Person Identification through IRIS Recognition

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Abstract

In this paper we propose a new biometric-based Iris feature extraction system. The system automatically acquires the biometric data in numerical format (Iris Images) by using a set of properly located sensors. We are considering camera as a high quality sensor. Iris Images are typically color images that are processed to gray scale images. Then the Feature extraction algorithm is used to detect "IRIS Effective Region (IER)" and then extract features from "IRIS Effective Region (IER)" that are numerical characterization of the underlying biometrics. Later on this work will be helping to identify an individual by comparing the feature obtained from the feature extraction algorithm with the previously stored feature by producing a similarity score. This score will be indicating the degree of similarity between a pair of biometrics data under consideration. Depending on degree of similarity, individual can be identified. Authentication is also a major concern area of this thesis. By considering Biological characteristics of IRIS Pattern we use Statistical Correlation Coefficient for this 'IRIS Pattern' recognition where Statistical Estimation Theory can play a big role.

1. Introduction

The human iris recently has attracted the attention of biometrics-based identification and verification research and development community. The iris is so unique that no two irises are alike, even among identical twins, in the entire human population.

Automated biometrics-based personal identification systems can be classified into two main categories: identification and verification. In a process of verification (1-to-1 comparison), the biometrics information of an individual, who claims certain identity, is compared with the biometrics on the record that represent the identity that this individual claims. The comparison result determines whether the identity claims shall be accepted or rejected. On the other hand, it is often desirable to be able to discover the origin of certain biometrics information to prove or disprove the association of that information with a certain individual. This process is commonly known as identification (1-to-many comparison).

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Actual iris identification can be broken down into four fundamental steps. First, a person stands in front of the iris identification system, generally between one and three feet away, while a wide angle camera calculates the position of their eye. A second camera zooms in on the eye and takes a black and white image. After the iris system has one's iris in focus, it overlays a circular grid (zone's of analysis) on the image of the iris and identifies where areas of light and dark fall. The purpose of overlaying the grid is so that the iris system can recognize a pattern within the iris and to generate 'points' within the pattern into an 'eyeprint'. Finally, the captured image or 'eyeprint' is checked against a previously stored 'reference template' in the database. The time it takes for a iris system to identify your iris is approximately two seconds.

In the iris alone, there are over 400 distinguishing characteristics, or Degrees of Freedom (DOF), that can be quantified and used to identify an individual (Daugman, J. & Williams, G. O. 1992). Although, approximately 260 of those are possible to captured for identification. These identifiable characteristics include: contraction furrows, striations, pits, collagenous fibers, filaments, crypts (darkened areas on the iris), serpentine vasculature, rings, and freckles. Due to these unique characteristics, the iris has six times more distinct identifiable features than a fingerprint..

2. Previous works

Plenty of works are done on Iris Recognition System, since last 3-4 years. Most of the cases, authors claimed the better performance of speed in capturing images and recognition over the existing systems available at that time. To gather the knowledge, we have considered the following selective works.

Lye Wi Liam, Ali Chekima, Liau Chung Fan and Jamal Ahmad Dargham, in 2002, proposed [1] a system consisting of two parts: Localizing Iris and Iris Pattern Recognition. They used digital camera for capturing image; from the captured images Iris is extracted. Only the portion of selected Iris then reconstructed into rectangle format, from which Iris pattern is recognized.

Eric Sung, Xilin Chen, Jie Zhu and Jie Yang, December 2002, proposed a modified Kolmogora, complexity measure based on maximum Shannon entropy of wavelet packet reconstruction to quantify the iris information [2]. Real-time eye-comer tracking, iris segmentation and feature extraction algorithms are implemented. Video images of the iris are captured by an ordinary camera with a zoom lens. Experiments are performed and the performances and analysis of iris code method and correlation method are described. Several useful findings were reached albeit from a small database. The iris codes are found to contain almost all the discriminating information. Correlation approach coupled with nearest neighbors classification outperforms the conventional thresholding method for iris recognition with degraded images.

Jiali Cui, Yunhong Wang, JunZhou Huang, Tieniu Tan and Zhenan Sun have proposed [3] the iris recognition algorithm based on PCA (Principal Component Analysis) is first introduced and then, iris image synthesis method is presented. The synthesis method first constructs coarse iris images with the given coefficients. Then, synthesized iris images are enhanced using super resolution. Through controlling the coefficients, they create many iris images with specified classes. Extensive experiments show that the synthesized iris images have satisfactory cluster and the synthesized iris databases can be very large.

Hyung Gu Lee, Seungin Noh, Kwanghyuk Bae, Kang-Ryoung Park and Jaihie Kim have introduced [4] the invariant binary feature which is defined as iris key. Iris image variation is not important in their work. Iris key is generated by the reference pattern, which is designed as lattice structured image to represent a bit pattern of an individual. Reference pattern and Iris image are linked into filter. In the filter Iris texture is reflected according to the magnitude of iris power spectrum in frequency domain.

