IRIS DETECTION BASED ON PRINCIPAL COMPONENT ANALYSIS WITH GSM INTERFACE

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Abstract: This paper describes the technique of personal verification and identification using Iris Patterns. It detects Irisesbased on the principal Component technique analysis. The Principal Component Analysis (PCA) is one of the most successful techniques that have been used in image recognition and compression. There has been a lot of work carried out on face recognition using the PCA. This paper tries to use the same concepts in trying to detect Irises. Identification starts with localizing the portion of the eye that corresponds to the iris. After localization, the iris is center aligned with the image frame and unwanted portions of the iris occluded by the eyelids is removed. In order to minimize the time consuming pattern matching process of the input iris with each sample in the database, the input iris image is compared with database image based on ratio of limbus diameter to pupil diameter. Only if the diameter ratio matches, the input image is cross-correlated with database image to obtain correlation coefficients. Once the comparison is completed then the result is sent to the security administrator with the help of GSM. This message consist of the results of comparison weather the iris samples has been matched or not.

Keywords: PCA, iris, algorithm, frame, Eigenvalues

I. INTRODUCTION

Security and the authentication of individuals is necessary for many different areas of our lives, with most people having to authenticate their identity on a daily basis; examples include ATMs, secure access to buildings, and international travel. Biometric identification provides a valid alternative to traditional authentication mechanisms such as ID cards and passwords, whilst overcoming many of the shortfalls of these methods; it is possible to identify an individual based on \who they are" rather than \what they possess" or\what they remember".

Iris recognition is a particular type of biometric system that can be used to reliably identify a person by analyzingthe patterns found in the iris. The iris is so reliable as a form of identification because of the uniqueness of its pattern. Although there is a genetic intense, particularly on the iris' color, the iris develops through folding of the tissue membrane and then degeneration (to create the pupil opening) which results in a random and unique iris.In comparison to other visual recognition techniques, the iris has a great advantage in that there is huge variability of the pattern between individuals, meaning that large databases can be searched without findingany false matches. This means that iris can be used to identify individuals rather than just confirm their given identity; a property that would be useful in a situation such as border control, where it might be important to not just show that an individual is not who they say they are but also to show exactly who they are. The objective of this paper is to produce a working prototype program that functions as an iris recognition tool using the algorithms and other techniques in order to implement this in an accurate and useful waythat is also user-friendly. Commercial iris recognition systems are available that implement similar algorithms to these;

II. TECHNICAL BACKGROUND

2.1. Iris Recognition Background

Like any other biometric systems, iris recognition uses the same threesteps. The first step is enrollment, wherein an image of a person's specific trait is captured for the first time of use. Next, is the storage, wherein the trait is analyzed and translated into a code or graph. The last step is comparison wherein the trait is matched for the second time of use of the system. It either rejects or accepts that one is he/she claims to be.Iris recognition is a very reliable method for personal identity verification. It was designed to be less intrusive than retina scans, which often require infrared rays or bright light to get an accurate reading. Scientists also say a person's retina can change with age, while an iris remains unchanged. And no two iris blueprints are mathematically alike, even between identical twins and triplets.According to Meng and Xu (2006) comparing with other biometrics, irisrecognition has the following exclusive characteristics:

1. Uniqueness of the iris: The statistical probability that two irises would be exactly the same is estimated at 1 in 2173.

2. Stability over time: Iris is one of the most carefully protected organs in one's body. It is not affected by aging; the feature of the iris remains fixed and stable from one year of age until death.

3. Discriminating the impostor: Changing the size of the pupil can distinguish the iris whether alive or dead. However, as a new technology, iris recognition still has many problemsthat need to be solved. For example, the affection of eyelashes and eyelids, iris' non-elastic deformation as the pupil changes size, head tilt and cyclovergence of the eye.

