CHAPTER 1

INTRODUCTION

The iris is an externally visible, yet protected organ whose unique epigenetic pattern remains stable throughout adult life. These characteristics make it very attractive for use as a biometric for identifying individuals. The purpose of 'Iris Recognition', a biometrical based technology for personal identification and verification, is to recognize a person from his/her iris prints. In fact, iris patterns are characterized by high level of stability and distinctiveness. Each individual has a unique iris. The difference even exists between identical twins and between the left and right eye of the sameperson.

The probability of finding two people with identical iris patterns is considered to be approximately 1 in 10^{52}(population of the earth is of the order 10^{10}). Not even one-egged twins or a future clone of a person will have the same iris patterns. The iris is considered to be an internal organ because it is so well protected by the eyelid and the cornea from environmental damage. Iris recognition is the most precise and fastest of the biometric authentication method.

HUMAN IRIS:

The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. A front-on view of the iris is shown in Figure 1.1. The iris is perforated close to its centre by a circular aperture known as the pupil. The function of theiris is toControl the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the irisdiameter.The iris consists of a number of layers; the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles. The density of stromal pigmentation determines the colour of theiris.The externally visible surface of the multi-layered iris contains two zones, which often differ in colour. An outer ciliary zone and an inner pupillary zone, and these two zones are divided by the collaret – which appears as a zigzagpattern.

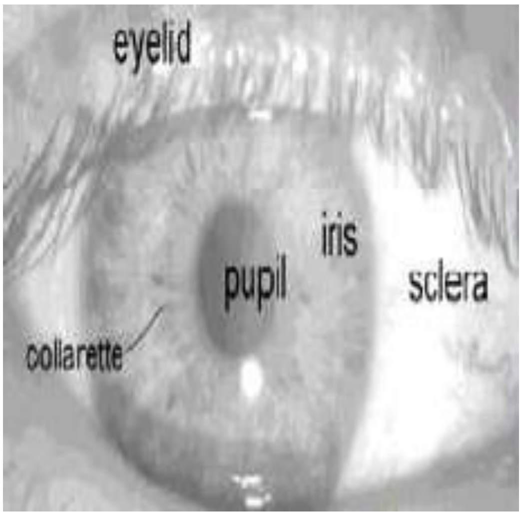

Figure 1.0 Human Eye

1.1 ProblemDefinition:

This project is meant to be the Design of an SDK (software Development Kit) consisting of hardware and Software required to implement Automatic Iris Recognition. The on- board memory storage is to support minimum of 500x2 iris samples.

1.2 ExistingMethodology:

1. ImageAcquisition:

Acquiring high definition iris images either from iris scanner or pre-collected images.

2. Pre-Processing

- HoughTransform
- Daugman'sAlgorithm
- Eyelash and Noise Detection

3. FeatureExtraction

- Log GaborFilters

4. Matching

- HammingDistance

1.3 Motivation:

This project is carried out as a result of the Federal Government of Nigeria's Science and Technology Education at the Post-Basic Level (STEP-B) project initiative to introduce the research and use of biometric systems in undergraduate level. This is to facilitate the teaching and use of biometric signal processing in the technicallaboratory.

1.4 Aim andObjectives:

Aim:

The aim of this project is to Design and Simulate an Experimental Iris Recognition System

Objectives:

1. To study the different aspect of Hardware and Software Requirements for Iris Recognition
2. To facilitate the Teaching of Biometrics signalProcessin.

1.5 ThesisOutline:

The project is organized in the following manner:

Chapter 1 contains the Introduction, problem Definition, existing Methodology and Aim and Objectives.

Chapter 2 deals with the Literature Review of the project describing the various procedures incorporated in the past works on the project.

Chapter 3 entails the Design Calculations and System Design including the explanation of the various units in the hardwaredesign.

Chapter 4 discusses the operation of the system involving the various processes in the Iris Recognition System and the Bill of Engineering Measurement and Evaluation of the hardware design.

Chapter 5 contains the Conclusion and Recommendation.

Technology Education at the Post-Basic Level (STEP-B) project initiative to introduce the research and use of biometric systems in undergraduate level. This is to facilitate the teaching and use of biometric signal processing in the technicallaboratory.

Summary:

This is the introduction to iris recognition system, which entails the biometri technology, a brief description of the optical system Eye in which the Iris is located whose feature is extracted for the image processing. This chapter also contains the problem definition, the existing methodology, the motivation, the aim and objectives and the thesis outline of theproject.

CHAPTER 2

LITERATURE SURVEY

Many algorithms have been developed for various steps in iris recognition. Some of which are brieflydiscussed.

A technique is required to isolate and exclude the artefacts as well as locating the circular iris region. The objective of the segmentation step is to locate the iris region in the image. This consists of finding the inner boundary between the pupil and the iris and the outer boundary between the iris and the sclera. These boundaries, although not always perfectly circular, are modelled in most methods as two non-concentric circles, with the exception of the method purposed in [4] in which the boundaries are approximated as ellipses. A result of boundary fitting with a circular model is illustrated in Figure 2.0. Using these models the problem is then reduced to finding the circles or ellipses best describing the iris boundaries. A variety of methods has been proposed to do this and the most successful ones will be presented in thissection.

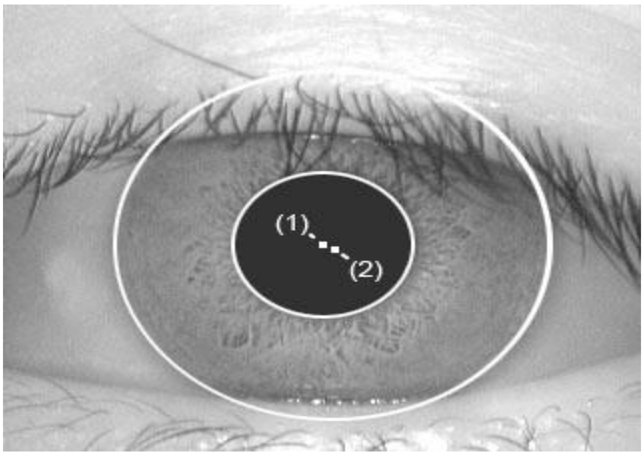

Figure 2.1 Iris Segmentation using non-concentric circles.(1) Centre of inner circle. (2) Centre of outer circle.

2.1 Exixting Preposition:

Hough Transform:

The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions.

There are a number of problems with the Hough transform method. First of all, it requires threshold values to be chosen for edge detection, and this may result in critical edge points being removed, resulting in failure to detect circles/arcs. Secondly, the Hough transform is computationally intensive due to its 'brute-force' approach, and thus may not be suitable for real timeapplications.

Methods based on the Hough transform for circles have been proposed by Tisse et al. [5], Ma et al.[6] and Wildes et al.[7]. The methods all apply an edge detector to the iris image followed by searching for the best inner and outer circular boundaries for the iris using the Hough transform. The edge detectors used vary between the methods, and in the case of the method proposed in [7] also between detection of the outer and inner boundaries of the iris. These methods all rely on good threshold parameters for the edge detection step, making them sensitive to varying imagingconditions.

Daugman'sIntegro-differentialOperator:

Daugman makes use of an integro-differential operator for locating the circular iris and pupil regions, and also the arcs of the upper and lower eyelids. It works with raw derivative information, so it does not suffer from the thresholding 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.

