

**Smart Vault System**Nisha Dhamale¹, Sanjana Gaikwad², Shweta Kotkar³, Mrs. K.K.Adoni⁴¹Electronics & telecommunication, P.E.S Modern College of Engineering²Electronics & telecommunication, P.E.S Modern College of Engineering³Electronics & telecommunication, P.E.S Modern College of Engineering⁴Professor, Electronics & telecommunication, P.E.S Modern College of Engineering,

Abstract — Banks provide locker system for their customers for safekeeping. In traditional methods, every time a customer wishes to access his locker, he must wait until a banker becomes free, so that he can give access to the locker after signing certain registers. It results in wastage of time for both the banker as well as the customer. The customer has to wait until the banker becomes free and the banker has to stop his work and attend to the customer. There are chances to loose the keys.

The next locker system access further developed, where password were required to access the locker. But there are chances that the password may be forgotten or stolen by third party.

The latest are the smart cards. To access the locker, it is required to swipe the card & enter the security code which is unique for every user, every time. There are chances that the card may be lost or stolen.

To overcome the all above drawbacks, Biometric methods of authentication came into existence. It includes face recognition, fingerprints, palm, iris, etc. Face recognition, fingerprint & palm has less security as it can be duplicated. But iris has high security as it cannot be stolen or copied. Even the left & right iris of a human being are different. It does not require any password to remember. So iris detection is the most reliable & secured way of authentication.

Smart Vault System is based on iris recognition. In this prototype, when the person enters, iris detection is takes place. If the person is authorized, locker number is sent from PC via RF transmitter to the robot. At the other side when robot receives the person's locker number. Then depending on the locker number, stepper motor does its operation & picks up the particular locker & the user can access that locker.

Keywords- PIC Controller (PIC16f877a); RF Module(CC2500); LCD; DC Motor; robot;

1. INTRODUCTION

Security and the authentication of individuals is necessary for many different areas of our lives, with most people having to authentic their identity on a daily basis; for example ATMs, secure access to buildings, and international travel. Few years before, banks used to provide lockers for safekeeping of the wealth such as money, files, important documents and will letters etc.

The traditional methods of providing the locker system for safekeeping the personal items are such as :

The banks used to provide lockers to the customer so every time the person wishes to access his locker , he must wait until a banker becomes free so that he can have authentic access to the locker. This results in waste of time for both the banker as well as the customer, as the customer has to wait until the banker becomes free and the banker has to stop his work and attend to the customer & also there are chances to lose the keys. Then the locker system based on smart cards, magnetic stripe cards were invented. Passwords can be forgotten, shared or unintentionally observed by a third party. Forgotten passwords & lost smart cards cause trouble for users & waste the expensive time of system administrators.

The advanced method for authentication is biometric authentication which includes face recognition, fingerprint, palm, iris, etc. It removes all above drawbacks. Face, fingerprint & palm have accuracy of 90%. But it can be duplicated. Hence, it is not reliable. DNA (Deoxyribo Nucleic Acid) based recognition has good accuracy but every time it is not possible to check the DNA for daily transactions. It may waste the time & complexity increases.

This problem can be overcome by Iris recognition. It is a particular type of biometric system that can be used to reliably identify a person by analyzing the patterns found in the iris. The iris is reliable as a form of authentication because of its uniqueness in the pattern. The iris is called the living password because of its unique features. It is always with you and cannot be stolen or faked. The iris of each eye is absolutely unique. No two irises are alike in their details, even among

identical twins. Even the left and right irises of a single person seem to be highly distinct. Generation of an iris artificial

duplication is virtually impossible. It does not depend upon genetic material. Iris usually have no contact with sensing device. Process of iris recognition is very fast.

The project includes Iris based authentication to access the smart vault system. In this prototype, when the person enters, his iris will be checked. If the person is authentic, then the locker number is sent via RF transmitter. Then the PIC controller will send the data to the robot & the

robot will detect the locker. If the person is non-authorized, process of locker number detection will not be completed.