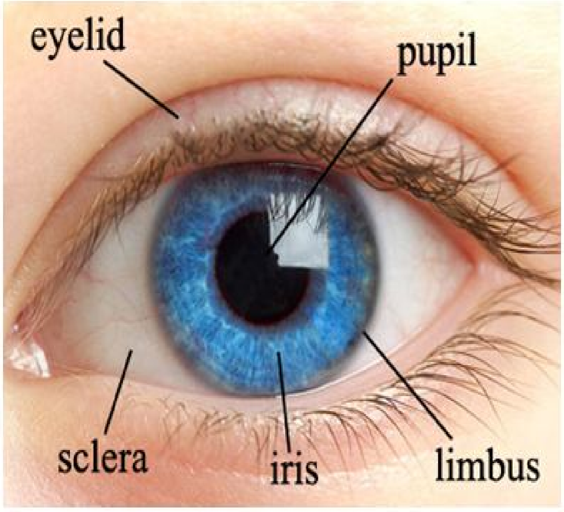

Figure 2.1. A front-on view of the human eye

2.2Iris Image Acquisitions

In iris image acquisition systems, the average iris diameter is averagely 10millimeters, and the required pixel number in iris diameter is normally more than150 pixels. International standard regulates that 200 pixels is "good quality", 150-200 is "acceptable quality" and 100-150 is "marginal quality". So, the iris image with smaller pixel is considered as better quality image and bigger pixel as less quality imageDaugman (2004) has proposed λ value of 1/15 to 1/22 (150~220 pixels in iris diameter) for good performance, that's to say, the biggest λ value may be 1/15. The digital camera parameters wp, hp and σ are vital to the capture volume, but they are restricted by the camera design techniques. In optics, the only method to extend the capture depth is to reduce the aperture size. But when the aperture is too small, little photons can come into the sensor, so there is a need to enhance the outer illumination, or enhance the camera's exposing time. However, too intensive illumination may hurt human eyes. The normal infrared lamp intensity should be less than 2.5mw/cm2. However, if theillumination cannot be increased too much, exposing time must be increased, which means more motion-blurred images. In short, the capture depth extend by reducing aperture is also limited. Careful analysis on the camera design metrics is of utmost importance. These metrics will help in capturing rich iris image texture. Some of the well-known metrics are motion blur, illumination, depth, and contrast. Motion blur gives the feeling of motion. Motion blur is determined by the shutter speed. The slower the shutter speed (sometimes deliberately done), the harder motion is to stop. That is, fast motion (such as a moving car) appears motion blurred at slower shutter speeds. At higher speeds, the moving car is 'stopped' and therefore in focus. Illumination is the use of light resources. Since we are dealing with the human eye, safety must always be a part of the study. The near-infrared illumination is safe to the human eye. Near infraredlight consists of light just beyond visible red light (wavelengths greater than 780nm). Depth of field is the region of sharp focus in a photograph. Depth of field is determined by the camera's aperture setting. At wide aperture settings (forexample, at fStop f/2), the depth of field is shallow, and more of the foreground and background (that brackets the area in sharp focus) is out of focus. At narrow aperture settings (for example, at fStop f/22), the depth of field is large, and more of the foreground and background is in focus. Contrast is the difference in visual properties that makes an object (or itsrepresentation in an image) distinguishable from other objects and the background. It is very significant in image processing.

2.3Algorithms and Principles

The following discussion presents the studies that are useful in choosingthe software to be utilized in testing the captured iris image. The following alsohelps in identifying the requirements and limitations of the camera design.Huang and Hu (2005) stated that at present, the methods proposed by Daugman, Wildes et al., Boles and Boashash are well-known among the existing methods. Daugman (1993) used multiscale Gabor filters to perform a coarse quantization of the local texture signal, and an iris code computed of 2048 bits. Then Hamming distance is adopted to match the iris codes. This method has the highest accuracy and is the basis of present commercial systems. Wildes et al. (1197) applied Laplacian pyramid with four different resolution levels to form feature vectors, and used the goodness-of-match based on normalized correlation and Fisher's discriminant for pattern matching. This method is very computationally demanding. Boles and Boashash (1998) used the wavelet transform zero-crossing representation to represent the features of the iris byfine-coarse approximations at different levels, and then the dissimilarity function between two irises is calculated. This algorithm is sensitive to the gray value of an image. Zhou et al. (2008) developed a new iris recognition method based onGabor Wavelet Neural Network. The extraction algorithm layer of GWNN is used for selecting the feature extraction method and obtaining the optimum wavelet basal function parameter values. In this process, Gabor parameters are adjusted adaptively through Gabor