John Daugman presented in 1993 the segmentation method described in [2]. This method is based on his integro-differential operator, defined in equation 2.0 which searches for the best fitting circles for the inner and outer boundaries of the iris. The operator is used twice, once for the inner boundary and once for the outer boundary searching iteratively for the best centre coordinates (x0, y0) in the image.

I. This is done by looking for the max value of the derivative in the radius dimension of the result of a circular contour integration. This search is performed iteratively from a

Coarse scale down to pixel level through convolution with a gaussian kernel function [21], g_(r) with decreasing size.Once for the inner boundary and once for the outer boundary searching iteratively for the best centre coordinates (x0, y0) in the image.

$$max_{(r,x_0,y_0)} \left| G_\sigma(r) * \frac{\partial}{\partial r} \oint_{r,x0,y0} \frac{I(x,y)}{2\pi r} ds \right|$$

This operator is frequently referred to in literature and different versions of this operator have been tested, for example in [4] in which a more general model was applied for the boundaries, modelling the iris as a rotated ellipse rather than a circle.

Normalization:

The normalization process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location.After segmentation has been completed, normalization is performed in all studied iris recognition systems to obtain invariance to iris size, position and different degrees of pupil dilation when matching different iris patterns at a later stage.The problem of that the iris can be rotated in the image is not resolved by this transformation, but is instead taken care of during matching.

The method that is widely accepted for doing this is applying Daugmans rubber sheet model [2] to the iris and transforming it into a rectangular block. This transforms to polar coordinates is defined in equations 2.1, 2.2, 2.3 and is illustrated in figure 2.1.

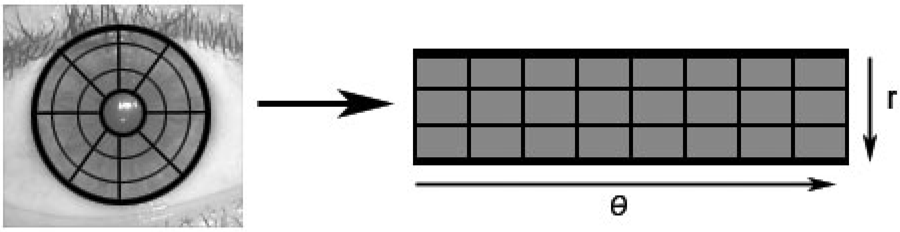

Figure 2.4 Illustration of normalization

$$I\left(x\left(r,\theta\right),y\left(r,\theta\right)\right)\rightarrow I\left(r,\theta\right)$$

$$x\left(r,\theta\right)=\left(1-r\right)x_i\left(\theta\right)+r\cdot x_o+cos(\theta)\cdot\left(r_i+r\cdot\left(r_o-r_i\right)\right)$$

$$y\left(r,\theta\right)=\left(1-r\right)y_i\left(\theta\right)+r\cdot y_o+sin(\theta)\cdot\left(r_i+r\cdot\left(r_o-r_i\right)\right)$$

Daugman's Rubber Sheetoperation:

The homogenous rubber sheet model devised by Daugman [1] remaps each point within the iris region to a pair of polar coordinates (r,θ) where r is on the interval [0,1] and θ is angle [0,2π].Even though the homogenous rubber sheet model accounts for pupil dilation, imaging distance and non-concentric pupil displacement, it does not compensate for rotational inconsistencies. In the Daugman system, rotation is accounted for during matching by shifting the iris templates in the θ direction until two iris templates are aligned.

Featureencoding:

The significant features of the iris must be encoded so that comparisons between templates can be made. Most iris recognition systems make use of a band pass decomposition of the iris image to create a biometric template.The encoding, or feature extraction, aims to extract as many discriminating features as possible from the iris and results in an iris signature, or template, containing these features. The matching process between two templates aims to maximize the probability of a true match for authentic identification tries and minimize false matches for impostors. In other words, images of the same iris taken at different times should be identified as being from the same person and images from different irises should be marked as coming from different persons.

In this section Daugmans methods for encoding and matching [2] will be presented in detail as this method was used in the testing along with an overview of other methods found in literature.

Gaborfilters:

Gabor filters are able to provide optimum conjoint representation of a signal in space and spatial frequency. A Gabor filter is constructed by modulating a sine/cosine wave with am Gaussian. This is able to provide the optimum conjoint localisation in both space and frequency,sinceasinewaveisperfectlylocalisedinfrequency,butnotlocalisedin space. Daugman makes uses of a 2D version of Gabor filters in order to encode iris pattern data.

Log-Gaborfilters:

A disadvantage of the Gabor filter is that the even symmetric filter will have a DC component whenever the bandwidth is larger than one octave. However, zero DC components can be obtained for any bandwidth by using a Gabor filter which is Gaussian on a logarithmic scale; this is known as the Log-Gabor filter.

Hammingdistance:

The Hamming distance gives a measure of how many bits are the same between two bit patterns. Using the Hamming distance of two bit patterns, a decision can be made as to whether the two patterns were generated from different irises or from the same one.

Matching is performed, using the normalized Hamming distance measure defined in equation 2.4, taking into account the occluded regions defined as masks by not comparing the feature points extracted from these regions. The result is the number of bits that are different between the binary codes in the non-occluded regions, divided by the number of bitscompared.

$$HD = \frac{\|codeA \otimes codeB \cap maskA \cap maskB\|}{\|maskA \cap maskB\|}$$

If the iris images would not be subject to noise and segmentation errors would not occur, the Hamming distance between two pictures taken of the same iris would be 0, however even at the most perfect conditions for imaging this is not the case. Daugman reports that the mean Hamming distance between two iris templates of the same iris, imagined at different occasions and under near perfect conditions, is 0.11 [2.].The theoretical Hamming distance between two different irises results in a Bernoulli trial, or coin toss test, Pp(m|N), where p is the probability that two bits are equal, m is the number of equal bits and N is the total number of bits compared. For uncorrelated iris codes p = 0.5. The fractional function associated with the binomial distribution is defined in equation 4.8 where x = N/m is the normalized hamming distance spanning from 0 to 1.

$$f(x) = \frac{N!}{m!(N-m)!} p^{m} (1-p)^{(N-m)}$$

Invariance of rotation of irises is resolved during matching by performing a series of matching between rotated versions of the encoded irises and using the best match as the final result.

Other methods:

A variety of methods has been purposed in literature and can be roughly categorized into correlation based methods and filter based methods. Correlation based methods utilizes a more direct texture matching approach in comparison to the filter based methods. This section will list a number of successful methods as a pointer to further reading on the subject.Correlation based methodsWildes et al. proposed in [7] a method based of normalized correlation of iris patterns, in which the iris images is divided up in Laplacian pyramids which are then correlated separately for each individual level, resulting in a matching vector. Fishers linear discriminant [8] is then applied on this vector, resulting in a scalar equality score.Another method based on correlation, is the one proposed by Miyazawa et al. in [4]. This method applies band-phase correlation to discriminate between authentic and impostor matches.

Wavelet and filter based methods:

To perform a wavelet transform or apply some sort of filter are the most common solutions for featuretraction. A variety of methods and filters have been proposed. Ma et al [6] purposed use of filters similar to [2] together with an enhanced matching method based on an extended version of Fishers linear discriminant. Lim et. al. purposed in [9] a method based on the Haar wavelet transform and a matching algorithm based on a neural network.