2. Implementation

The iris images are first collected. After the collection of the iris images preprocessing steps are carried out on these images. The steps required for preprocessing are as follows:

- i) Convert the color image into gray image
- ii) Perform image adjustment and histogram equalization
- iii) Segmentation

After the segmentation, Feature extraction is then conducted using two directional filters (vertically & horizontally oriented). The presence (or absence) of ridges and their dominant direction are determined, based on maximum directional filter response. Then the polar to rectangular conversion is done to generate the rectangular template using RED Algorithm. The generated templates are matched with the stored templates using hamming distance. If the template is matched the person ID is displayed on LCD and can access the system.

Block Diagram for Iris Recognition:

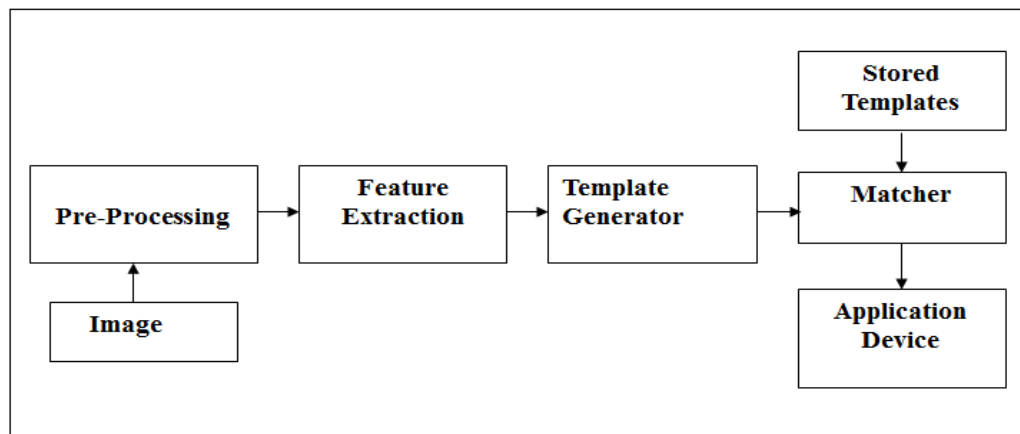


Figure 2. Block Diagram of Iris Recognition

2.1 Capture Image:

Images are captured using 3CCD Camera working at infrared light. The captured image should have high resolution, good lightning and good sharpness. Here the images are collected from net which are provided by CASIA Institute.

2.2 Pre-Processing:

Pre-processing is carried out using following steps:

i) Gray Image:

The colored iris images are converted into into gray images. In such types of images one pixel can be represented by 8 bits i.e. there are total 256 gray levels in one pixel.

ii) Histogram Equalization:

Histogram equalization is to enhance the brightness and contrast of an image. It is used for obtaining a uniform histogram. It assigns the intensity values of pixels in the input image such that output image contains a uniform distribution of intensities. Histogram Equalization increases the brightness and contrast of a dark and a low contrast image, making features observable that were not visible in the original image. It equalizes intensity and saturation components of an image while hue remains unchanged. The transformation used for the histogram equalization is given below:

$$S_k = T(r_k) = \sum_{i=0}^{k} h_i \quad \text{For } 0 \leq k \leq G_{\max}, \quad h_i = n_i/n_r \quad \dots (1)$$

where, h_i is the normalized histogram of the image

Here $T(r_k)$ must satisfy 2 conditions,

- $T(r_k)$ must be single valued function. It must monotonically increase in the interval $0 \leq r \leq 1$
- $0 \leq T(r_k) \leq 1$ for $0 \leq r \leq 1$

iii) Segmentation:

Segmentation is used to separate an image into various regions, to separate objects from the background. The boundaries of the iris and pupil are detected. The left and right boundaries of the iris are found by selecting the largest gradient change to the left and right of the pupil. Since pupil is the darkest part so a rough estimate of its center (C_x , C_y) is performed using formula:

$$C_x = \min \sum I(x, y);$$

$$C_y = \min \sum I(x, y);$$

Where $I(x, y)$ is the iris image intensity at point (x, y) .

To find the exact center of the pupil, image is binarized using an adaptive threshold obtained by the histogram with centered at the estimated center (C_x , C_y). Then the centroid of the image is determined which gives the exact center of the pupil. After this, radius of the pupil is obtained by tracing from center of the pupil to the boundary between iris and pupil on different direction in the binary image.