Zhenan Sun, Yunhong Wang, Tieniu Tan, and Jiali Cui, in 2005, proposed [5] to overcome the limitations of local feature based classifiers (LFC). In addition, in order to recognize various iris images efficiently a novel cascading scheme is proposed to combine the LFC and an iris blob matcher. When the LFC is uncertain of its decision, poor quality iris images are usually involved in intra-class comparison. Then the iris blob matcher is resorted to determine the input iris identity because it is capable of recognizing noisy images. Extensive experimental results demonstrate that the cascaded classifiers significantly improve the system's accuracy with negligible extra computational cost.

Kazuyuki Miyazawa, Koichi Ito, Takafumi Aoki, Koji Kobayashi, Hiroshi Nakajima developed [6] phase-based image matching algorithm. The use of phase components in 2D (two-dimensional) discrete Fourier transforms of iris images makes possible to achieve highly robust iris recognition in a unified fashion with a simple matching algorithm.

Pan Lili and Xie Mei, proposed [7] a new iris localization algorithm, in which they adopted edge points detecting and curve fitting. After this, they set an integral iris image quality evaluation system that is necessary in the automatic iris recognition system.

Iris image denoising algorithm is proposed by Wang Jian-ming and Ding Run-tao [8], in which phase preserving principle is held to avoid corruption of iris texture features. Importance of phase information for iris image is shown by an experiment and the method to implement phase preserving by complex Gabor wavelets is explained. To verify the algorithm, white noise is added to iris images and Hamming distances between the iris images are calculated before and after the denoising algorithm are applied.

Weiki Yuan, Zhonghua Lin and Lu Xu have analyzed eye images [9] that they have based on structure characteristics of eyes, they put forward a rapid iris location arithmetic. Firstly, they have got an approximative center by gray projection, have got two points that located at left and right boundary by threshold value respectively, and have got a point that located at the lower boundary by direction edge detection operators, then they ensured the boundary of pupil and probable center. Secondly, they have got exact pupil boundary and center by Hough transform that is processed at a small scope surrounding the probable center. Thirdly, they have searched two points that located at left and right boundaries between iris and sclera along horizontal direction by using the exact center and direction edge detection operators. Then they ensured the horizontal coordinate of the center of iris based on the above two point accurately. Finally, they have searched two points that located at upper and lower boundaries between iris and sclera beginning at the horizontal coordinate of the center of iris along the directions that making plus and minus thirty angles between horizontal direction respectively by using direction edge detection operators, so they ensured the coordinate of the center of iris and the boundary between iris and sclera. The experiments indicated that this method reached about zero point two second at speed and percentage of ninety nine point forty five at precision. This method is faster than existing methods at speed, they claimed.

Christopher Boyce, Arun Ross, Matthew Monaco, Lawrence Hornak and Xin Li examined [10] the iris information represented in the visible and IR portion of the spectrum. It is hypothesized that, based on the color of the eye, different components of the iris are highlighted at multiple wavelengths. To this end, an acquisition procedure for obtaining co-registered multispectral iris images associated with the IR, Red, Green and Blue wavelengths of the electromagnetic spectrum, is first discussed. The components of the iris that are revealed in multiple spectral channels/wavelengths based on the color of the eye are studied. An adaptive histogram equalization scheme is invoked to enhance the iris structure. The performance of iris recognition across multiple wavelengths is next evaluated. They claimed the potential of using multispectral information to enhance the performance of iris recognition systems.

Chengqiang Liu Mei Xie, proposed [11] Direct Linear Discriminant Analysis (DLDA) which combines with wavelet transform to extract iris feature. In their method, firstly, they apply wavelet decomposition to the normalized iris image whose size is 64×256 and just choose the coefficients of the approximation part of the second level wavelet decomposition to represent the iris image because this part contains main feature of the original iris image but the size of this part is only 16×64. And then make use of DLDA to extract the iris feature from this approximation part. During classification, the Euclidean distance is applied to measure the similarity degree of two iris classes.

Hugo Proenca and Luis A. Alexandre [12] analyzed the relationship between the size of the captured iris image and the overall recognition's accuracy. Further, they have identified the threshold for the sampling rate of the iris normalization process above that the error rates significantly increased.

An efficient technique on iris image acquisition, iris de-nosing, iris localization, and quality assessment have proposed by Kefeng FAN, Qingqi Pei, Wei MO, Xinhua Zhao, and Qifeng Sun [13]. An automatic focusing system based on a decision function is introduced into the iris acquisition device to achieve the feedback control, which can capture the high-resolution iris image with real-time. Iris localization differs from previous iris localization schemes in that it combines iris acquisition with edge detection technique. On the basis of coarse detection, the iris accurate detection is based on the combination of wavelet-based least square method, Laplacian of Gaussian function and an improved Hough Transform. They claimed that the technique has a good performance, which not only capture high quality iris image, but also improve the speed and accuracy or iris localization.