wavelet atomic transform function, one defined, Gabor filtering and wavelet methods are used to extract the iris texture features. This resulted in a compact and efficient feature vector and better recognitionperformance. For fast iris recognition, it is very important to capture the user's focused eye image at fast speed. Park and Kim (2005) proposed a new iris image acquisition method to capture focused eye images at very fast speed based oncorneal specular reflection. The method of changing the decoder value of frame grabber board and successive ON/OFF schemes for IR-LED illuminators is used. Experimental results show that the focusing time for both users with and withoutglasses averages 480 ms, hence, applicable for real-time iris recognition camera. Nabti and Bouridane (2007) proposed a novel segmentation method based on wavelet maxima and a special Gabon filter bank for feature extraction which obtains an efficient recognition with an accuracy of 99.43%. The steps
are as follows: multi-scale edge detection method for iris image processing, extraction of features from iris-polarized image using the proposed Gabor filter bank, and matching with hamming distance for identification and recognition.Narote et al. (2007) proposed a new algorithm for iris recognition based on dual tree complex wavelet transform. The DTCWT provide three significant advantages: they have reduced shift sensitivity with low redundancy, improveddirectionality and explicit phase information. Experimental results show that the above algorithm based on DTCWT is nearly 25 times faster. Also, the authentication using DTCWT demonstrates that the approach is promising to improve iris based identification. Mask developed an 'open-source' iris recognition system in order to verify both the uniqueness of the human iris and also its performance using MATLAB software. For determining the recognition performance of the system two databases of digitized greyscale eye images were used.

The iris recognition system consists of an automatic segmentation system that is based on the Hough transform, and is able to localize the circular iris and pupil region, occluding eyelids and eyelashes, and reflections. The extracted iris region was then normalized into a rectangular block with constant dimensions to account for imaging inconsistencies. Finally, the phase data from 1D Log-Gabor filters was extracted and quantized to four levels to encode the unique pattern of the iris into a bit-wise biometric template. The Hamming distance was employed for classification of iris templates, and two templates were found to match if a testof statistical independence was failed. The system performed with perfect recognition on a set of 75 eye images; however, tests on another set of 624 images resulted in false accept and false reject rates of 0.005% and 0.238% respectively.

III. PRINCIPAL COMPONENTS ANALYSIS

Principal Components Analysis (PCA). What is it? It is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences. Since patterns in data can be hard to find in data of high dimension, where the luxury of graphical representation is not available, PCA is a powerful tool for analyzing data. The other main advantage of PCA is that once you have found these patterns in the data, and you compress the data, i.e. by reducing the number of dimensions, without much loss of information. This technique used in image compression.

3.1 Method

Step 1: Get some data
Consider a simple example, here simple random data set is taken just to explain how the calculation is carried out using PCA. The data considered is of 2 dimensions.

Step 2: Subtract the mean
For PCA to work properly, we have to subtract the mean from each of the data dimensions. The mean subtracted is the average across each dimension. So, all the <values have <_ (the mean of the <values of all the data points) subtracted, and all the = values have =_ subtracted from them. This produces a data set whose mean is zero.

Table 2.1 Data samples used for calculation

Data =

x	y
2.5	2.4
0.5	0.7
2.2	2.9
1.9	2.2
3.1	3.0
2.3	2.7
2	1.6
1	1.1
1.5	1.6
1.1	0.9

DataAdjust =

x	y
.69	.49
-1.31	-1.21
.39	.99
.09	.29
1.29	1.09
.49	.79
.19	-.31
-.81	-.81
-.31	-.31
-.71	-1.01

Step 3: Calculate the covariance matrix
Covariance is always measured between 2 dimensions, the definition for the covariance matrix for a set of data with 2_ dimensions is:

$$C^{mxn} = (ci,j \, , \, ci,j = \mathrm{cov} \, (\, Dim_i , Dim_j))$$

Considering the above equation the following results are computed for the data considered.

$$\mathrm{Cov} = \begin{pmatrix} .616555556 & .615444444 \\ .615444444 & .716555556 \end{pmatrix}$$

So, since the non-diagonal elements in this covariance matrix are positive, we should expect that both the <and = variable increase together.