Summary:

This Chapter is of utmost important to the accomplishment of this project as it entails the whole work been carried out and the technology involved in the implementation of the various past projects. This review makes the basic references required in the technology of Iris Recognition Systems in order to understand the trend in the existing methodology from differentsources.

CHAPTER 3

IRIS DETECTION

3.1 Working principle:

In this project, there are some peripheral devices for the design which are DSPIC, LCD, keypad, flash memory and camera which are categorised into the following units. Figure
3.0 is the block diagram showing the interconnection of the various units.

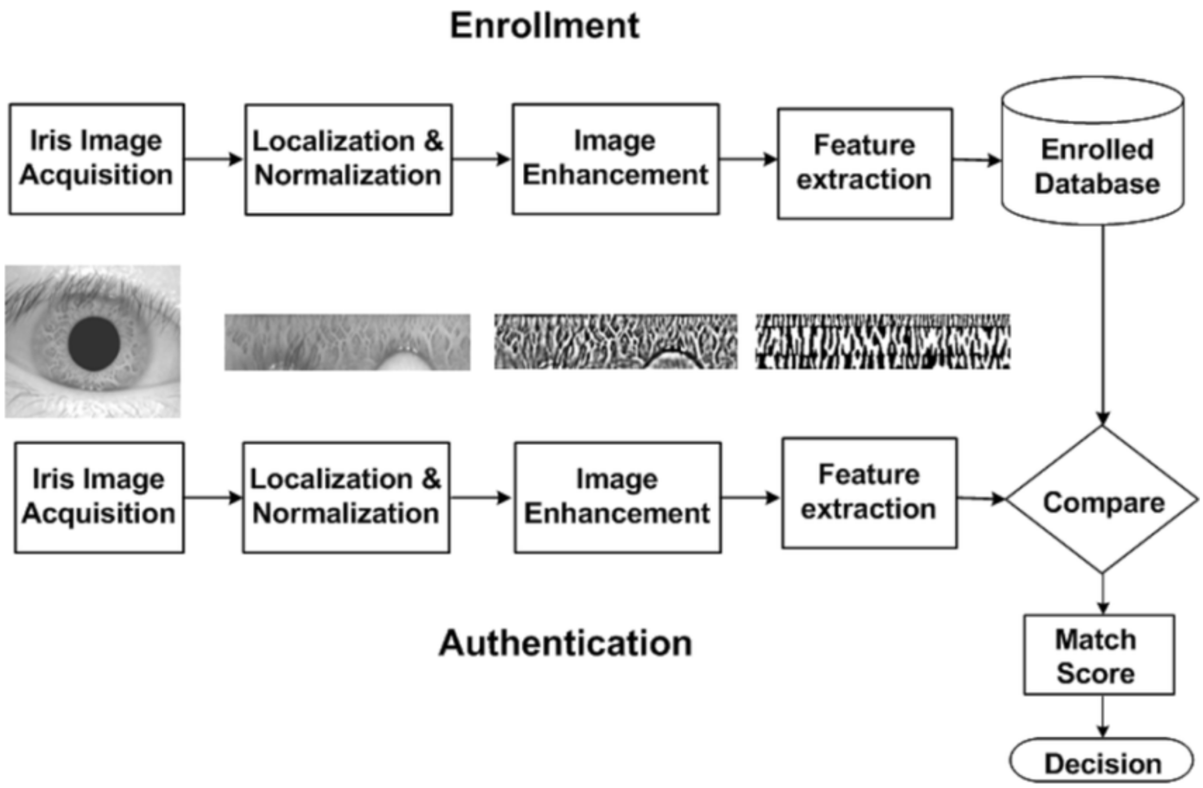

Figure 3.1 Block Diagram of Hardware

The Power SupplyUnit:

This unit comprises of a voltage source which supplies the system power, a step down transformer two capacitors and a bridge rectifier.

1. The voltage source: This supplies the 230V from mains to thesyste
2. The transformer: This is a 230V/12V step down transformer which steps down the input voltage to the requiredvoltage.
3. The bridge rectifier: This is the component that converts alternating current

from the source to directcurrent.

4. The capacitor: This is a passive component that filters out the ripples from the rectified voltage.

5. The voltage regulator: This is the component which also makes the internal voltages independent of fluctuations that may be produced in the rectifiedvoltage.

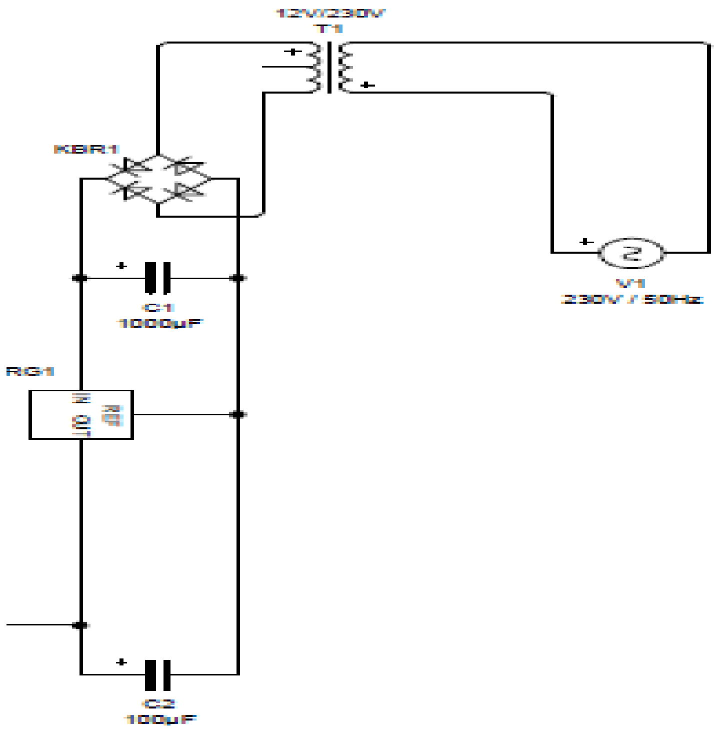

Figure3.2 Power Supply Unit.

The power supply unit is connected to pin 13, 20 and 28 of the microcontroller (DSPIC30F3013), pin 16 of the BCD to seven segment decoder (CD4511 IC), pin 2 of the flash memory (M25P80) and the webcamera.

From figure 3.1;

AC inputs supply: 230v, 50Hz

Ac supply from source is step down by Transformer to 12v, the 12v is then rectified by a Rectifier (full wave bridge rectifier) to remove any unwanted pulses. The full wave bridge rectifier consist of four diodes .Each diodes has a drop of 0.7v since rectifier consist of four diode, the diodes has a drop of 0.7, hence the wave full wave bridge rectifier has a total drop of 4 ×0.7 =2.8VMaximum voltage $V_{max} = \sqrt{2} \times 12 = 16.97$v.

The maximum voltage in the circuit = (16.97- 2.8) =14.17v

The 14.17v supply is then fed as an input in to the 7805 Regulator which regulates the supply to 5v that is needed to power the circuit .Both pre – filtration and post filtration filter (Capacitor) is then label as $C_1$and C_2 respectively.

