IRIS Identification based on Multilayer Feed forward Neural Network

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Abstract - IRIS recognition is advance replacement for traditional security system where IRIS biometric features of humans are used for the purpose of recognition. The stages of Recognition include image acquisition, localizing the iris, normalizing the localized iris from a captured image and pattern matching.In this paper the faster algorithm is perposed for iris segmentation using rectangular method. After the localization , normilazation and image enhance –ment, it is represented by a data set. The neural network is then used for training and classification purpose. Finally results are shown for effectiveness of the system.

Index Terms— **Data security, IRIS, Localization,neual network.**

1. INTRODUCTION

IRIS Recognition system provides automatic recognition of an individual based on IRIS feature possessed by the individual. Several Biometric systems have been developed based on fingerprints, voice, hand geometry, handwriting, the retina and the IRIS.

IRIS Biometric identification is an emerging technology which gains more attention in recent years. IRIS is basically physiological characteristics where physical presence of person is mandatory. The three main stages of an iris recognition system are image pre-processing, feature extraction and template matching. The iris image needs to be pre-processed to obtain useful iris region. Image pre-processing is divided into three steps: iris localization, iris normalization and image enhancement [1].

Advantages - The IRIS of the eye has been described as the ideal part of the human body for biometric identification for several reasons:

1. It is an internal organ that is well protected against damage and wear by a highly transparent and sensitive membrane (the cornea). This distinguishes it from fingerprints, which can be difficult to recognize after years of certain types of manual labour.
2. Iris patterns possess a high degree of randomness
   - ✓ variability: 244 degrees-of-freedom
   - ✓ entropy: 3.2 bits per square-millimeters
   - ✓ uniqueness: set by combinatorial complexity
3. An iris scan is similar to taking a photograph and can be performed from about 10 cm to a few meters away. There is no need for the person to be identified to touch any equipment that has recently been touched by a stranger, thereby eliminating an objection that has been raised in some cultures against finger-print scanners, where a finger has to touch a surface, or retinal scanning, where the eye can be brought very close to a lens (like looking into a microscope lens).
4. Limited genetic penetrance of iris patterns makes iris unique from other biometrics.
5. Some argue that a focused digital photograph with an iris diameter of about 200 pixels contains much more long-term stable information than a fingerprint.
6. While there are some medical and surgical procedures that can affect the colour and overall shape of the iris, the fine texture remains remarkably stable over many decades. Some iris identifications have succeeded over a period of about 30 years.
7. As with other identification infrastructure (national residents databases, ID cards, etc.), civil rights activists have voiced concerns that iris-recognition technology might help governments to track individuals beyond their will.

Disadvantages - The disadvantages are as follows:

1. Contact lenses are available which can change the colour of an individual's iris. These present a problem to any iris recognition system, since a fake iris pattern is printed on the surface of the lens, and will falsely reject an enrolled user, or falsely accept them, if the fake iris pattern has been enrolled in the database. Another problem to consider, although it would be quite minor, is that the border of any contact lens is slightly visible in an eye image, and this circular border may confuse the automatic segmentation algorithm in detecting it as the iris boundary.
2. The spectacles could introduce too much specular reflection resulting in failure of automatic segmentation and/or recognition.
3. The illumination in eye could create invisibility for accurate segmentation process.

4. The iris recognition process easily obscured by eyelashes, eyelids due to continuous blinking of eye.
5. Acquisition of iris image requires more training and attentiveness than other biometrics.

Issues in the design and implementation of a system for automated iris recognition can be subdivided into four parts Fig.1 The first stage is image acquisition. The second stage is concerned with localizing the iris per se from a captured image. The third stage is concerned with normalizing the localized iris from a captured image. The forth part is concerned with matching an extracted iris pattern with candidate data base entries.