Step 4: Calculate the eigenvectors and eigenvalues of the covariance matrix

Since the covariance matrix is square, we can calculate the eigenvectors and eigenvalues for this matrix.Here are the eigenvectors and eigenvalues:

$$\text{Eigenvalues} = \begin{pmatrix} .490833989 \\ 1.28402771 \end{pmatrix}$$

$$\text{Eigenvectors} = \begin{pmatrix} -.735178656 & -.677873399 \\ .677873399 & -.735178686 \end{pmatrix}$$

Step 5: Choosing components and forming a feature vector

Here is where the notion of data compression and reduced dimensionality comes into picture. If we look at the eigenvectors and eigenvalues from the previous section, you will notice that the eigenvalues are quite different values. In fact, it turns out that the eigenvector with the highest eigenvalue is the principle component of the data set.

Given our example set of data, and the fact that we have 2 eigenvectors, we have two choices. We can either form a feature vector with both of the eigenvectors:

$$\begin{pmatrix} -.677873399 & -.735178656 \\ -.735178656 & .677873399 \end{pmatrix}$$

or, we can choose to leave out the smaller, less significant component and only have a single column:

$$\begin{pmatrix} -.677873399 \\ -.735178656 \end{pmatrix}$$

Step 6: Deriving the new data set

This is the final step in PCA. Once we have chosen the components (eigenvectors) that we wish to keep in our data and formed a feature vector, we simply take the transpose of the vector and multiply it on the left of the original data set, transposed.

FinalData=RowFeatureVector x RowDataAdjust

Where Row feature vector is the matrix with the eigenvectors in the columns *transposed* so that the eigenvectors are now in the rows, with the most significant eigenvectorat the top, and Row data adjust is the mean-adjusted data *transposed*, i.e. the dataitems are in each column, with each row holding a separate dimension.

IV. IMPLEMENTATION

The block diagram represents the overall implementation of the project module.

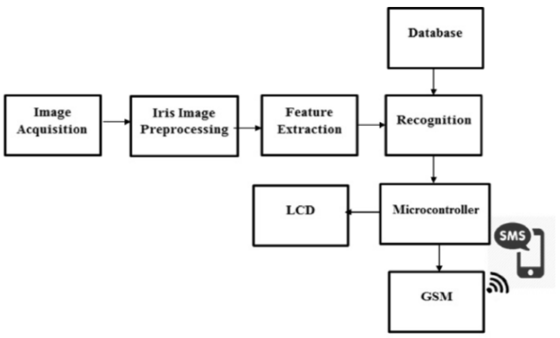

Figure 4.1.Functional Block Diagram

A.IMAGE ACQUISITION:

Acquisition system captures sequenceof images from a specially designed sensor. Since the iris isfairly small (1cm diameter) capturing iris images of high quality is one of the major challenges for practical applications. The following points are of particular concern. Firstly, the image, which is acquired, must have sufficient resolution and sharpness to support recognition. Secondly, it is important to have good contrast without restoring the level of illumination that annoys the subject. Thirdly, these images must be well framed (i.e. centered) without constraining the subject and finally artifacts in the acquired images (e.g. Specular reflections, optical aberrations etc.) should be removed.

B. IRIS DETECTION:

This is the main component of any iris detection system and determines the systems performance. The iris detection method in this paper is divided into three steps viz. iris localization and centering, pattern matching and finally identification. The first stage solves the problem of how to choose a clear and well-focused iris image. Without placing undue constraints on the human operator, image acquisition of the iris cannot be expected to yield an image containing only the iris. The standard image acquisition systems will capture the iris as a part of a larger image that also contains information surrounding the iris which is not of much use in iris detection. Therefore before performing iris matching, it is important to isolate the iris and eliminate the surrounding structures like the pupil, the eyelashes etc. In particular it is necessary to localize that portion of the image derived from inside the limbus (the border between the sclera and the iris) and outside the pupil. The iris localization must be sensitive to a wide range of edge contrasts, robust to irregular borders and capable of dealing with variable occlusion. Having isolated the region that corresponds to the iris, the final task is to decide if this pattern matches a previously stored iris pattern.