In order to implement the canny edge detector algorithm, a series of steps must be followed:

- 1) **Noise Reduction:** The canny edge detector uses a filter based on 1st derivative of a Gaussian. The image is smoothed using a Gaussian filter with standard deviation σ .
- 2) **Find the intensity gradient of the image:** The local maxima gradient, $g(x, y) = [G_x^2 + G_y^2]^{1/2}$, and edge direction, $\theta(x, y) = \tan^{-1}(G_x/G_y)$, are computed at each point.
- 3) **Non-maximal suppression:** The edge points give rise to ridges in the gradient magnitude image. The algorithm then tracks along the top of these ridges and sets to zero all pixels that are not actually on the ridge top so as to give a thin line, a process known as non-maximal suppression.
- 4) **Hysteresis thresholding:** Canny uses thresholding called hysteresis.

iv) Polar to rectangular conversion:

After separating the pupil the polar to rectangular conversion is applied this generates the rectangular template as shown below:

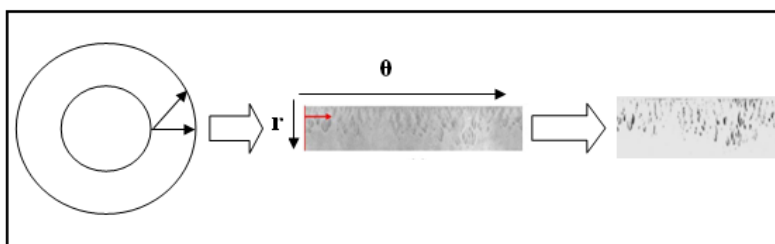


Figure 2 (iv) Polar to rectangular co-ordinate conversion

The hollow disk is mapped to a rectangle using following formula:

$$I [x (r, \Theta); y (r, \Theta)] \rightarrow I(r, \Theta)$$

Where r lies on the unit interval $[0,1]$ and Θ is circular angle in $[0, 2\pi]$.

2.3 Feature Extraction:

Feature extraction is based on the prominent direction of the ridges that appear on the image the polar coordinates are converted into rectangular co-ordinates and transformed into an energy image. Feature extraction is conducted using two directional filters (vertically & horizontally oriented). The presence (or absence) of ridges and their dominant direction are determined, based on maximum directional filter response. Finally, the template is generated by comparing the results of two different directional filters.

2.4 Template Matching:

The template can now be compared with the stored template using Hamming distance (HD) as the measure of closeness.

$$HD = \frac{\| (\text{template A} \oplus \text{template B}) \cap \text{mask A} \cap \text{mask B} \|}{\| \text{mask A} \cap \text{mask B} \|}$$

If the template is matched the person can access the authenticate system.

3. Results

Stage 1: Original Image:

The original image is colored one as displayed below:

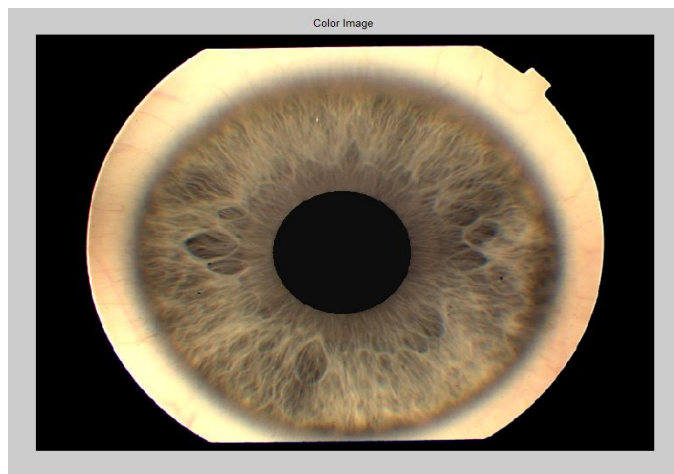


Fig. Color Image

Stage 2: Preprocessing:

- i) **Gray Image:** The above color image is converted into gray shade image as shown in Fig.