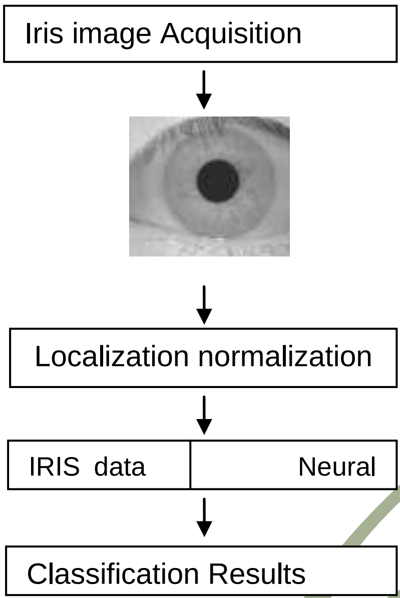

Fig.1 Schematic diagram of iris recognition

2. IMAGE PRE-PROCESSING

Image processing techniques can be employed to extract the unique iris pattern from a digitized image of the eye, and encode it into a biometric template, which can be stored in a database. Image pre-processing is divided into three steps: iris localization, iris normalization and image enhancement

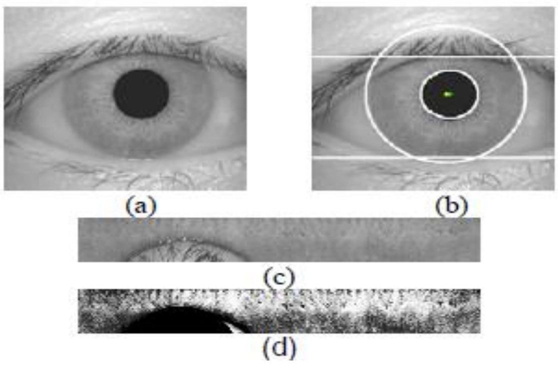

Fig.3 Iris image pre-processing
(a) Original iris image, (b) localized iris image, (c) normalized iris image, (d) enhanced iris image

2.1 IRIS LOCALIZATION

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 IRIS localization step. The inner circle is located between the iris and pupil boundary, the outer circle is located between the sclera and iris boundary. A variety of techniques have been developed for iris localization.

Hough transform - Since the inner and outer boundaries of an iris can be modeled as circles, circular Hough transform is used to localize the iris [3],[6-8]. Firstly, edge detector is applied to a gray scale iris image to generate the edge map. The edge map is obtained by calculating the first derivative of intensity values and thresholding the results. Gaussian filter is applied to smooth the image to select the proper scale of edge analysis. The voting procedure is realized using Hough transform in order to search for the desired contour from the edge map. Assuming a circle with center coordinate (xc,yc) and radius r, each edge point on the circle casts a vote in Hough space. The center coordinate and radius of the circle with maximum number of votes is defined as the contour of interest. For eyelids detection, the contour is defined using parabolic curve parameter instead of the circle parameter. The disadvantage of Hough transform algorithm is that it is computationally intensive and therefore not suitable for real time applications. It requires a threshold value to generate the edge map. The selected threshold value may remove some critical edge points and result in false circle detection.

Integro-differential operator - Daugman J [1] proposed to use the integro-differential operator to locate the pupil and iris circles as well as the upper and lower eyelid boundaries. The iris is modeled as two circles, which are not necessarily concentric. Each circle is defined by three parameters (xo, yo, r), where (xo, yo) locates the center of a circle with radius r. It utilizes an integro-differential operator to estimate the three parameter values for each circular boundary. It searches the whole image with respect to an increasing radius r to maximize

$$G(r) * \partial/\partial r \int_{xo,yo,r} (I(x,y)/2\pi r) * ds \qquad (1)$$

Where I(x, y) is the intensity value in the image at location (x, y), ds means the circular arc, 2*pi*r is used to normalize the integral, G(r) is a Gaussian filter used as a smoothing function, and means the convolution operation [3]. An integro-differential operator as described in equation 1 is also used to locate the upper and lower eyelids. In that case the integral is computed over a parabolic arc instead of a circular arc. The regions detected for the eyelids are excluded from the iris image. The integro-differential can be seen as a variation of the Hough transform, since it too makes use of first derivatives of the image and performs a search to find geometric parameters. Since it works with raw derivative information, it does not suffer from the threshold problems of the Hough transform. However, the algorithm can fail where there is noise in the eye image, such as from reflections, since it works only on a local scale.