It should be noted that AN7805 Regulator gives an output current of 500mA

I.e.I_{RMS} =

500m

A $I_{max}=\sqrt{2}$

×500mA

Maximum output current = 707Ma

The MicrocontrollerUnit:

The microcontroller unit is responsible for software organisation and control of the system. The microcontroller used for this system is a programmable integrated circuit (IC) which is theDSPIC30F3013.The DSPIC30F3013 is a programmable IC that aids digital signal processing. It is a 28 pin, 16 bit high performance modified RISC central processing unit. It has a CPU speed of 30 MIPS and a program memory of 24KB, Low power, high speed Flash program memory which has 10,000 erase/write cycles (min.) with a RAM byte of 2,048. Has low power consumption with operating voltage range between 2.5-5.5V, 20 High current sink/source I/O pins: 25 ma/25ma.It has C compiler optimized instruction set architecture with In circuit serial programming which is compatible with our choice of programming software.The choice of the DSPIC30F3013 is due its DSP features which include dual data fetch and all single cycle instructions.The microcontroller unit is responsible for software organisation and control of the system. The microcontroller used for this system is a programmable integrated circuit (IC) which is theDSPIC30F3013.The DSPIC30F3013 is a programmable IC that aids digital signal processing. It is a 28 pin, 16 bit high performance modified RISC central processing unit. It has a CPU speed of 30 MIPS and a program memory of 24KB, Low power, high speed Flash program memory which has 10,000 erase/write cycles (min.) With a RAM byte of 2,048. Has low power consumption with operating voltage

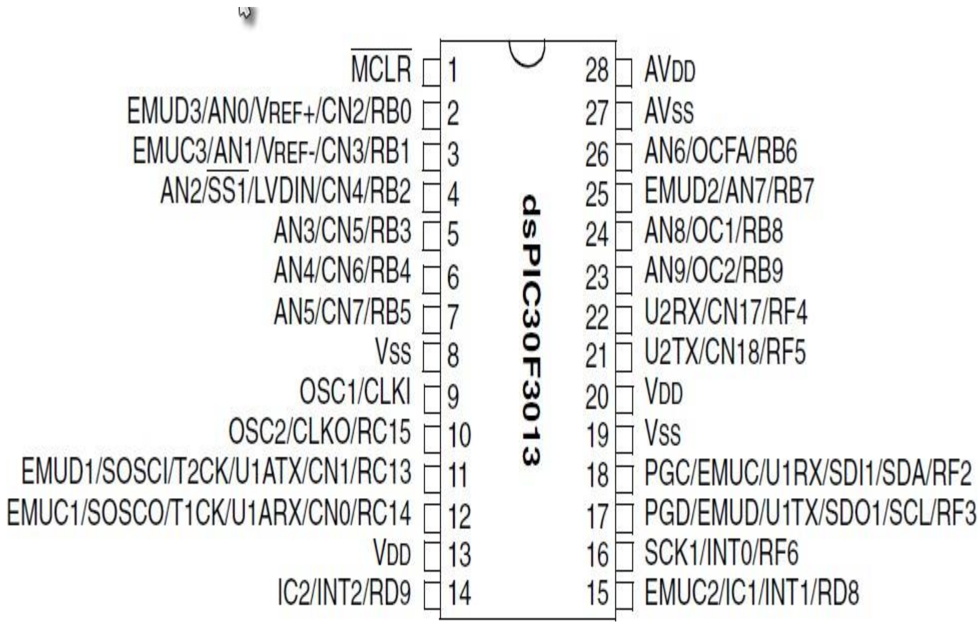

Figure 3.3 DSPIC30F3013 pin configuration

Image AcquisitionUnit:

Image acquisition unit consists of two web cameras and 2 USB to serial converters.

The web camera is a high resolution camera of 3MP which captures high quality image of the eyes. Two web cameras are used to capture the two eyes separately. The two cameras have USB terminals through which they are connected to the microcontroller via the USB to serialconverter.

Figure 3.4 web camera

The USB to serial converter is a component that enables the conversion from USB communication to serial communication readable with the microcontroller.

The KeypadUnit:

The keypad unit consists of four buttons which are power button which is used to power on/off the system, the mode button which is used to select between enrolment and authentication operation, the capture button which is used to capture the image during authentication and the store button which is used store the captured image during enrolment. These are shown as interfaced to the microcontroller in the circuit diagram.

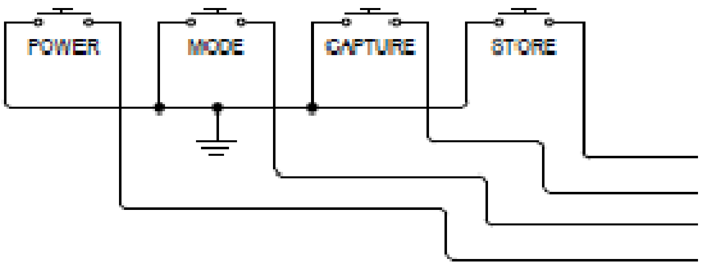

Figure 3.5 keypad configuration

One terminal of each of the four buttons is connected to the ground while the other terminals of the power, mode, capture and store button are connected to pins 16, 23, 24 and 25.

The MemoryUnit:

This is a 1MB flash memory M25P80 IC, which executes a page program up to 256 Bytes in 1.4ms, has a maximum clock rate of 40MHz, SPI bus compatible serial interface. It also has 2.7 to 3.6V Single Supply Voltage. The choice of the flash memory for the memory unit is due to its relatively high write speed and data can be selectively rewritten. The M25P80 IC is connected in parallel to 3V Zener diode due to it input voltage requirements as shown in figure3.

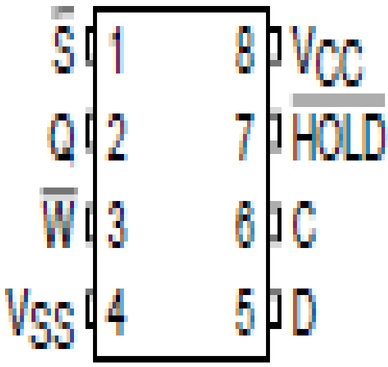

Figure 3.6 M25P80 pin configuration

The pin 8 of the M25P80 IC is connected to the PSU, pin 1 to 14 of the MCU, pin 2 to pin 12 of the MCU, pin 5 to pin 11 of the MCU, pin 6 to pin 15 of the MCU and pin 4 to theground.

The DisplayUnit:

The Display Unit displays the number of images captured by the two web cameras during the enrolment phase and displays 111 or 000 during recognition phase. It consists of Seven Segment Display, BCD to Seven Segment Decoder (CD4511 IC), switching transistors and limiting current resistors as shown in figure 3.8.

1. Seven SegmentDisplay:

This incorporates two MAN6410 IC so as to achieve a three digit display. The seven- segment display has 7, 8, or 9 leads on the chip. Usually leads 8 and 9 are decimal points. The figure below is a typical component and pin layout for a seven segment display.

A seven-segment display is a form of electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays. Seven-segment displays are widely used in digital clocks, electronic meters, basic calculators, and other electronic devices that display numerical information.

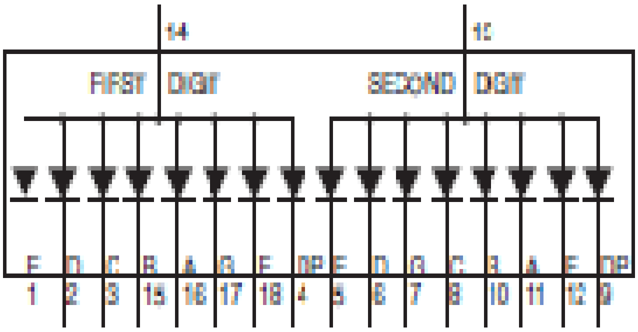

Figure 3.7 Display digit and MAN6410 pin configuration

The common anodes of the MAN6410 IC are connected to the collector of the switching transistor C9014 as shown in figure 3.7 the switching transistors are multiplexed internally in the microcontroller. The respective pins from each MAN6410 IC are connected so as to have a three digit display. These pins are then connected through the limiting resistors to the Display Driver CD4511 IC.

