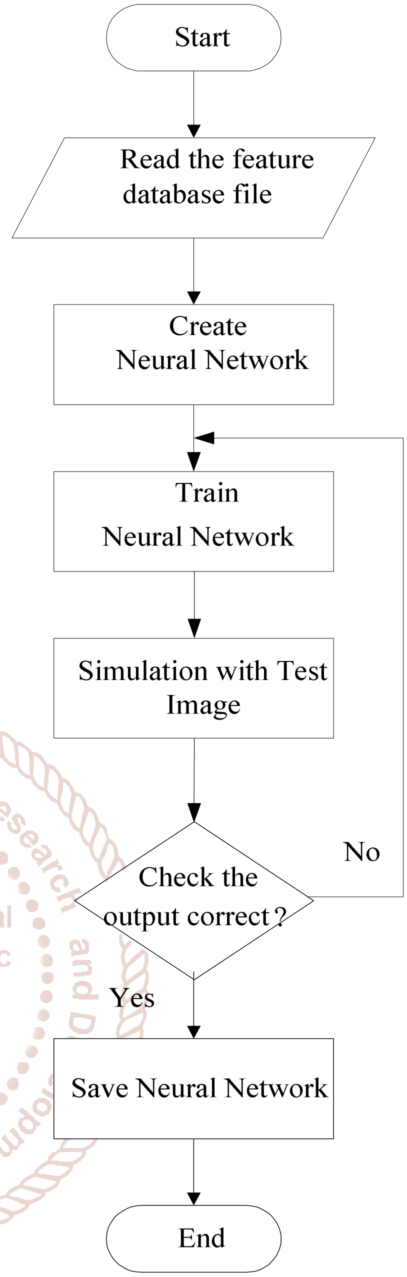

Figure11. Flow Chart for Neural Network Training and Identified Program

GUIDE stores a GUI in two files, where are generated the first time save or run the GUI and shows the creation of user interface in Fig 12: The proposed iris recongitnion system is implement the GUI based system using matlab as shown in figure 12 .

Figure 12.Graphical User Interface of Software Development

In the first mode, training process is applied for the feature vectors, histogram analysis and training neural network. The isolating of iris is collected by feature vectors. Each of feature vectors displays a histogram for the iris image with a gray scale colorbar. The histogram of a gray scale image uses a default value of 256 bins.

If a grays scale image is a binary image, histogram uses two bins. Then these vectors become the training data set for the neural network. The training of recognition system is carried out using grayscale value of iris images. Neural network is trained with the selected iris images. The selected iris input layers obtain good classification results. The output layer will be continued as much neuron as there are class to recognize. In this process, the user has to extract the features. When the feature extraction part is finished, the output can be seen as in Fig 13. The mean square error is decreasing with the epoch. When the goal is met or the predefined epoch is arrived, the training process will be stopped.

Figure13. Feature Database Display

The open file contains the trained eye image from CASIA database. The gray scale eye images were acquired from database. It is choose one iris image for the identify person. The edge detection is described differentiation form the foundation for many applications in computer vision. It detects each edge point of selected eye image by canny operator.

The localization is the detection of the iris area between pupils and sclera because of the eye image contains not only the iris region but also some unuseful parts; such as the pupil, eyelids, and sclera and so on. So the subparts of the input data image is evaluated by separated process using localization.

Feature extraction achieves the texture of the iris after pupils were extracted from the image.

The adaptive histogram equalization is a useful method iris image processing for contrast adjustment using the image's histogram.

In order to evaluate the iris recognition algorithms the CASIA iris image database is used. Currently this is largest iris database available in the public domain. This image database contains 756 eye images from 108 different persons. In this thesis the performance of the iris recognition system as a whole is examined. Tests were carried out to find the best separations that the false match and false accept rate is minimized, and to confirm that iris recognition can perform accurately as a biometric for recognition of individuals. As well as, confirming that the system provides accurate recognition, experiments were also conducted in order to confirm the uniqueness of human iris patterns by deducing the number of degree of freedom present in the iris template representation.

The iris recognition can be test with GUI interface as shown in figure 14.

Figure14. Graphical User Interface of Iris Recognition

Table 5.1 demonstrates the comparative results of different iris images used for identification. In this process, only five train databases are applied for using Neural Network. The iris pattern classification using NN is performed. For each type of iris database, the test data set consists of three from the trained data and four from the untrained data. Five person's irises are selected from iris database for classification. The average time for the recognition of the iris images was 0.02 s for NN classification. So, the accuracies of correct classification are 100 % and 50 % for database 001, 002, 004 and 003, 005. The identification result obtained using the neural network approach the success of its efficient use iris recognition.

Table 5.1 Performance Comparison of Accrual and Test Result

Iris database	No: of train file	Correct for train file	Accuracy time for (NN)	No: of test file	Correct for test file	% Correct for test file
001	3	3	0.02 s	2	2	100 %
002	3	3	0.02 s	2	2	100 %
003	3	3	0.02 s	2	1	50 %
004	3	3	0.02 s	2	2	100 %
005	3	3	0.02 s	2	1	50 %

VI. CONCLUSION

Analysis of the developed iris recognition system has revealed a number of interesting conclusions. It can be stated that localization is the critical stage of iris recognition, since areas that are wrongly identified as iris regions will corrupt biometric templates resulting in very poor recognition. The results have also shown that localization can be the most difficult stage of iris recognition because its success is dependent on the imaging quality of eye images. So, these input images have been used the off line data using database from CASIA according to image acquisition steps. The iris database provides images that are 320×280 pixels. Another interesting finding was that the texture extraction for the iris area. The localized iris images have been isolated after cropping the pupil in the original image with threshold value. The result of feature extraction from resized localized image is captured the function of feature_vector. Every Test_feature were segmented into 6×6 matrix. The feature vectors btained from feature extraction have been used as inputs to neural networks for classification, trained with 107 epochs. The well trained neural network can enhance the performance of the system. The classification of trained network is identified the iris patterns. The recognition method can be used in security purposes because Iris pattern is different from one person to another so that this can be highly reliable more than security system.

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