Discrete circular active contour - Ritter proposed an active contour model to localize iris in an image [9]. The model detects pupil and limbus by activating and controlling the active contour using two defined forces: internal and external forces. The internal forces are responsible to expand the contour into a perfect polygon with a radius r larger than the contour average radius. The internal forces are designed to expand the contour and keep it circular. The force model assumes that pupil and limbus are globally circular, rather than locally, to minimize the undesired deformations due to specular reflections and dark patches near the pupil boundary. The contour detection process of the model is based on the equilibrium of the defined internal forces with the external forces. The external forces are obtained from the grey level intensity values of the image and are designed to push the vertices inward. The movement of the contour is based on the composition of the internal and external forces over the contour vertices. The final equilibrium is achieved when the average radius and center of the contour becomes the same as the one in m iterations ago.

Black hole search method - Black hole search method is used to compute the centre and area of a pupil [10], [11]. Since the pupil is the darkest region in the image, this approach applies threshold segmentation method to find the region.
Firstly, a threshold is defined to identify the dark areas in the iris image. The dark areas are called as "black holes". The centre of mass of these black holes is computed from the global image. The area of pupil is the total number of those black holes within the region. The radius of the pupil can be calculated from the circle area formula. Black hole search method is not suitable for iris image with dark iris. The dark iris area would be detected instead of the area of pupil.

Bisection method - In both [12] and [13], the bisection method is used to locate the centre of the pupil. The centre of the pupil is used as reference to detect the inner and outer boundaries of the iris. Firstly, edge detection is applied to the iris image to extract the edge information. For every two points on the same edge component, bisection method is applied to draw the perpendicular lines to the centre point. The centre point with maximum number of line intersections is selected as the centre of the pupil. A virtual circle is drawn with reference to the centre of the pupil and the radius is increased within a certain range. Two virtual circles with the largest number of edge points are chosen as the inner and outer boundaries of the iris. Bisection method is affected by the non-uniform illuminations and glasses reflections. As a result, the iris inner boundary cannot be localized accurately. Similar to the discrete circular active contour method, image pre-processing algorithm is needed to remove the high intensity areas caused by illuminations and reflections.

2.2 PURPOSED LOCALIZATION METHOD –

Purposed method includes Kong's rectangular area technique, and is able to localise the circular iris and pupil region, occluding eyelids and eyelashes, and reflections.
A fast algorithm of Kong's rectangular area algorithm for detecting the boundaries between pupil and iris and also sclera and iris has been implemented. To find the boundary between the pupil and iris, it must detect the location (centre coordinates and radius) of the pupil. The rectangular area technique is applied in order to localize pupil and detect the inner circle of iris. The pupil is a dark circular area in an eye image. Besides the pupil, eyelids and eyelashes are also characterized by black colour. In some cases, the pupil is not located in the middle of an eye image, and this causes difficulties in finding the exact location of the pupil using point-by- point comparison on the base of threshold technique. It is required to find the black rectangular region in an iris image figure 3.3.
Choosing the size of the black rectangular area is important, and this affects the accurate determination of the pupil's position. If a small size is chosen, then this area can be found in the eyelash region. A (10x10) rectangular area is used to accurately detect the location of the pupil. Searching starts from the vertical middle point of the iris image and continues to the right side of the image. A threshold value is used to detect the black rectangular area. Starting from the middle vertical point of iris image, the greyscale value of each point is compared with the threshold value.

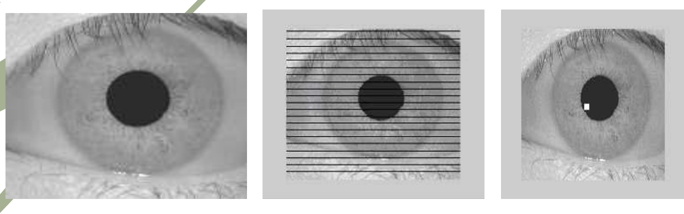

Fig.4 (a) Iris image, (b) The lines that were drawn to detect rectangular areas,
(c) The result of detecting of rectangular area

As in the iris database, the value of the threshold is set to 65 in grey level scale. If greyscale values in each point of the iris image are less than the threshold value, then the rectangular area will be found. If this condition is not satisfactory for the selected position, then the search is continued from the next position. This process starts from the left side of the iris, and it continues until the end of the right side of the iris. In case the black rectangular area is not detected, the new position in the upper side of the vertical middle point of the image is selected and the search for the black rectangular area is resumed. If the black rectangular area is not found in the upper side of the eye image, then the search is continued in the down side of image. Fig 4(a) shows iris image.
In Fig.4 (a), the searching points are shown by the lines. In Fig. 4(b), the black rectangular area is shown in white colour. After finding the black rectangular area, we start to detect the boundary of the pupil and iris. At first step, the points located in the boundary of pupil and iris, in horizontal direction, and then the points in the vertical direction are detected. The border of the pupil and the iris has a much larger greyscale change value.