2. BCD to Seven SegmentDecoder:

This is a display driver that converts the binary input from the MCU to signals ready for display. The pins 6, 7, 2 and 1 of the CD4511 are connected to pins 2, 3, 4 and 5 of the microcontroller respectively.

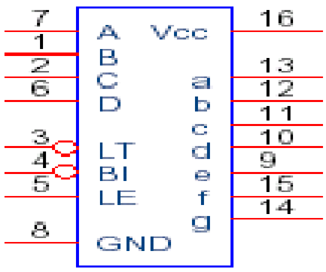

Figure 3.8 CD4511 pin configuration

Summary:

This Chapter deal with the Hardware Design of the Iris Recognition System including the circuit analysis and components details of the Design. It also describe in details how each of the components are connected to one another

Operation of the system in software:

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. This biometric template contains an objective mathematical representation of the unique information stored in the iris, and allows comparisons to be made between templates. When a subject wishes to be identified by iris recognition system, their eyes is first photographed, and then a template created for their iris region.This template is then compared with the other templates stored in a database until either a matching template is found and the subject is identified, or no match is found and the subject remains unidentified.

WorkingProcedure:

The basic procedure for iris recognition is the same for most products. The first phase is enrolment. A person is taken to a controlled and monitored environment in which their identity is manually confirmed. Once their identity is confirmed both of their irises are recorded by the web cameras (they are not “scanned” as the common term “iris scan” suggests).The recorded image then goes through iris localization. In this stage a computer takes the recorded image and filters out everything but the iris. The localization process is done through complex algorithms which eliminate eyebrows, eyelashes, and the sclera (the white part of the eyes). Once the pictures are localized they are stored in a binaryformat.

The last stage of iris recognition occurs after the enrolment process. Once a person has been enrolled they can proceed to the recognition phase. At the recognition phase, the iris is recorded and the two steps from enrolment are processed. An additional pattern matching step is required in the recognition phase. In the pattern matching stage the localized iris picture is compared with other irises in the database. If a match is found, the subject is identified and if no match is found, the subject remainsunidentified.

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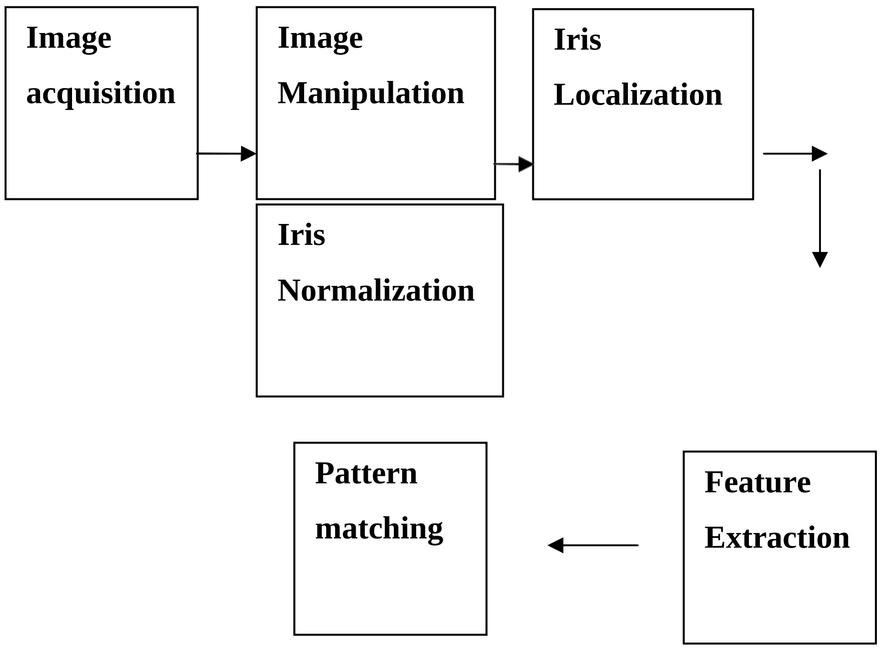

Figure 3.9 Block Diagram of Iris Recognition

ImageAcquisition:

Image acquisition is considered the most critical step in the project since all subsequent stages depend highly on the image quality. In order to accomplish this, the web cameras are used which are of high resolution of 3Mpixel. Setting the type of the image to bitmap, and the mode to white and black for greater details. The camera is situated normally between half a meter to one meter from the subject (3 to 10 inches).

ImageManipulation:

In the pre-processing stage, we transformed the images from RGB to gray level and from eight-bit to double precision thus facilitating the manipulation of the images in subsequentsteps.

IrisLocalization:

Before performing iris pattern matching, the boundaries of the iris should be located. In other words, the part of the image that extends from inside the limbus (the border between the sclera and the iris) to the outside of the pupil are to be detected. It is done by determining the outer edge by first down sampling the images by a factor of 4 then use the canny operator with the default threshold value given, to obtain the gradientimage.

Furthermore, the thresholding on the edge detection can be set very high as to ignore smaller less contrasting edges while still being able to retrieve the entire perimeter of the pupil. The edge detection algorithm to be used for outlining the pupil is canny edge detection.This algorithm uses horizontal and vertical gradients in order to deduce edges in the image. After running the canny edge detection on the image a circle is clearly present along the pupil boundary.Canny Edge Detector finds edges by looking for the local maxima of the gradient of the input image. It calculates the gradient using the derivative of the Gaussian filter. The Canny method uses two thresholds to detect strong and weak edges. It includes the weakedges in the output only if they are connected to strong edges. As a result, the method is more robust to noise, and more likely to detect true weak edges.

Iris Normalisation:

Once the iris region is successfully segmented from an eye image, the next stage is to transform the iris region so that it has fixed dimensions in order to allow comparisons. The dimensional inconsistencies between eye images are mainly due to the stretching of the iris caused by pupil dilation from varying levels of illumination. Other sources of inconsistency include, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye socket. The normalisation process will produce iris regions, which have the same constant dimensions, so that two photographs of the same iris under different conditions will have characteristic features at the same spatial location. Another point of note is that the pupil region is not always concentric within the iris region, and is usually slightly nasal. This must be taken into account if trying to normalize the 'doughnut' shaped iris region to have constantradius.

Feature Extraction:

This step is responsible of extracting the patterns of the iris taking into account the correlation between adjacent pixels. For this wavelets transform is used, and more specifically the "Gabor Filtering"

Pattern Matching:

This test enables the comparison of two iris patterns. This test is based on the idea that the greater the Hamming distance between two feature vectors, the greater the difference between them. Two similar irises will fail this test since the distance between them will be small. In fact, any two different irises are statistically "guaranteed" to pass this test as already proven. The Hamming distance (HD) between two Boolean vectors is defined as follows:

$$HD = \frac{1}{N}\sum_{j=1}^{N} C_A(j) \oplus C_B(j)$$

Where, CA and CB are the coefficients of two iris images and N are the size of the feature vector. This is the known Boolean operator that gives a binary 1 if the bits at position j inCAand CB are different and 0 if they are similar.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. This biometric template contains an objective mathematical representation of the unique information stored in the iris, and allows comparisons to be made between templates. When a subject wishes to be identified by iris recognition system, their eyes is first photographed, and then a template created for their iris region.This template is then compared with the other templates stored in a database until either a matching template is found and the subject is identified, or no match is found and the subject remains unidentified.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. This biometric template contains an objective mathematical representation of the unique information stored in the iris, and allows comparisons to be made between templates. When a subject wishes to be identified by iris recognition system, their eyes is first photographed, and then a template created for their iris region.This template is then compared with the other templates stored in a database until either a matching template is found and the subject is identified, or no match is found and the subject remains unidentified.