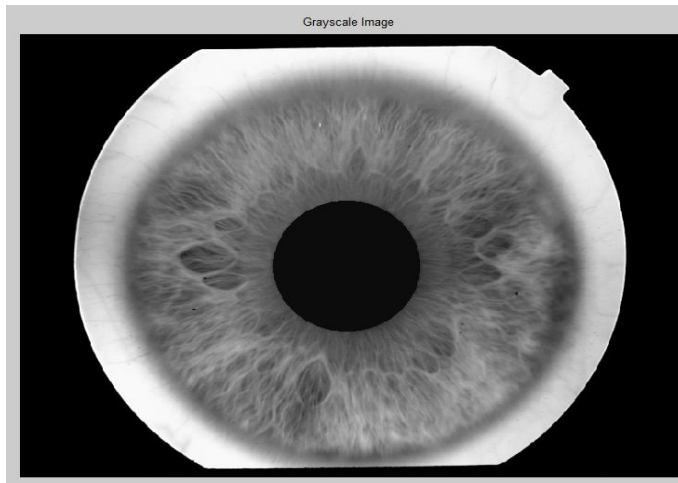


Fig. Gray Image

- ii) **Enhance image:** On the above image histogram equalization is carried out as shown below:

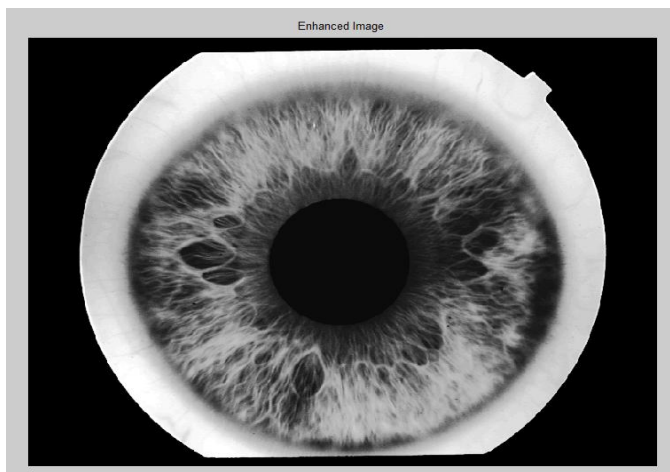


Fig. Enhanced Image

- iii) **Edge Detection:** Apply canny edge detector to the above image to detect the boundary of pupil, iris and edge as displayed in Fig.

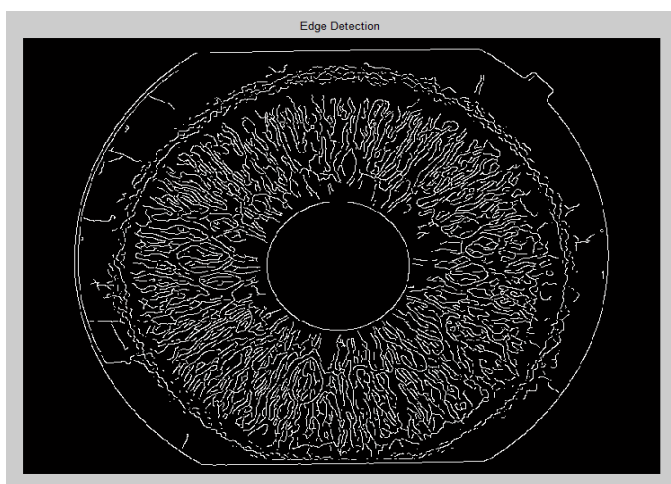


Fig. Canny Edge Detector

- iv) Start and end point of image:** Find the start and end point of the image and obtain the center of the image as displayed below:

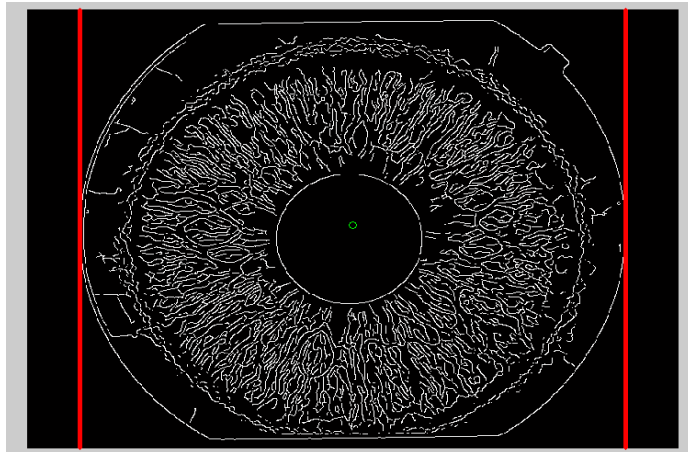


Fig. Start and end point of image

- v) Center of pupil:** Obtain the center of pupil using the above center point of image as trace below:

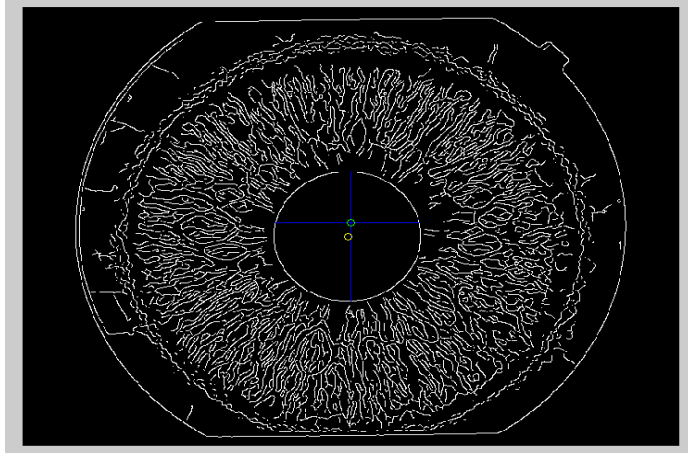


Fig. Center of pupil

- vi) Center and radius of pupil:** Display the center and radius of pupil as shown in Fig.

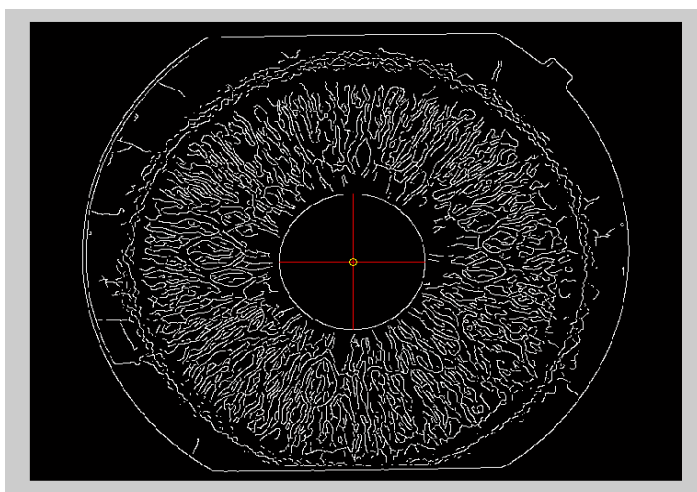


Fig. Center Point

- vii) **Area of interest:** Obtain area of interest from which features are to be extracted as below:

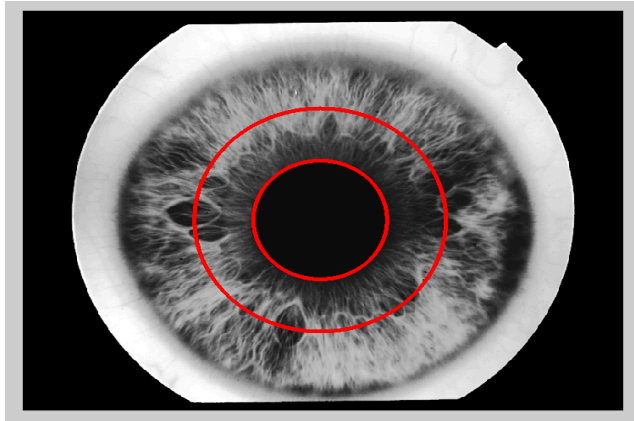


Fig. Area of interest

- viii) **Binary image:** Convert the above image into binary image as follows:

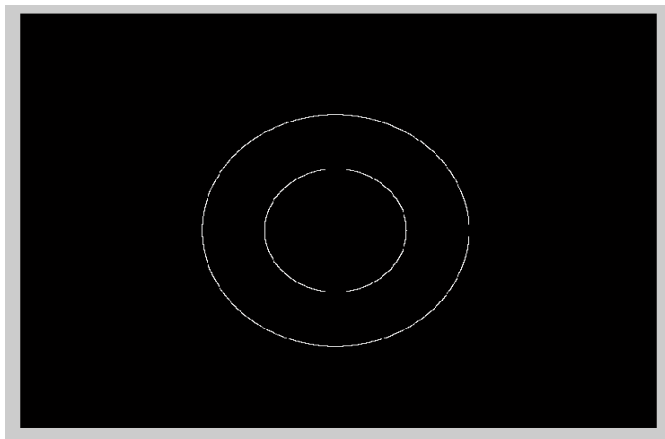


Fig. Binary Image

- ix) **Region of interest:** Separate area of interest from which features are to be extracted is shown below:

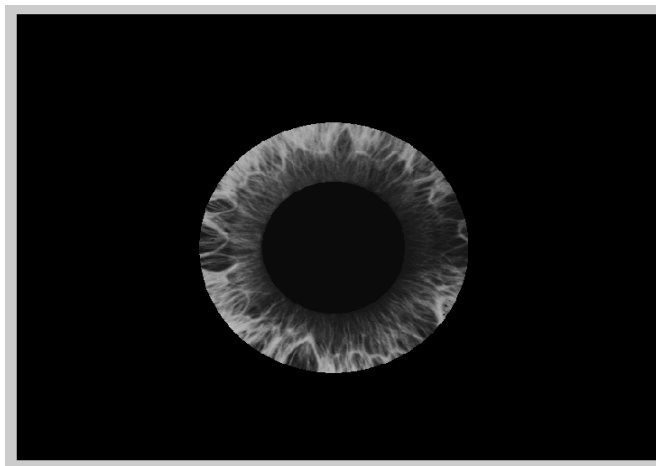


Fig. Region Of Interest

x) Polar to rectangular conversion: Convert the above image into rectangular template as displayed below:



Fig. Polar to rectangular

Stage 3: Horizontal and vertical template: Apply the RED algorithm on the above image and extract the features using horizontal and vertical filters as displayed below:

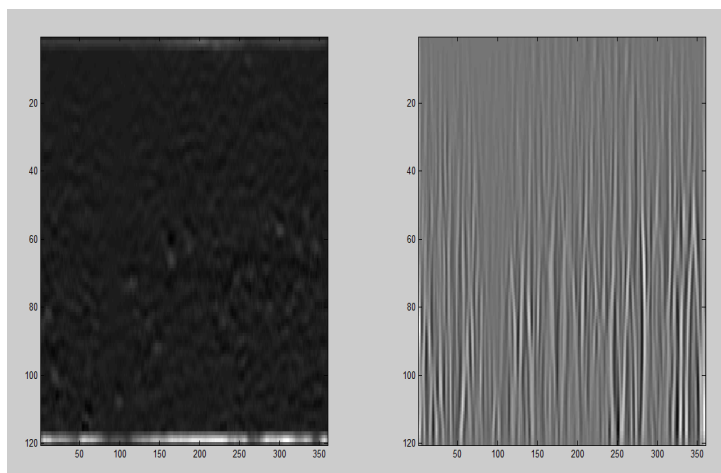


Fig: Horizontal and vertical template.

Stage 4: ID: Display the match ID of the person.