C. IRIS LOCALIZATION:

The first objective is to isolate the iris of the subject. A circular contour is formed of the desired diameter around the iris to eliminate the region that surrounds the iris. This circular image formed is binary having the inner area of value 1 and the outer area of value 0. One has to be careful regarding the diameter of the circular image, as it should encircle the entire iris. The diameter chosen should be common to all human iris images. This binary image when multiplied with the iris image leaves us with only the iris and most of the surrounding regions get eliminated.The circular contour image is moved such that it is concentric with the pupil. The limbus as the pupillary boundary of the iris, are concentric about the pupillary center and hence this center needs to be determined.

We use simple point processing techniques viz. thresholding and grey level slicing to eliminate every feature other than the pupil.Once the center is known, we shift the center of the circular contour that we had generated to the center of the pupil. This alignment is required as minor shifts occur due to offsets in the position of the eye along the cameras optical axis. The localized iris is now at the center of the image frame. At this stage we also calculate the limbus and the pupil diameters.

D. EIGEN IRIS VALUES:

Once the iris is isolated and centered, we proceed with the Principal Component Analysis (PCA) of the iris. The

PCA is a statistical method under the broad title of factor analysis. Because PCA is a classical technique which can be applied in the linear domain, they are suitable in applications having linear models such signal processing, image processing, and communications etc. This paper uses 5 different images of a single iris taken at different instances of time. Given below are the steps involved in computing the Eigen irises.

1. We compute the average of all 6 iris images I_1, I2….., I5.

$$I_{avg}(x, y) = 1/5 \overset{6}{\Sigma} I_i (x, y) \text{ ------------ } (1)$$

2. We then compute the Zero mean images

$I_z = I_i - I_{avg}(2)$

This gives us 5-Zero mean images

3. Each of these Zero mean Images are then converted into a One-dimensional column vector by placing each column one below the other. Assuming the original size of the iris image to be N×N, this stacking would give us 5 column vectors each of size N2×1. These are then arranged as a matrix of size N2 ×
5

$$O = \left\| \begin{matrix} - - - - - \\ - - - - - \\ . \\ - - - - - \end{matrix} \right\|_{N^2 x5}$$

4. We now compute the Covariance matrix using the simple formula

$$C = [OT \times O] \text{ ------------ } (3)$$

Since OT is of size 5 × N2 and O is of size N2 × 5, Covariance matrix, C, will be of size 5 × 5.

5. The covariance matrix is symmetrical; hence it is fairly easy to compute its eigenvectors.

Eigenvectors and eigenvalues are computed using the formulae

$$CV = \lambda V \text{ and ------------ } (4)$$

$[C – \lambda I] V = 0$

Where λ's are the eigenvalues and V's are the eigenvectors.

As stated earlier, a set of 5 images of the same iris, captured at different times, were taken. This gives us 5 eigenvectors (V1,
V2,..,V5).

6. We multiply each of the eigenvectors with O.

fi= [O] Vi ------------------------- (5)

Since O is of size N2 × 5 and Vi is of size 5 × 1, fiwould be a one-dimensional column vector of size N2 × 1.

7. We finally compute the *Eigen-irises* by converting fi into a
2-dimensinal image Fi. This can be achieved by reversing the steps given in step 3.

Once the Eigen-irises have been computed, several types of decision can be made depending on the application.

E. RECOGNITION:

Recognition of a person is a process where it must be decided if the individual has already been seen,

A new image Inewis transformed into its Eigen-iris components

(Projected into 'iris-space') by a simple operation,

$$w k = Vk$$
$$T\ (Inew – Iavg) \text{ --------------- } (6)$$

Here k = 1, 2,….5. The weights obtained from the equation are arranged to form a vector

$$\Omega T = [w1, w2, w3, w4, w5] \text{ ------- } (7)$$

This vector describes the contribution of each Eigen-iris in representing the new input iris image [20]. This vector can then be used in a standard pattern recognition algorithm

An iris class can be calculated by averaging the weightvectors for the images of one individual. The Euclidean distance of the weight vector of the new image from the iris class weight vector can be calculated using the Euclidean distance as follows,

$$\varepsilon k = \| \Omega – \Omega k \| \text{ ------------ } (8)$$

Where, Ωkis a vector describing the kthiris class. The iris isclassified as belonging to class k when the distance εkis below some threshold value θε. Otherwise the face is classified as unknown. The concept of Eigen-irises for recognition can be used in conjunction with Multi-resolution analysis involving Laplacian of Gaussian operator to design a robust iris recognition algorithm.