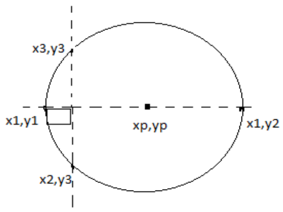

Fig.5 finding centre of pupil

Using a threshold value on the iris image, the algorithm detects the coordinates of the horizontal boundary points of (x1, y1) and (x1,y2).The same procedure is applied to find the coordinates of the vertical boundary points (x3,y3) and (x4,y3). After finding the horizontal and vertical boundary points between the pupil and the iris, the following formula is used to find the centre coordinates (xp, yp) of the pupil.

$$x_p = (x_3 + x_4)/2, \quad y_p = (y_3+y_4)/2 \qquad (2)$$

The same procedure is applied for two different rectangular areas. In case of small differences between coordinates, the same procedure is applied for four and more different rectangular areas in order to detect a more accurate position of the pupil's centre. After determining the centre points, the radius of the pupil is computed using equation 3.2.

$$rp = \sqrt{(xc-x1)2 + (yc-y1)2} \;\; \text{or} \;\; rp = \sqrt{(xc-x3)2 + (yc-y3)2} \qquad (3)$$

Because of the change of greyscale values in the outer boundaries of iris is very soft, the current edge detection methods are difficult to implement for detection of the outer boundaries. Another algorithm is applied in order to detect the outer boundaries of the iris. Start from the outer boundaries of the pupil and determine the difference of sum of greyscale values between the first ten elements and second ten elements in horizontal direction. This process is continued in the left and right sectors of the iris. The difference corresponding to the maximum value is selected as boundary point. This procedure is implemented by the following formula.

$$DLi = \sum(Si+1 - Si) \; ; \quad DRj = \sum(Sj+1-Sj) \qquad (4)$$

Here DL and DR are the differences determined in the left and right sectors of the iris, correspondingly. xp and yp are centre coordinates of the pupil, rp is radius of the pupil, right is the right most y coordinate of the iris image. In each point, S is calculated as

$$Sj = \sum I(i,k) \qquad (5)$$

where i=xp, for the left sector of iris j=10,…,yp-(rp+10), and for the right sector of iris j=yp+(rp+10). Ix(i,k) are greyscale values.
The centre and radius of the iris are determined using

$$ys = (L+R)/2, \quad rs = (R-L)/2 \qquad (6)$$

L=i, where i correspond to the value max (|DLi|), R=j, where j correspond to the value max(|DRj|).

The extracted iris region was then normalised using Daugman's Rubersheet model into a rectangular block with constant dimensions to account for imaging the inconsistencies. Normalized iris provides important texture information. The normalized iris image is represented by a two-dimensional array. This array contains the greyscale values of the texture of the iris pattern. These values are input signals for the neural network and design a Feed forward Error backpropagation Neural Network to classify patterns presented to the network.

We have used MMU Iris Database for developing Iris recognition technique in this paper. The Images are 320x280 pixels gray scale taken by a digital optical sensor designed by National Laboratory of Pattern Recognition – Chinese Academy of Sciences.

3. NEURAL NETWORK CLASSIFICATION

Neural networks (nn) are simple models to built intelligent system. NN models are inspired by biological nervous system.
The development of neural network leads to maintain relationship b/w input and output in complex and non-sequential manner. In recent years this approach have been conducted for pattern recognition, image processing, forecasting, data compression etc[15].
There are several Artificial Neural Network (ANN) have been purposed models so far for example feed forward (FFBPNN), cascade forward (CFBPNN), function fitting , pattern recognition and learning vector quantization[16].
Here we have used a basic neural network FFBPNN (feed forward) with two hidden layers. The normalized and enhance image is the input to the neural network in 2-D array form. This array basically has greyscale values of iris pattern found.