3. Our work

We have divided our work into four main phases related with three different algorithms before recognition, which are given and discussed hereunder:

3.1. 24-bit bitmap Color Image to 8-bit Gray Scale Conversion

1. At first a picture of an individual's Eye with a Powerful Digital Camera, such that the picture must be a size of 100*100 in 24-Bit BMP format.
2. Take this 24-Bit BMP file as Input file and open the file in Binary Mode.
3. Copy the ImageInfo (First 54 byte) of the Header from Input 24-Bit Bmp file to a newly created BMP file and edit this Header by changing filesize, Bit Depth, Colors to confirm to 8-Bit BMP.
4. Copy the ColorTable from a sample gray scale Image to this newly created BMP at 54th Byte place on words.
5. Convert the RGB value to Gray Value using the following formula:
   blueValue = (0.299*redValue + 0.587*greenValue + 0.114*blueValue);
   greenValue = (0.299*redValue + 0.587*greenValue + 0.114*blueValue);
   redValue = (0.299*redValue + 0.587*greenValue + 0.114*blueValue);
   grayValue = blueValue = greenValue = redValue;
6. Write to new BMP file.

Take 24-bit BMP color image as input. Then convert it to 8-bit Gray Scale image by following this algorithm. This 8-bit Gray Scale image is the output of the algorithm. In this algorithm, first read the red, blue and green value of each pixel and then after formulation, three different values are converted into gray value.

3.2. IRIS Edge Detection

1. Take 8-Bit gray Scale Image produced from previous Algorithm as input and open this BMP file in Binary Read mode.
2. Detect the PUPIL Boundary and set the boundary pixels to 255 (white) using following logic:

```
for(x=0;x<=originalImage.rows-1;x++)
{
  for(y=0;y<=originalImage.cols-1;y++)
  {
     if (Grayvalue(x, y)==0)
     {
        if((GrayValue(x,y-1)!=0) && (GrayValue(x,y+1)==0)))
        {
           GrayValue (x, y-1) = 255
        }
        else if((GrayValue(x,y-1)==0) && (GrayValue(x,y+1)!=0)))
        {
           GrayValue (x, y+1) = 255
        }
        else
           No change in the GrayValue.
     }
  }
}
```

3. Detect the IRIS Boundary and set the boundary pixels to 255 (white) using following logic:

```
for(x=0;x<=originalImage.rows-1;x++)
{
   for(y=0;y<=originalImage.cols-1;y++)
   {
        if(x>12 && x<70 && y>12 && y<50)
        {
           if(Grayvalue(x,y)<100 && Grayvalue(x,y)!=0)
           {
                 if( ((Grayvalue(x,y-1))-(GrayValue(x,y+1))>24 &&
                 (Grayvalue(x,y-1))>=100 && (Grayvalue(x,y- 1))!=255 &&
                  (Grayvalue(x,y+1))<100 && (Grayvalue(x,y+1))!=0 )
                 {
                       GrayValue(x,y-1) = 255
                 }
                 else
                       No change in the GrayValue
           }
           else
                 No change in the GrayValue.
        }
```

```
                else
                    Write to new BMP file
            }
        }
```

Here we are considering 8-bit Image, two-pass masking is used, namely, Horizontal and Vertical kernels. The PlanarImage now passed through these masks or kernels. Resultant transformed Image generates the distinct marks for IRIS area; the process is edge detection [14].

The 8-bit grayscale eye images have some gray distribution characteristics, these are ---

- The gray value of pupil should be less than the gray value of iris.
- The gray value of iris should be less than the gray value of sclera.

First we project all the gray values of every pixel in the grayscale image along the horizontal and vertical direction separately. Now we analyze the histogram of grayscale image and this analysis will say very clearly that the sum of gray value is lower than other area such that iris and sclera. Figure 3, shows the histogram of 8-bit grayscale image (Figure 1).

Figure 1. 8-bit grayscale BMP image

In Figure 2, which is gray level histogram of Figure 1, there are three peaks. The first peak represents the pupil region's intensity values. Similarly, the image intensity values near the second and third peaks represent the intensity values of the iris and sclera region respectively.

Now, in the grayscale image we can detect the pupil area. We can find out the small region, in which the sum of the entire pixel's intensity value is minimal. Experimentally we prove that the gray values change within the pupil is very small. So, the detector of pupil area is applied for 100 x 100 grayscale image.

$$\min_{(i,j)} \sum_{x=xi}^{xi+8} \sum_{y=yj}^{yj+8} I(x,y) \quad \text{--------------} \ (1)$$

Where, represent the intensity value at location,

Xi = (i-1) × 20 + 5, i = 1, 2, 3, 4, 5.
Yj = (j-1) × 20 + 5, j = 1, 2, 3, 4, 5.