F. GSM AND MICROCONTROLLER:

It is another way to get updated information of the patient's health at some interval of time.

GSM module is used for long distance communication and here it is used to send the SMS which contains details of patient and android application is developed in such a way that it detects the message received and displays the details received in the application.

The project makes use of LPC2148 to establish serial communication it is responsible to collect the result from the execution of program and forwarding it to GSM.

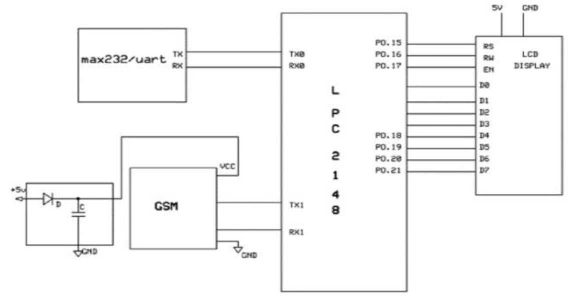

Figure 4.2 Circuit Diagram of Interfacing between LPC2148 with GSM and LCD Display

G.HARDWARE IMPLEMENTATION

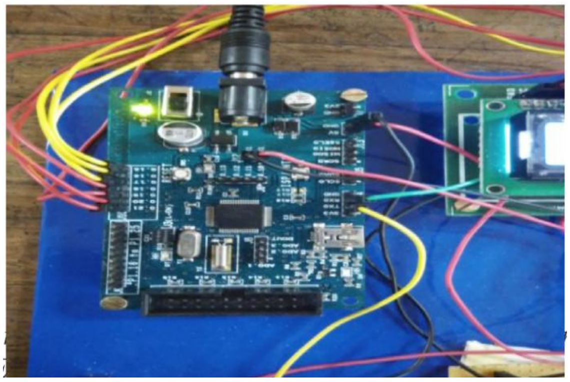

Figure 4.3.ARM board

Figure 4.3 represents ARM boars. Here we connect the two UART, one is used to get information from PC and another is used to give commands to GSM and is also used to display outputs on LCD display.

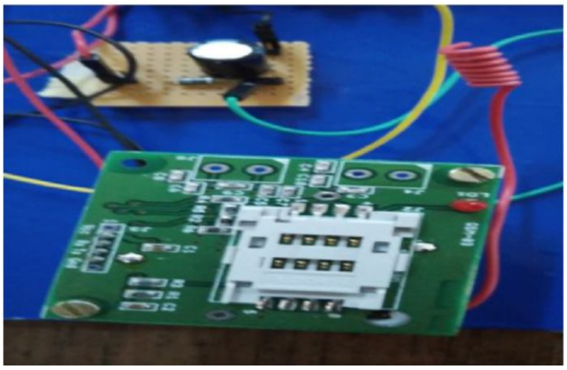

Figure 4.4.GSM module

Figure 4.4 shoes the GSM module which is used send messages to security administrator.

Figure 4.5 LCD Display

Figure 4.5 shows the LCD display which displays the output when ARM sends a message through UART as the iris is matched or not.

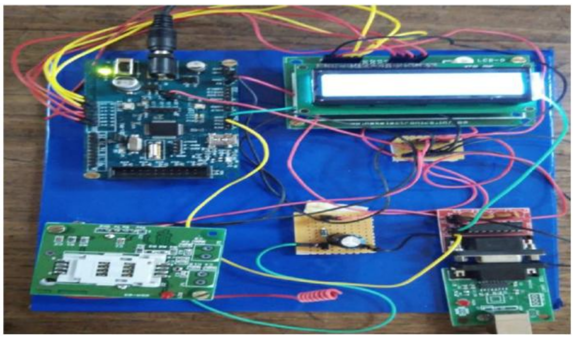

Figure 4.6 Complete hardware module

Figure 4.6 shows the complete hardware prototype of our project, which includes ARM microcontroller, GSM and LCD display.