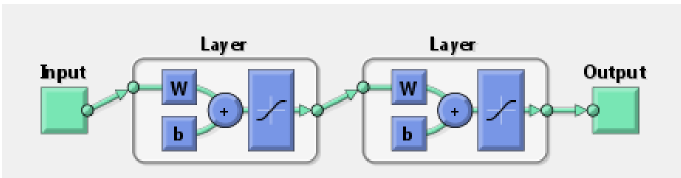

Fig.6 FFBPNN with 2 layers

To reduce the error the training algorithms are used, by using adjustments of weights and biases to minimize the performance function. Here performance is based on MSE (Mean Square Error) and also reduces it to minimize to get the desired results. And training is done by TRAINGDA (Gradient descent algorithm), some other algorithms are also available -LM, CFG, BR, GDX, OSS etc. MSE is basically the difference between expected value and output value.

$$MSE = \sum_{i=1}^{N} (error_i)^2/n \quad \text{i.e.} \quad MSE = \sum_{i=1}^{n} (T_i-O_i)^2/n \qquad (7)$$

Researches also show increasing hidden layers results in better estimation [101] .

4. EXPERIMENT RESULTS

We have used MMU Iris Database for developing Iris recognition technique. Each image in size of 320x240. This contains 7 instances of 20 objects.

For segmentation we have found the accuracy of 97.32% with Pentium Dual Core and matlab 7.6.0 version. The speed also has boosted. By Using the traingda MSE (Mean Square Error) the results are shown. The purposed method results in performance 95% with hidden layers 2. Performance function used here is MSE. Researches also show decreasing of MSE with increasing hidden layers [16].

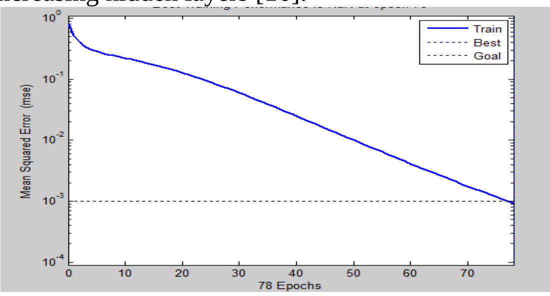

Fig.7 Performance plot

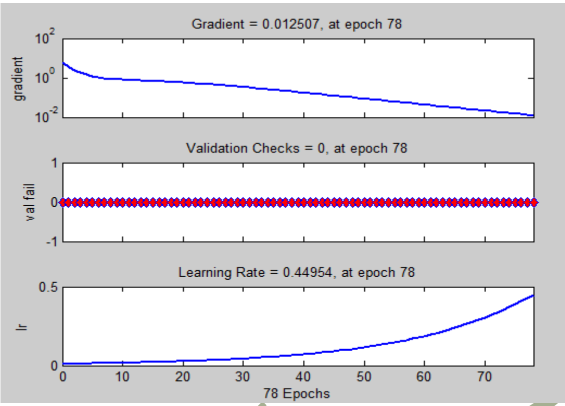

Fig.8 Training State

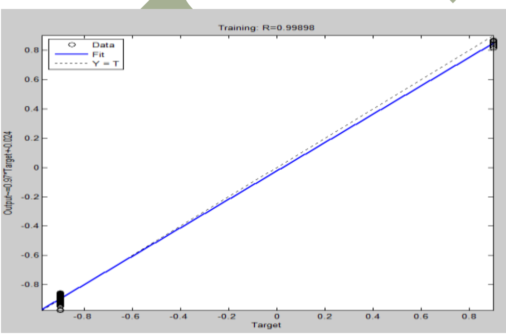

Fig.9 Regression State

5. Conclusion

This paper provides a wide review of researches in the field of IRIS recognition. They are categorized into three categories Image Processing (iris localization, iris normalization and image enhancement), Feature Extraction, Template Matching .Neural network is used for classification of results. The performance of each algorithm implemented in each stage is evaluated. There are increasing demands on iris recognition due to its reliability and accuracy. If the iris recognition algorithms are optimized for low-cost dedicated hardware, it will be employed in various applications.

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