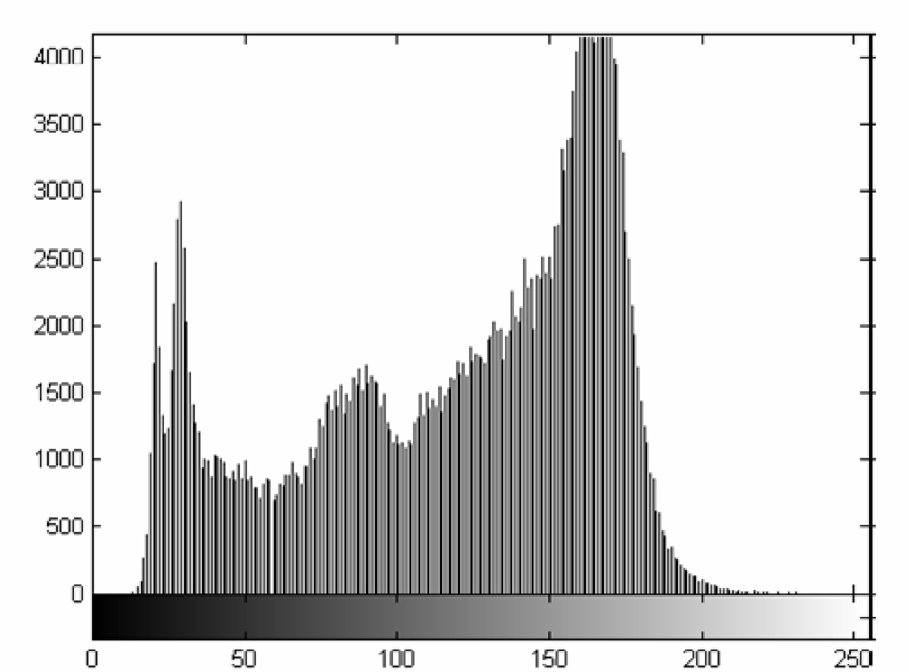

Figure 2. Histogram Analysis of grayscale image.

In this region the sum of the intensity value of all pixels is minimal. So, this region always must be in the part of pupil.

By using the detector in equation (1), a pixel in the pupil can be easily detected.

Let, that pixel is in location (xp, yp). Then, at yp, we detect the left edge point in the gray image is (xl, yp) and right edge point is (xr, yp).

Therefore, Horizontal – Coordinate of the pupil's centre is ----------

$$x_c = \frac{(x_l + x_r)}{2}$$

Also, we get the upper edge point at xp in the gray image is (xp, yu) and bottom edge point is (xp, yl). Therefore, Vertical – Coordinate of the pupil's centre is -------

$$y_c = \frac{(y_u + y_l)}{2}$$

Therefore the centre point of pupil is (x_c, y_c).

3.3. IRIS Effective Region Extraction and Pattern Generation

Extracting a 8*12 Iris Pattern from Edge Detected IRIS Image.

1. Take the 8-Bit BMP Image produced from previous Algorithm as Input and open this BMP file in binary Read Mode.

2. Read the raster Data and Store the raster Data into a Matrix of vectorSize. Where vectorSize = filesize - (54+ (4*256)).
3. Then a 8*12 Iris Pattern is extracted from Edge Detected BMP using following logic-

```
for (x=0;x<=originalImage.rows-1;x++)
{
    for (y=0;y<=originalImage.cols-1;y++)
    {
      if ( y<30 && x=((originalImage.rows/2)+4) && GrayValue == 255)
      {
        for (i=0;i<8;i++)
        {
          for (j=0;j<12;j++)
          {
            *(edgeImage.data + (i * edgeImage.cols) + j) =
            *(originalImage.data +  (x * riginalImage.cols) - (i *
            originalImage.cols) + (y + j));
            Write to new BMP Image file
           }
        }
      }
    }
}
```

Take 8-bit BMP image produced from previous step as an input. Then convert it to 12X8 8-bit BMP image by following this algorithm. This 12x8 8-bit BMP image is the output of the algorithm. In this algorithm, first go to the middle row and first column of the input image, then go to the 4 pixels upward and check the gray value of each pixel until gray value becomes 255 (white). After this start reading the pixels and store the corresponding gray value into a 8x12 matrix.

Generally, there are four major processes for a particular iris recognition system. They are image acquisition, iris preprocessing, feature extraction and matching.

In our work we have considered MMU1 iris database where a total number of 450 iris images which were taken using LG IrisAccess®2200. This camera is semi-automated and it operates at the range of 7-25 cm. On the other hand, MMU2 iris database consists of 995 iris images. The iris images are collected using Panasonic BM-ET100US Authenticam and its operating range is even farther with a distance of 47-53 cm away from the user. 100 volunteers with different age and nationality contribute these iris images. They come from Asia, Middle East, Africa and Europe. Each of them contributes 5 iris images for each eye [15].