Pattern matching in computer science is the checking and locating of specific sequences of data of some pattern among raw data or a sequence of tokens. Unlike pattern recognition, the match has to be exact in the case of pattern matching. Pattern matching is one of the most fundamental and important paradigms in several programming languages. Many applications make use of pattern matching as a major part of their tasks.

Pattern matching, in its classical form, involves the use of one-dimensional string matching. Patterns are either tree structures or sequences. There are different classes of programming languages and machines which make use of pattern matching. In the case of machines, the major classifications include deterministic finite state automata, deterministic pushdown automata, nondeterministic pushdown automata and Turing machines. Regular programming languages make use of regular expressions for pattern matching. Tree patterns are also used in certain programming languages like Haskell as a tool to process data based on the structure. Compared to regular expressions, tree patterns lack simplicity and efficiency.

. Many systems have been implemented and their performances have been tested; each of them has its own advantages and disadvantages. In order to get over the drawbacks of these systems mixed techniques were described to implement an iris recognition system.

Flowchart of ControllingSoftware:

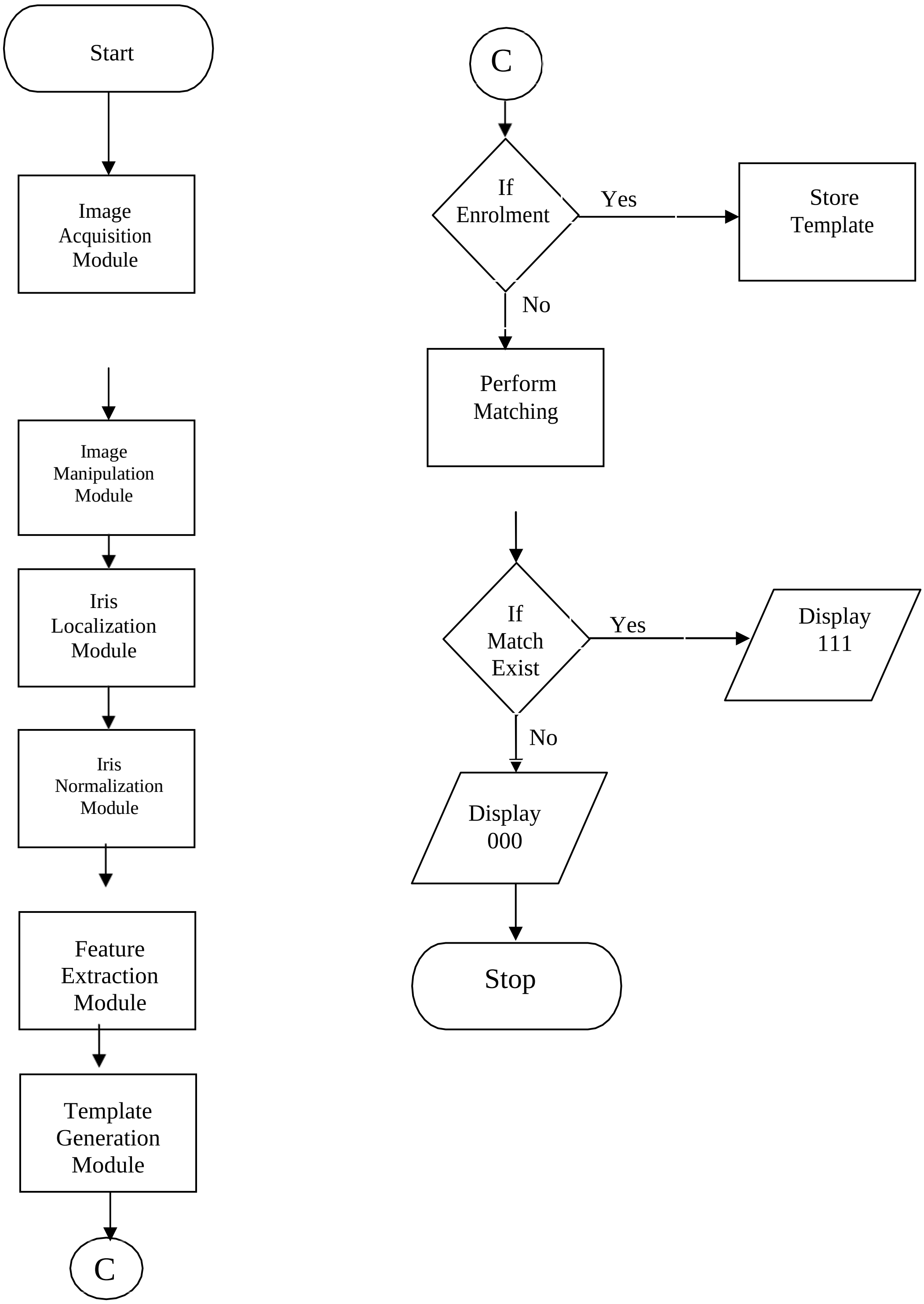

Figure 3.10 Flowchart

The Image Acquisition Module: This is where the high resolution Image of the Eye is captured by the web camera. The Image Manipulation Module: This is where the image is converted to 8 bit and further converted to gray scale.Iris localization Module: This is where the Iris region is isolated from the other part of the image.Irisnormalisation module: This module transforms the iris region so that it has fixed dimensions in order to allow comparisons.Feature Extraction Module: This module provides the digital representation of the image. Template Generation module: this is the binary representation of the image.Pattern Matching: Evaluates the goodness of match between the newly acquired iris pattern and the stored pattern. Hamming Distance is used to determine if the patterns match.

Bill of Engineering Measurement andEvaluation:

S/N	Item	Description	Quantity	Price (#)
1	Transformer	230V/12V	1	500
2	Bridge Rectifier		1	100
3	Capacitor		4	200
4	Voltage Regulator	AN7805	1	50
5	Zener Diode	3V	1	10
6	Display Driver	CD4511	1	200
7	Resistor		10	50
8	Switching Transistor	C9014	3	30
9	USB to Serial converter		2	14000
10	Web Camera	3MPixel	2	5000
12	Memory	M25P80	1	1000
13	Keypad Button		4	120
14	7 Segment Display	MAN6410	2	400

Table 3.11BEME

3.2Applications

- Computer login.
- National border controls.
- Premises access control (Home, Office, Laboratory).
- Anti-terrorism(Security screening at airports).
- Financial Transactions (Electronic commerce and banking).
- Secure accesses to bank cash machine accounts.
- Credit-card authentication
- Automobile ignition and unlocking; anti-theft devices.

