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Secure Vault System using Iris Biometrics and PIC Microcontroller

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Abstract - *The paper here proposes work which involves developing a secure vault system based on iris recognition system using a point to point element template matching algorithm and PIC microcontroller. Iris recognition systems capture an image from an individual's eye. The iris in the image is then segmented and normalized for feature extraction and matrix matching process. The iris recognition system consists of an automatic segmentation system, and is able to localize the circular iris and pupil region, excluding eyelids and eyelashes, and reflections. The extracted iris regions were normalized into a rectangular block with constant dimensions to account for imaging inconsistencies. This method can successfully detect all the pupil boundaries and increase the recognition accuracy. The Secure 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*

Key Words: **Biometrics, Iris, MATLAB, PIC, Microcontroller, RFID.**

1. INTRODUCTION

The 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 lose 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.

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 (De-oxyribo 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 has no contact with sensing device. Process of iris recognition is very fast. The system includes Iris based authentication to access the secure 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.

Alice Nithya A. et. al. (2016), here author is presenting Feature Extraction technique for improve the efficiency and accuracy of Human identification and recognition. The iris based biometric system is only one stable and reliable system compare to any other biometric system. In this paper biometric system of iris has various methods that are image segmentation, image normalization, image feature extraction and matching. It is plays an important role in improving the system performance, accuracy and reliability [1].

Mr. P.P.Chitte, et. al. (2014) of J.N.E.C Aurangabad have done work for the performance evaluation of iris recognition algorithms to construct very large iris databases. However, limited by the real conditions, there are no very large common iris databases now. An iris image synthesis method based on Principal Component Analysis (PCA), Independent component analysis (ICA) and Daugman's rubber sheet model is proposed. Iris Recognition is a rapidly expanding method of biometric authentication that uses pattern-recognition techniques on images of iris to uniquely identify an individual [2].

In Liu et al. (2014) proposed a video sequence based iris recognition system which works based on bionic recognition and distance distribution histogram. Same technique was tested against still images as well and resulted with more robustness and stability. Experimental results were tested using JLUBRIRIS database with videos of 78 subjects and CASIA V1 and V4 databases [3].

In Rai et al. (2014) proposed a technique to perform code matching based on combination of two techniques to achieve better accuracy rate. Circular Hough transform is used to isolate the iris image followed by finding the zigzag collarette area and then detecting and removing the eyelids and eyelashes using parabola detection technique and trimmed median filters. Haar wavelets and 1-d Log Gabor filters are used to extract features from the zigzag collarette region of iris. Extracted patterns were recognized with the help of combination of techniques called support vector machine and hamming distance approach [4].

In Song et al. (2014) proposed a method based on sparse error correction model, since the noise factors like eyelid and eyelash occlusion and specular and pupil reflections are mainly spatially localized. In this approach training sets of all iris images are considered as a dictionary used for the purpose of classification of simple test sample and finally converted to a huge size dictionary. To make this error correction model efficient, a K-SVD algorithm is implemented. It is proved that the dictionary when learned with help of this algorithm is said to have a better representation [5].

In Pillai et al. (2014) proposed a cross sensor based iris recognition system which works on kernel learning technique. This paper proposes a recognition framework which works on multiple sensors and provides better cross sensor recognition rate. LG2200, LG4000, Iris on the Move portal system by Sarnoff, Combined Face and Iris Recognition System (CFAIRs) by Honeywell, HBOX system by Global Rainmakers Inc., and Eagle-Eyes system by Retica are some popular systems used to acquire iris images. A kernel based learning approach is used for sensor adaptation [6].

In Sun et al. (2014) provided an iris image classification framework based on texture information using a representation technique called Hierarchy Visual Codebook (HVC). HVC is based on two techniques called Vocabulary Tree (VT), and Locality-constrained Linear Coding (LLC), for representing iris textures sparsely. Experimental results show that this method helps in achieving better image classification for iris liveness detection, race classification, and coarse-to-fine iris identification methods. Gabor filter and ordinal filters are used to extract features from the segmented iris image [7].

In Z.Z. Abidin et al. (2013) proposed a feature extraction technique based on the epigenetic traits using several edge detection operators. Edge detection operators like Sobel, Prewitt and Canny were applied to extract the features from the iris. Among them Canny operator was found to provide a more accurate results. By applying these operators, the PSNR values of iris texture information before and after processing were calculated [8].