V. RESULTS

A. CASIA-IrisV4 Database:-

CASIA Iris Image Database (CASIA-Iris) developed by our research group has been released to the international biometrics community and updated from CASIA-IrisV1 to CASIA-IrisV3 since 2002. More than 3,000 users from 70 countries or regions have downloaded CASIA-Iris and much excellent work on iris recognition has been done based on these iris image databases. Although great progress of iris recognition has been achieved since 1990s, the rapid growth of iris recognition applications has clearly highlighted two challenges, i.e. usability and scalability. CASIA-IrisV4 is an extension of CASIA-IrisV3 and contains six subsets. The three subsets from CASIA-IrisV3 are CASIA-Iris-Interval, CASIA-Iris-Lamp, and CASIA-Iris-Twins respectively. The three new subsets are CASIA-Iris-Distance, CASIA-Iris-Thousand, and CASIA-Iris-Syn.

CASIA-IrisV4 contains a total of 54,601 iris images from more than 1,800 genuine subjects and 1,000 virtual subjects. All iris images are 8 bit gray-level JPEG files, collected under near infrared illumination or synthesized. Some statistics and features of each subset are given in Table 1. The six data sets were collected or synthesized at different times and CASIA-Iris-Interval, CASIA-Iris-Lamp, CASIA-Iris-Distance, CASIA-Iris-Thousand may have a small inter-subset overlap in subjects.

B.IIIT-Delhi Multi-spectral Periocular Database:-

The multi-spectral periocular database used in this research comprises images from three spectrum:

1. Visible
2. Night Vision
3. Near Infrared

Here we are using visible spectrum for our project. IIIT-D CLI database comprises of 6570 iris images pertaining to 101 subjects. Both left and right iris images of each subject are captured and therefore, there are 202 iris classes. The lenses used in the database are soft lenses manufactured by either CIBA Vision or Bausch and Lomb. For textured lenses, four colors are used. To study the effect of acquisition device on contact lenses, iris images are captured using two iris sensors: (1) Cogent dual iris sensor (CIS 202) and (2) VistaFA2E single iris sensor. The database contains a minimum of three images for each iris class in each of the above mentioned lens categories for both the iris. To perform the experiments for lens detection, images pertaining to the first 50 subjects are used for training and the remaining 51 subjects are used for testing.

C. Personalized Database:-

Here, we also consider our personal database which includes images of our batch mates. We have considered 6 iris sample images of a single person and is stored in our database for iris matching purpose. All images are stored as gray scale images.

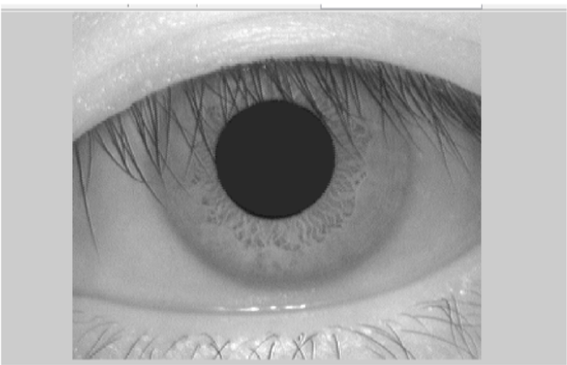

Figure 5.1 Image acquired from acquisition system

This is thegrey image test sample acquired from the camera to match with preloaded image.

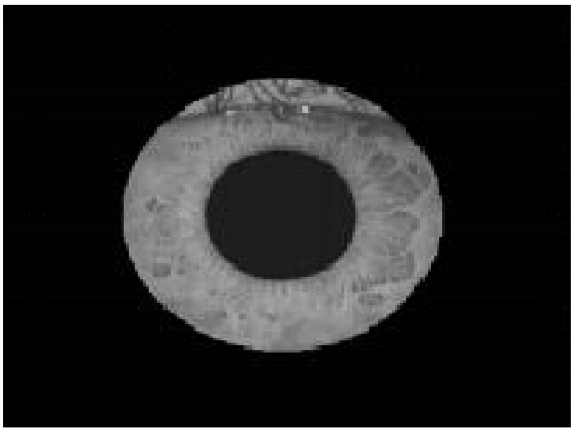

Figure 5.2 Formation of a circular contour around the iris

This is an image obtained by formation of circular contour of the desired diameter around the iris to eliminate the region that surrounds the iris. This circular image formed is binary having the inner area of value 1 and the outer area of value 0.