3.3 Advantages

1. **Accuracy**: Iris recognition is one of the best biometric modalities in terms of accuracy. The false acceptance rate and false rejection rate is very low in this modality, thus ensuring a higher rate of accuracy in its results.
2. **Scalability**: This technology is highly scalable and can be used in both large and small scale programs. It has been deployed in many large scale programs including the respective government’s biometric authentication programs in several countries across the world.
3. **Distance:** Unlike retina scanning, iris scanning can be done from a normal distance. It is like taking a normal photo, which can be taken from the regular distance of taking pictures.
4. **Stable**: Iris patterns remains stable throughout an individual’s life. It is protected by the body’s own mechanism.
5. **Easy to use**: Iris recognition system is plug & play compared to other modalities of biometric recognition. A person needs to stand still in front of the camera and the job is done instantly. It is a comfortable process for everyone.

Summary:

This Chapter deal with the Software Design of the Iris Recognition System including the circuit analysis and components details of the Design. It also describe in details how each of the components are connected to one another

CHAPTER-4
MATLAB SOFTWARE

4.1 Version:

MATLAB (an abbreviation of "MATrixLABoratory") is a proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

Although MATLAB is intended primarily for numeric computing, an optional toolbox uses the MuPAD symbolic engine allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

Figure 4.1 Matlab logo

In the beginning (before version 1.0) MATLAB "was not a programming language; it was a simple interactive matrix calculator. There were no programs, no toolboxes, no graphics. And no ODEs or FFTs. The MATLAB application is built around the MATLAB programming language. Common usage of the MATLAB application involves using the "Command Window" as an interactive mathematical or executing text files containing MATLAB code.

Our techies have known the above topics and reveal the noble result to the client's need. Clearly, our experts make known to new paths in iris recognition projects such as quality assessment, grouping, and more. Also, we worked with hybrid methods via merging feature descriptors with deep learning methods. Nowadays, these methods play a crucial role in iris-based projects.

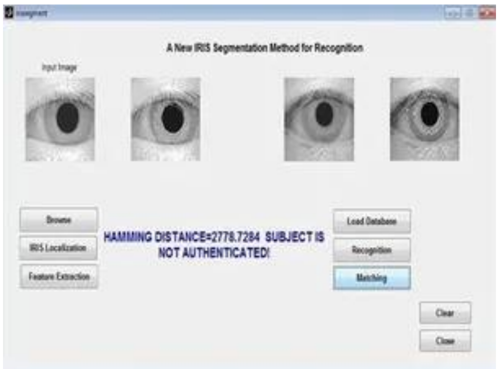

Figure 4.2 IRIS segmentation method for recognisation

In fact, our techies brush up their intellect in new methods. All in all, our outcome always hit your doorstep on time. Besides, our official crew all the time fend for you an in-depth study iris recognition using matlab. If you get in touch with us, then you need not wait for your vision end since our aid goes sooner than you think. Still, are you strain to continue your research? Then it is apt to get in touch with us.

Iris recognition has been paid more attentions due to its high reliability in personal identification recently. In this paper, an iris recognition system has been proposed. The steps of the proposed method include iris recognition, feature extraction and matching of the iris pattern. To describe the iris data DWT based features are used and for analyze purpose feature matching is employed. Experiments are performed using iris images obtained from database. The method gives correct classification rate.