In Zhou et al. (2013) proposed a new code matching technique. During segmentation stage following steps were followed: (i) to localize pupil boundary histogram analysis and morphological processing were performed, (ii) Outer boundary was considered to have twice the size of pupillary boundary and (iii) To detect and remove upper and lower eyelids, Canny edge operator followed by polynomial curve fitting algorithm were used. After segmenting the iris, it was unwrapped to a rectangular block of fixed size with the help of a convolution operator.1-d Log Gabor filter were applied to extract the texture information and were then store in a k-dimension tree structure [9].

Ashish Kumar Dewangan et. al. (2012) have developed a biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. 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 [10].

2. METHODOLOGY

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 the person can access the system.

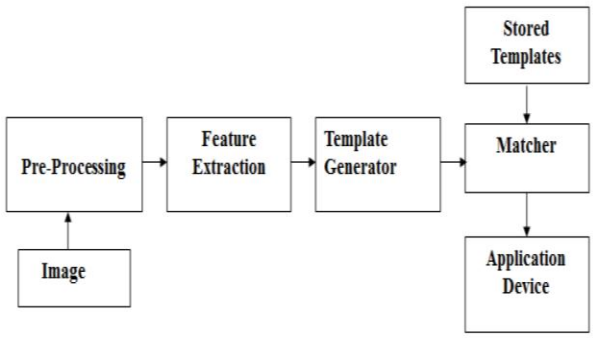

Fig -1: Block Diagram of Iris Recognition System

The basic steps in the above system are:

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.

Pre-Processing: Pre-processing is carried out using following steps:

Gray Image: The colored iris images are converted 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.

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 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.

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

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 ϭ.

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.

Hysteresis Thresholding: Canny uses thresholding called hysteresis.

Polar to Rectangular conversion: After separating the pupil the polar to rectangular conversion is applied this generates the rectangular template

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.

Matching: Use the Hamming Distance (HD) between two iris codes which is a fraction of No. of different bits upon total no. of bits done by point to point element template matching for two images one from database and the other selected for match input.

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

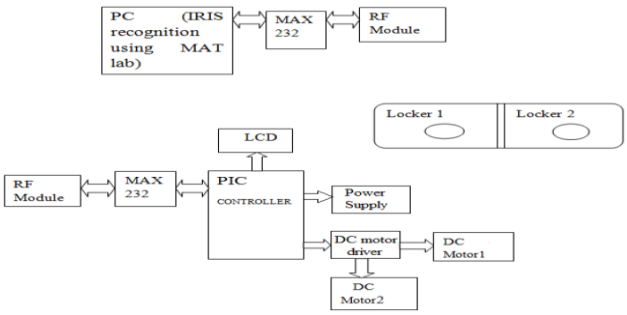

Fig -2: Block Diagram of Iris Recognition System

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

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 communicates with the devices according to the program being written.

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.

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.

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.

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.

Verification Process: 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.

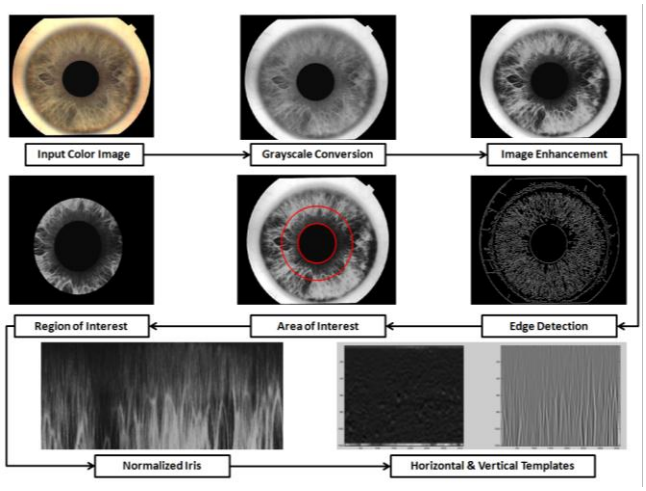

Fig -3: Results for of Iris Recognition Process

3. CONCLUSIONS

The Secure 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. A point to point template matching algorithm incorporates local statistical analysis in segmentation and uses the direction of the different patterns that appear in the unwrapped iris in the feature extraction process. Hamming distance is used to find the exact match. This algorithm reduces the effects of illumination since only direction is used. After successful authentication a person can access the secure vault system.

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