3.4. IRIS Recognition and Person Identification

Authentication is a major concern area of this thesis. By considering Biological characteristics of IRIS Pattern we use Statistical approach for this ‘IRIS Pattern’ recognition where Statistical Estimation Theory has played a big role. The algorithm and discussion are stated hereunder:

Linear correlation coefficient [16] measures the strength and the direction of a linear relationship between two variables. It is denoted by r and defined as –

$$r = \frac{cov\,(X,Y)}{S_x\,S_y}$$

Where, r varies from -1 to +1. So, $-1 \leq r \leq +1$.

If x and y have a strong positive linear correlation, r is close to +1 which is called Positive Correlation and if x and y have a strong negative linear correlation, r is close to -1 which is called Negative Correlation. If there is no linear correlation or a weak linear correlation, r is close to 0. A value near zero means that there is a random, nonlinear relationship between the two variables. A correlation greater than 0.8 is generally described as strong, whereas a correlation less than 0.5 is generally described as weak. These values can vary based upon the "type" of data being examined. A study utilizing scientific data may require a stronger correlation than a study using social science data.

Now, the second central moment µ2 is called the **variance of x**. It is denoted by S_x^2. S_x is the standard deviation of x which is the positive square root of the variance. Variance of x is defined by –

$$S_x^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2$$

$$= \frac{1}{N}\sum_{i=1}^{N}(x_i^2 - 2x_i\bar{x} + \bar{x}^2)$$

$$= \frac{1}{N}\sum_{i=1}^{N} x_i^2 - 2\bar{x}.\frac{1}{N}\sum_{i=1}^{N} x_i + \bar{x}^2.\frac{1}{N}.N$$

$$= \frac{1}{N}\sum_{i=1}^{N} x_i^2 - 2\bar{x}^2 + \bar{x}^2$$

$$= \frac{1}{N}\sum_{i=1}^{N} x_i^2 - \bar{x}^2$$

$$\therefore N.S_x^2 = \sum_{i=1}^{N} x_i^2 - N.\bar{x}^2$$

$$= \sum_{i=1}^{N} x_i^2 - N.\left(\frac{1}{N}\sum_{i=1}^{N} x_i\right)^2$$

$$\boxed{S_{xx} = \sum_{i=1}^{N} x_i^2 - \frac{\left(\sum_{i=1}^{N} x_i\right)^2}{N}} \qquad \text{------------ (2)}$$

Where, is the mean of x, N is the number of pairs of data. Now, the variance of y is defined by-

$$S_y^2 = \frac{1}{N}\sum_{i=1}^{N}(y_i - \bar{y})^2$$

$$= \frac{1}{N}\sum_{i=1}^{N}(y_i^2 - 2y_i\bar{y} + \bar{y}^2)$$

$$= \frac{1}{N}\sum_{i=1}^{N} y_i^2 - 2\bar{y}.\frac{1}{N}\sum_{i=1}^{N} y_i + \bar{y}^2.\frac{1}{N}.N$$

$$= \frac{1}{N}\sum_{i=1}^{N} y_i^2 - 2\bar{y}^2 + \bar{y}^2$$

$$= \frac{1}{N}\sum_{i=1}^{N} y_i^2 - \bar{y}^2$$

$$\therefore N.S_y^2 = \sum_{i=1}^{N} y_i^2 - N.\bar{y}^2$$

$$= \sum_{i=1}^{N} y_i^2 - N.(\frac{1}{N}\sum_{i=1}^{N} y_i)^2$$

$$S_{yy} = \sum_{i=1}^{N} y_i^2 - \frac{(\sum_{i=1}^{N} y_i)^2}{N} \qquad \text{-----------------} (3)$$

$\bar{y}$ is the mean of y ,
N is the number of pairs of data,
S_y is the standard deviation of y which is the positive square root of the variance.

Now, the second order mixed central moment μ_{11} is called the **covariance of X and Y.** It is denoted by $cov(X,Y)$ and is defined as-

$$cov(X,Y) = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})(y_i - \bar{y})$$

$$= \frac{1}{N}\sum_{i=1}^{N}(x_i y_i - x_i\bar{y} - y_i\bar{x} + \bar{x}\bar{y})$$

$$= \frac{1}{N}\sum_{i=1}^{N} x_i y_i - \bar{y}\,\frac{1}{N}\sum_{i=1}^{N} x_i - \bar{x}\,\frac{1}{N}\sum_{i=1}^{N} y_i + \frac{1}{N}\sum_{i=1}^{N} \bar{x}\bar{y}$$

$$= \frac{1}{N}\sum_{i=1}^{N} x_i y_i - \bar{y}\bar{x} - \bar{x}\bar{y} + \frac{1}{\not{N}}.\not{N}.\bar{x}\bar{y}$$

$$- \frac{1}{N}\sum_{i=1}^{N} x_i y_i - \bar{x}\bar{y}$$

$$\therefore\ N.cov(X,Y) = \sum_{i=1}^{N} x_i y_i - \not{N}.\frac{1}{\not{N}}\sum_{i=1}^{N} x_i . \frac{1}{N}\sum_{i=1}^{N} y_i$$

$$\boxed{S_{xy} = \sum_{i=1}^{N} x_i y_i - \frac{(\sum_{i=1}^{N} x_i \sum_{i=1}^{N} y_i)}{N}} \quad \text{------------------- (4)}$$