CHAPTER - 5
SOURCE CODE

```
%%%Image AquisitionProcess:-
clc; clear all; close all;
%warning off;


[FileName1,FilePath1] = uigetfile('*.jpg','Select 1st Iris Image');
file1= fullfile(FilePath1, FileName1);

[FileName2,FilePath2] = uigetfile('*.jpg','Select the Iris Image for
comparison');
file2= fullfile(FilePath2, FileName2);


% STEP:1 IMAGE
AQUISITION**************************************************

i=imread('C:\Users\reddy\Desktop\iris\Eye Database\Eye
Database\1.jpg');
subplot(1,2,1);
imshow(i);
title('STEP:1 Image Aquisition(Original Image:1)');

ii=imread('C:\Users\reddy\Desktop\iris\Eye Database\Eye
Database\1.jpg');
subplot(1,2,2);
imshow(ii);
title('STEP:1 Image Aquisition(Original Image:2)');

figure();


% STEP:2 GRAY SCALE
CONVERTION*********************************************

g =rgb2gray(i);
subplot(1,2,1);
imshow(g);
title('STEP:2 Converting into Gray Image:1');

gg=rgb2gray(ii);
subplot(1,2,2);
imshow(gg);
title('STEP:2 Converting into Gray Image:2');

figure();

% STEP:3 Subtraction of original
image***********************************
```

```
k = imread('C:\Users\reddy\Desktop\iris\Eye Database\Eye
Database\1.jpg');
v= rgb2gray(k);
v = imsubtract(v,60);
subplot(1,2,1);
imshow(v);
title('STEP:3 Subtracted Gray Image:1');

kk = imread('C:\Users\reddy\Desktop\iris\Eye Database\Eye
Database\1.jpg');
vv =rgb2gray(kk);
vv = imsubtract(vv,60);
subplot(1,2,2);
imshow(vv);
title('STEP:3 Subtracted Gray Image:2');

figure();

% Find HISTOGRAM of the
Image*********************************************
%imhist works with only 8 bit images
% Hence convert the image to unsigned 8 bit image and plot the
histogram

z=double(v);
subplot(1,2,1);
imhist(v);
axis off, axis tight;
title('STEP:4 Histogram of the Image:1');

zz=double(vv);
subplot(1,2,2);
imhist(vv);
axis off, axis tight;
title('STEP:4 Histogram of the Image:1');

figure();


% STEP:5 CROPED
IMAGE*****************************************************

c=imcrop(g,[210 86 627-210 402-86]);
subplot(1,2,1);
imshow(c);
title('STEP:5 Croped Image:1');

cc=imcrop(gg,[255 163 744-255 504-163]);
subplot(1,2,2);
imshow(cc);
title('STEP:5 Croped Image:2');

figure();


% STEP:6 RESIZED
IMAGE****************************************************
```

```
r=imresize(c,[256,256],'nearest');
subplot(1,2,1);
imshow(r);
title('STEP:6 Resized Image:1');

rr=imresize(cc,[256,256],'nearest');
subplot(1,2,2);
imshow(rr);
title('STEP:6 Resized Image:2');

figure();

% STEP:7 IMAGE
SMOOTHING***************************************************

s= fspecial('gaussian',3);
f = imfilter(r,s);
subplot(1,2,1);
imshow(f,[]),title('STEP:7 Using Gaussian Filter Smoothing Image:1
');

ss= fspecial('gaussian',3);
ff = imfilter(rr,ss);
subplot(1,2,2);
imshow(ff,[]),title('STEP:7 Using Gaussian Filter Smoothing
Image:2');

figure();

%%% Image Segmentation Process:-

% STEP:8 CANNY EDGE
DETECTION**********************************************

e=edge(f,'canny');
subplot(1,2,1);
imshow(e);
title('STEP:8 Edge Detection by Canny Filter Image:1');

ee=edge(ff,'canny');
subplot(1,2,2);
imshow(ee);
title('STEP:8 Edge Detection by Canny Filter Image:2');

figure();

%STEP:9 Sobel EDGE
DETECTION**********************************************

S1=edge(f,'roberts');
subplot(1,2,1);
imshow(S1);
title('STEP:9 Edge Detection by Sobel Filter Image:1');

SS1=edge(ff,'roberts');
subplot(1,2,2);
imshow(SS1);
title('STEP:9 Edge Detection by Sobel Filter Image:2');
```

```
figure()

% STEP:11 GAMMA
CORRECTION**************************************************
%Adjust the Gamma to 0.8

S=edge(f,'sobel');
u=double(S);
subplot(1,2,1);
y= imadjust(u,[],[],0.8);
imshow(y);
title('STEP:10 Gamma Adjusted Image:1');

SS=edge(ff,'sobel');
uu=double(SS);
subplot(1,2,2);
yy= imadjust(uu,[],[],0.8);
imshow(yy);
title('STEP:10 Gamma Adjusted Image:2');

figure();

% STEP:12 HISTERISIS
THRASHOLD*********************************************

mygrayimg = imread('C:\Users\reddy\Desktop\iris\Eye Database\Eye
Database\1.jpg');
mygrayimg = imresize(rgb2gray(mygrayimg),[256 256]);

myfftimage = fft2(mygrayimg);


tmp = abs(myfftimage);
mylogimg = log(1+tmp);


[M,N] = size(myfftimage);

low = 62;
band1 = 15;
band2 = 60;
mylowpassmask = ones(M,N);
mybandpassmask = ones(M,N)

for u = 1:M
for v = 1:N

tmp = ((u-(M+1))/2)^2 +(v-(N+1)/2)^2;
raddist = round((sqrt(tmp)));
disp(raddist)

ifraddist> low
mylowpassmask(u,v) = 0;
end

ifraddist> band2 || raddist< band1;
```

```
mybandpassmask(u,v) = 0;
end
end
end


f1 = fftshift(mylowpassmask);
f3 = fftshift(mybandpassmask);


resimage1 = myfftimage.*f1;
resimage3 = myfftimage.*f3;

% Display the low pass filtered image
r1 = abs(ifft2(resimage1));
subplot(1,2,1);
imshow(r1,[]),title('STEP:11 Hysteresis Thresholding of Image: 1');




% part 2*****


% Read the image, resize it to 256 x 256
% Convert it to grey image and display it

mygrayimg = imread('C:\Users\reddy\Desktop\iris\Eye Database\Eye
Database\1.jpg');
mygrayimg = imresize(rgb2gray(mygrayimg),[256 256]);
%subplot(2,2,1);
%imshow(mygrayimg),title('Original Gray-Image');

% Find FFT
% Use the command fft2() to get FFT of the image
% The log scale of FFT image is displayed

myfftimage = fft2(mygrayimg);

% Take logarithmic scale for display

tmp = abs(myfftimage);
mylogimg = log(1+tmp);

%subplot(2,2,2);
%imshow(mat2gray(mylogimg));
%title('FFT Image');

% Find size
[M,N] = size(myfftimage);

% Create Filter array

% The cut off frequency 20 is used here

low = 62;
band1 = 15;
```

```
band2 = 60;

% create ideal high pass filter mask

% Create matrix of size equals original matrix

mylowpassmask = ones(M,N);
mybandpassmask = ones(M,N);

% Generate values for ideal high pass mask

for u = 1:M
for v = 1:N

tmp = ((u-(M+1))/2)^2 +(v-(N+1)/2)^2;
raddist = round((sqrt(tmp)));
disp(raddist)

ifraddist> low
mylowpassmask(u,v) = 0;
end

ifraddist> band2 || raddist< band1;
mybandpassmask(u,v) = 0;
end
end
end

% Shift the spectrum to the centre
f1 = fftshift(mylowpassmask);
f3 = fftshift(mybandpassmask);

% Apply the filter H to the FFT of the Image
resimage1 = myfftimage.*f1;
resimage3 = myfftimage.*f3;


% Apply the Inverse FFT to the filtered image

% Display the low pass filtered image
r1 = abs(ifft2(resimage1));
subplot(1,2,2);
imshow(r1,[]),title('STEP:11 Hysteresis Thresholding of Image: 2');

figure();

% STEP:12 HUGH
TRANSFORM***************************************************

Hu=imread('C:\Users\reddy\Desktop\iris\Transfromation
Results\Transfromation Results\hug1.jpg');
subplot(1,2,1);
imshow(Hu);
title('STEP:12 After Hugh Transformation Image:1')

Hu1=imread('C:\Users\reddy\Desktop\iris\Transfromation
Results\Transfromation Results\hug3.jpg');
subplot(1,2,2);
```

```
imshow(Hu1);
title('STEP:12 After Hugh Transformation Image:2')

figure();


% STEP:13
NORMALIZATION*****************************************************
n=imread('C:\Users\reddy\Desktop\iris\Transfromation
Results\Transfromation Results\normal1.jpg');
subplot(2,1,1);
imshow(n);
title('STEP:13 Normalized Image:1')

nn=imread('C:\Users\reddy\Desktop\iris\Transfromation
Results\Transfromation Results\normal3.jpg');
subplot(2,1,2);
imshow(nn);
title('STEP:13 Normalized Image:2')

figure();



% STEP:15
MATCHING**********************************************************


N=im2double(f);
subplot(1,2,1);
imshow(N);
title('STEP:14 IMAGE 1');

NN=im2double(ff);
subplot(1,2,2);
imshow(NN);
title('STEP:14 IMAGE 2');


 w = msgbox('DIFFERENT IRIS','Result');

 w = msgbox('SAME IRIS','Result');
```

CHAPTER -6
OUTPUT

Fig: different eyes input

Fig: same eyes input

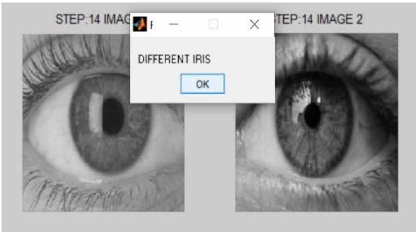

Fig: different eyes output

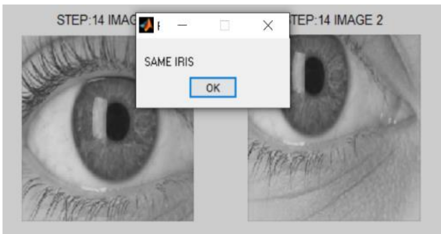

Fig: same eyes output

CHAPTER-7

CONCLUSION AND FUTURE SCOPE

7.1 Conclusion:

The hardware design has been successfully carried out for Iris Recognition system capable of comparing two digital eye-images. This identification system is quite simple requiring few components and is effective enough to be integrated within security systems that require an identity check. The errors that occurred can be easily overcome by the use of stable equipment. Judging by the clear distinctiveness of the iris patterns we can expect iris recognition systems to become the leading technology in identity verification.

7.2 Future Scope :

Biometrics industry continues to be dominated by fingerprint biometrics because of pricing and ease -of-use. Iris biometrics is poised for greater “traction” in the future, however pricing and user awareness pose challenges. Research id advancing to capture iris images in tha visible light spectrum which will help push growth higher-this will pave the way for iris biometrics smartphone integration pushing growth of : Ticketless travel, Single sign-on applications(sso).

In carrying out this project various problems were encountered from the availability of research materials on emerging biometric technology, the design of the required hardware components of the system and the understanding of the system’s mode of operation. Also some challenges were encountered in the area of software development for the control of the system due to inadequate facilities for software simulation.The solution to the above problems is the introduction and improvement of biometric research and studies in the undergraduate level to enhance the teaching of the technology and use of biometric system in the technical laboratories in the institutions. With this the under graduates can be more interested in and acquitted with the emerging biometric technology.

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