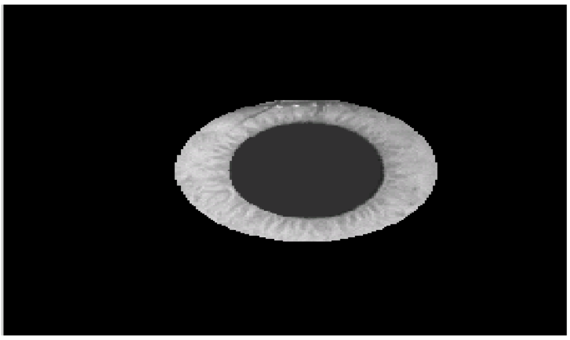

Figure 5.3 Isolated iris at the center of the frame

After we calculate the center, we shift the center of the circular contour that had been generated to the center of the pupil. This alignment is required as minor shifts occur due to offsets in the position of the eye along the cameras optical axis. The localized iris is now at the center of the image frame. Figure 6.3 represents result of this function over test image.

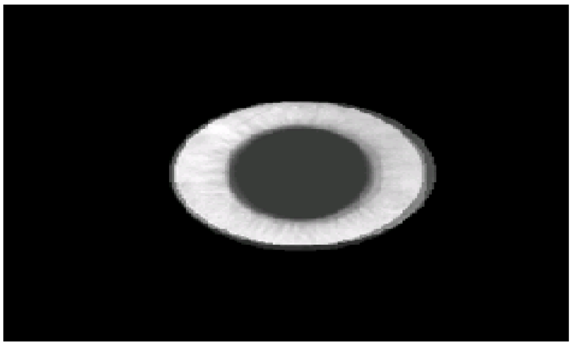

Figure 6.4 Mean Image

Figure 6.4 shows the output image that we obtain after step1.This is mean image we obtain after calculating average of all six iris.

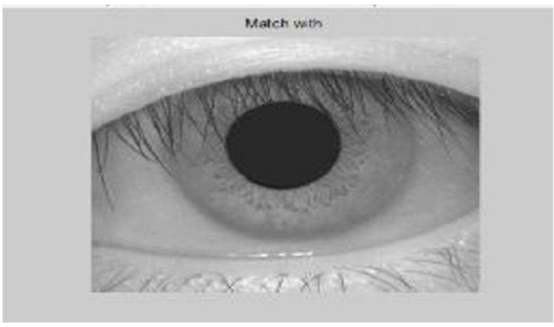

Figure 5.5 Final output image

Figure 6.5 shows the final output image after the matching is done. And if incase the figure does not matches with preloaded image then it gives the message as “Image not Matched”

IRIS IS
MATCHING

Figure 5.6.Output on LCD display

Figure 5.6 shows the output of the LCD display when the iris is matched.

Figure 5.7.Output on LCD display

Figure 5.7 shows the output on LCD display when iris is not matched

CONCLUSION AND FUTURE ENHANCEMENT

The Principal Component Analysis is one of the most successful techniques used in image recognition and face recognition. A great deal of work has been done in face recognition using the PCA. In literature, Eigen faces have been demonstrated to be very useful for face recognition. This is an attempt at using the same technique in identifying irises. The Principal Component Analysis reduces the dimensionality of the training set, leaving only those features that are critical for iris recognition. Iris recognition is a fast developing art. It is a classic biometric application. The work carried out in the paper could also be used in the near future to detect some of the abnormalities in the iris.

The future enhancement or further developments of our project can be making this real-time working project using a specialized Iris capturing cameras which are little costlier. We send a simple message saying whether iris is matched or not this can further developed saying the person’s name in that message. We in our project used LCD display this can further improvised by adding buzzer or other security locks when an unauthorized person tries breaking the security system.

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