Where, is the mean of x, is the mean of y, N is the number of pairs of data. Now, the correlation coefficient is-

$$r = \frac{cov(X,Y)}{S_x S_y}$$

$$= \frac{N.cov(X,Y)}{N.S_x S_y}$$

$$= \frac{N.cov(X,Y)}{\sqrt{N.S_x^2}.\sqrt{N.S_y^2}}$$

$$\boxed{\therefore\ r = \frac{S_{xy}}{\sqrt{S_{xx}.S_{yy}}}} \quad \text{------------ (5)}$$

Equation 2, 3, 4 and 5 are used in this algorithm for calculation of correlation coefficient.

Algorithm:

1. Take 1 training (input) iris pattern image of any individual and given identification number.
2. Read all 10 iris pattern images from database against his/her identification number.
3. Taking input pattern image with each stored iris pattern images in database, calculate correlation coefficient(r) using the following logic-

```
for(i=0;i<row;i++)
 {
    for(j=0;j<col;j++)
    {
        x = matrix_database[i][j];
        y = matrix_Input[i][j];
        sum_x2 += x*x;
        sum_y2 += y*y;
        sum_xy += x*y;
        sum_x += x;
        sum_y += y;
     }
 }
 Sxx = sum_x2 - ((sum_x*sum_x)/n);
 Sxy = sum_xy - ((sum_x*sum_y)/n);
 Syy = sum_y2 - ((sum_y*sum_y)/n);
 r = Sxy/(sqrt(Sxx*Syy));
```

4. In this way 10 correlation coefficient(r) values are generated and calculate the average of 10 r-values.
5. If this average value >= 0.8 then the individual with given input iris pattern is Authenticate to this organization.
6. Otherwise this individual is subject to be an unauthorized one to the Organization.

4. Result

Our test results shown in Figure 3 through Figure 6. 24-bit Color eye picture is taken by using a powerful digital camera, located in a suitable position. Numerous pictures are taken and these are resized and converted to 8-bit Images, here, these are considered as Iris Samle-1 through Iris Sample-n, which are displayed in Figure-4. For every sample Edge detection is done, here shown for Iris Sample-1 in Figure 5. Now using algorithm “IRIS Effective Region Extraction and Pattern Generation” Iris Effective Region is extracted, which is clearly shown in Figure-6 surrounded by rectangle. From this rectangle the 2D-Array is generated, shown in Table-1. In this process n number of 2D-Arrays will be generated for n number of IRIS Images.

We are considering the Table 1 is the IRIS Pattern of Iris Sample-1, so, we will get n number of IRIS Patterns of an individual. From this n number of IRIS Patterns one single

'IRIS Pattern' of an individual can be generated by Statistical Analysis, which can be strongly used for Pattern Recognition or over all Human Recognition.

In this thesis Iris recognition performance is evaluated using the False Acceptance Rate (FAR) and False Rejection Rate (FRR).

The false acceptance rate, or FAR, is the measure of the likelihood that the biometric security system will incorrectly accept an access attempt by an unauthorized user. A system's FAR typically is stated as the ratio of the number of false acceptances divided by the number of identification attempts. FAR is defined as

$$(\%)FAR = \frac{No.\ of\ incidents\ of\ false\ acceptence}{total\ No.\ of\ samples} \times 100\ \%$$

Figure 3. 24-bit bitmap Image.

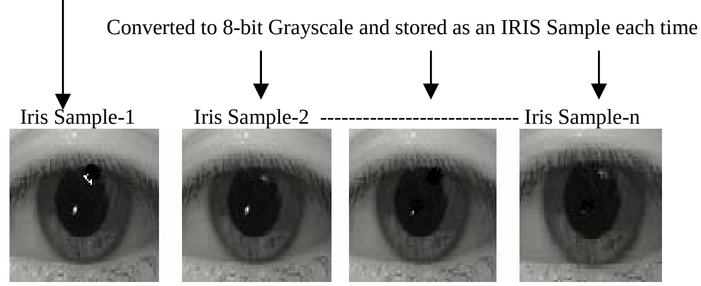

Figure 4. Series of sample images.

Figure 5. Sample-2.