4. Block Diagram

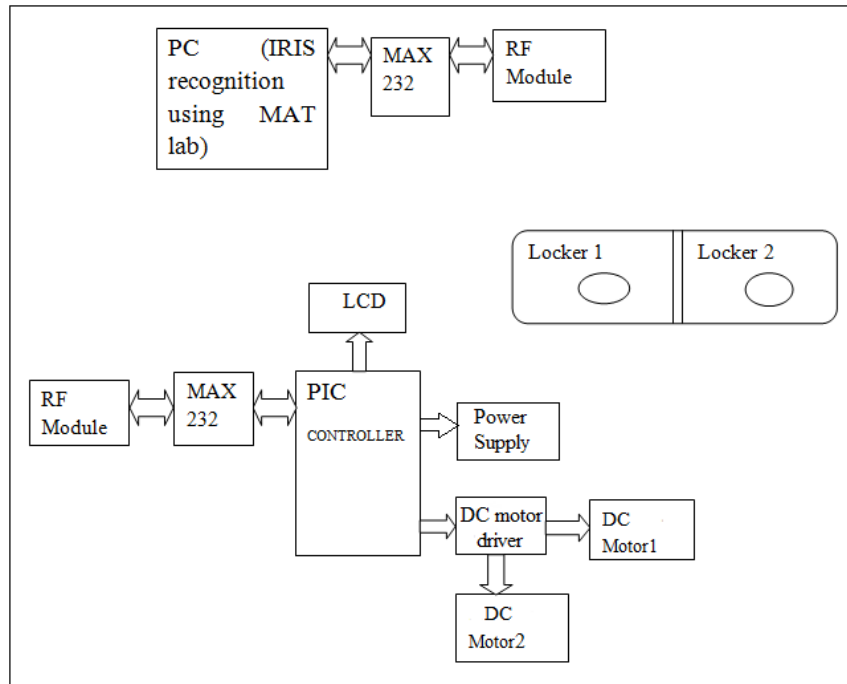


Fig. Block Diagram

- Switch on the system which will initialize the LCD
- When the person enters, his iris will be checked
- If the person is authentic, then locker number is sent via RF transmitter
- RF transmitter will pass the signal to RF receiver
- RF receiver will send the particular locker number to the PIC controller
- PIC controller will send the data to the robot & the robot will detect the locker
- If the person is not authentic, locker number will not be sent

Block Diagram Description

The hardware involved in this project is a PIC Controller, Power Supply, a LCD to display the concerned information, RF Module, DC motor, MAX232.

i)Power Supply:

It is meant for supplying Power to all the sections mentioned above.

ii)Microcontroller (PIC16F877A):It is the control unit of the whole project which basically consists of a Microcontroller, Crystal with capacitors, Reset circuitry, and so on. It controls the devices being interfaced and communicate with the devices according to the program being written.

iii)MAX 232:The microcontroller can communicate with the serial devices using its single Serial Port. The logic levels at which this serial port operates is TTL logics. But some of the serial devices operate at RS 232 Logic levels. In order to communicate the Microcontroller with either Smart Card Reader or PC, a mismatch between the Logic levels occurs. In order to avoid this mismatch a Serial driver is used.

iv) LCD Display(16X2) :This section is basically meant to show up the status of the project. This project makes use of Liquid Crystal Display to display / prompt for necessary information.

v) RF Module(CC2500):The CC2500 is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. The circuit is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band.

vi) DC Motors: DC motors are used to drive the wheels of the robot. In all three DC motors are used, two for driving two legs and the third for driving robotic arm.

5. Applications & Limitations

Applications:

- Internet security
- Bank
- Credit-card authentication
- Secure financial transaction (e-commerce, banking)

Limitations:

- The robot will not be able to move upward / downward.

6. Conclusions

A Ridges energy direction algorithm incorporates local statistical analysis in segmentation and uses the direction of the ridge patterns that appear in the unwrapped iris in the feature extraction process. Hamming distance is used to find the exact match. This Ridge-Energy-Direction (RED) algorithm reduces the effects of illumination since only direction is used. The expected accuracy is of 99.99%. After successful authentication person can access the system.

7. REFERENCES

- [1] Swetha J1,” “RFID Based Automated Bank Locker System,” International Journal of Research in Engineering and Technology, Volume: 03 Issue: 05 | May-2014.
- [2] Mayuri M. Memane, Sanjay R. Ganorkar ,”
RED Algorithm based Iris Recognition,”
Int.J.Computer Technology & Applications, Vol 3 (4),1605 -1612 .
- [3]” PIC microcontroller & embeeded system “,Mazidi,3rd Edition, Pearson .