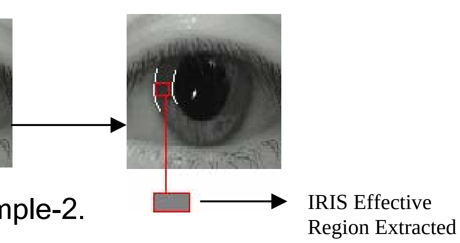

Figure 6. Highlighted
[n x m] Red Rectangle
from Figure 5, Sample-2.

The false rejection rate, or FRR, is the measure of the likelihood that the biometric security system will incorrectly reject an access attempt by an authorized user. A system's FRR typically is stated as the ratio of the number of false rejections divided by the number of identification attempts.

FRR is defined as:

$$(\%)FRR = \frac{No.\ of\ incidents\ of\ false\ rejections}{total\ No.\ of\ samples} \times 100\ \%$$

Table 1. 8*12 Matrix IRIS Pattern

87	65	49	47	41	49	51	49
81	65	49	45	45	49	51	47
89	65	53	49	47	47	47	47
93	75	61	49	47	49	49	47
89	75	57	53	47	49	49	47
95	87	63	49	49	57	49	55
97	89	67	61	53	51	55	55
95	89	67	63	55	55	55	59
111	89	73	65	55	51	61	63
111	87	75	69	55	55	57	63
111	105	75	71	55	59	57	57
113	111	77	89	67	57	57	61

From Table 2, we can see there are 0 falsely rejected incidents in 50 samples and from Table 3, there are 2 falsely accepted incidents in 50 samples in our experimental database results.

	MMU1 Iris Database
FAR (%)	2.0
FRR (%)	0

Output of the Algorithm and analysis are shown in Table 2 for Authorized Persons and Table 3 for Unauthorized Persons with graphical analysis.

In 2007, Ramy Ashraf Botros Youssef, Ahmed Salah EL-Din Mohamed and Mohamed Kamel Ahmed, have developed “Reliable High Speed Iris Detection For Video Based Eye Tracking Systems” [17]. We have compared the output of our work with this latest work available so far our knowledge, the comparison is shown Table 4.

Only one comparison is shown here, Table 4, because the mentioned system claimed the best output compare to other available systems so far. In our work, the False Acceptance Rate (FAR) can be trapped instantly and easily, that we have discussed earlier in detail. Our work is already implemented and responded very accurately in reality.

Table 2. For Authorized Persons.

	Person1	**Person2**	**Person3**	**Person4**	**Person5**
r1	0.92527	0.887013	0.90191	0.817018	0.771615
r2	0.920889	0.894657	0.94282	0.837767	0.9443

r3	0.901001	0.597282	0.950476	0.842439	0.698773
r4	0.866415	0.903323	0.896841	0.861058	0.811424
r5	0.813186	0.892065	0.923513	0.916403	0.884811
r6	0.841426	0.924572	0.773495	0.906519	0.84561
r7	0.944121	0.967363	0.900203	0.908223	0.731279
r8	0.931877	0.964236	0.932124	0.903906	0.85349
r9	0.925426	0.920788	0.932675	0.781454	0.792124
r10	0.946985	0.910433	0.930373	0.861127	0.83753

Following is the Graphical Analysis of Authorized Persons.

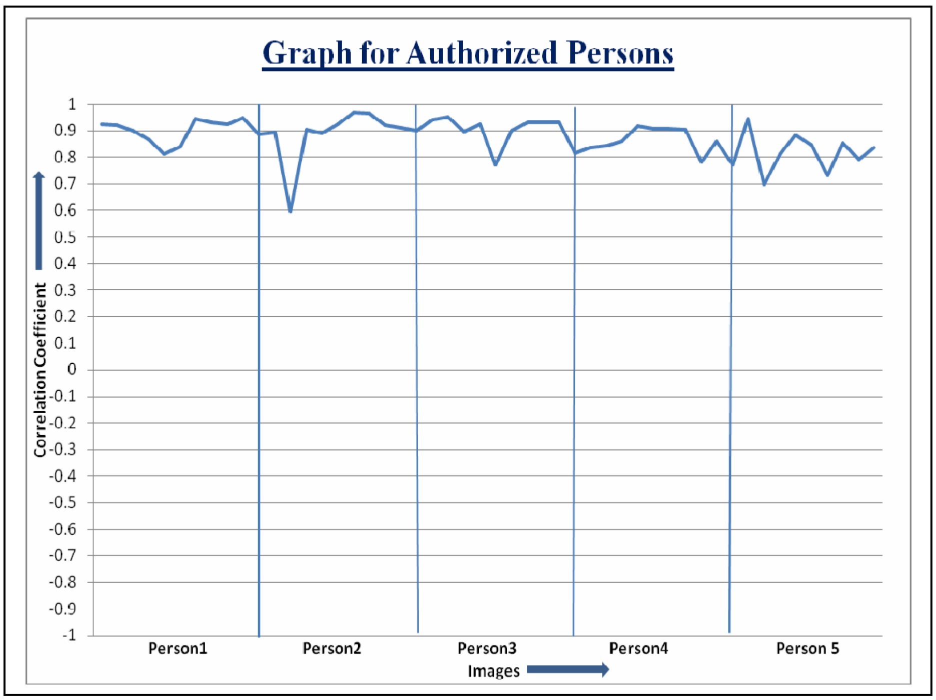

Table 3. For Unauthorized Persons.

	Person1	Person2	Person3	Person4	Person5
r1	-0.00599	-0.04326	-0.43106	0.019021	-0.04106
r2	-0.01092	-0.0285	-0.37071	-0.03883	0.06212

r3	0.023669	0.006919	-0.35172	0.067881	-0.06451
r4	-0.04637	0.064761	-0.39909	-0.08786	-0.0627
r5	-0.02285	0.009741	-0.34608	-0.07962	-0.03233
r6	-0.07197	-0.04319	0.027949	-0.02023	0.095871
r7	-0.01049	-0.06479	-0.44331	-0.01245	0.090123
r8	0.004875	-0.07535	-0.37269	0.005396	0.095601
r9	0.053236	-0.09937	-0.43547	-0.04114	0.106594
r10	-0.01722	-0.09589	-0.41842	-0.00903	0.073078

Following is the Graphical Analysis of Unauthorized Persons.

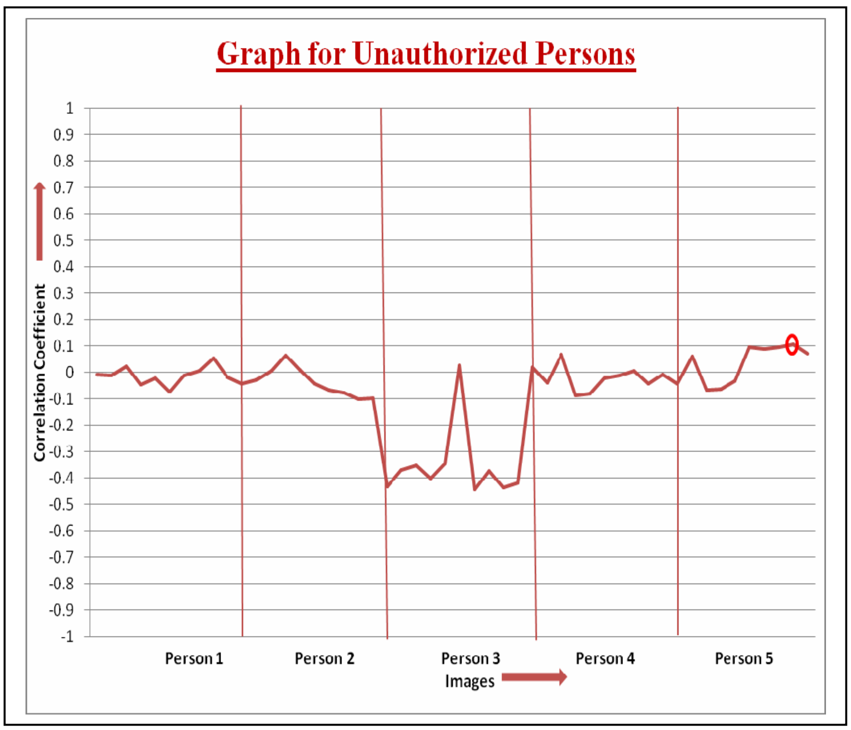

Table 4. Example Comparison.

System	False Acceptance Rate	False Rejection Rate	Accuracy	Avg. Speed
Reliable High Speed Iris Detection For Video Based Eye Tracking Systems	Not calculated	Not calculated	98%	0.01 sec.
Our Work	2%	0%	99%	0.01 sec.

5. Conclusion and future work

In this paper first we convert the color image to grayscale image to decrease huge amount of color handling. But if the images are already in 8-bit gray scale, this color to grayscale conversion algorithm is not required. Based on the structure characteristics of human eyes, then we locate the pupil area and detect the boundary of pupil by edge detection operator. Thirdly using some detector and distribution function we locate the left boundary portion of iris and detect the iris left boundary. The main logic behind that are gray distribution characteristics. Then, we extract the 12×8 rectangular area of iris effective region (IER) and store it into 12×8 matrix. Finally in authentication part, considering Biological characteristics of IRIS Pattern we use Statistical Correlation Coefficient for this 'IRIS Pattern' recognition where Statistical Estimation Theory can play a big role.

We have only checked our experimental results from MMU1 Iris database. However this database is standard database available in the market. We have seen FAR, FRR values for MMU1iris database. But we haven't checked that values for other database. Now we are trying to check the results from those other standard databases. And according to the expected results we are trying to improve our authentication algorithm.

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