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Automatic Physical Access Control System Based on Biometric Identification by Wavelet Transform Algorithm

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Abstract*—Nowadays, there is a need to improve security in many real-time usages. Hence, traditional biometric authentication based on fingerprint, iris, face, etc., may actively maintaining the security of a system. Since, these methods result in several limitations in terms of cost, accuracy and its requirements. Hence, this study proposes an automatic identification system based on hand vein biometric using a novel algorithm called Wavelet Transform (WT). Generally, the vein patterns get varied for each finger/person and these patterns are hidden underneath the skin's surface, it helps to avoid forgery. The process is initiated by a hand image is captured by a web camera with the help of IR light transmission to indicate the vein pattern, shade of finger muscles, bones, and tissue with different size of a live body. With different experimental tests, it is noticed that the veins are clear even capture image is faded. Secondly, the system extracts the vein patterns, thus there no barriers for identification and verification of the damage and tear, the dry and therefore the wet of hand surface. The hand is not in contact with the device instead hand is simply easily stretched and also the capturing of vein pattern in completed, due to non-contact, it's hygienic and non-duplicating and has no negative image associated with crime. Since the proposed system results in zero falsification and holds high-security grade. The proposed algorithm is processed by MATLAB and implemented in embedded hardware-based platform their by reducing the false acceptance rate and false rejection rate.

***Index Terms*— Authentication, Biometrics, biomedical imaging, embedded system, Humans, Veins.**

I. INTRODUCTION

In recent updating technology, the research interest towards several streams of biometric identification has grown up. The biometric unit helps to protect the document or any other government/private processing information as more confidential.

Some traditional biometric technologies such as fingerprints, face, voice, iris recognition, etc., are used. These methods fall into the categories of common physiological biometrics. Another methodology is behavioral biometrics named as voiceprints, handwritten signatures, and keystroke/signature dynamics.

Even though the tremendous growth in technology results in security and it further helps hacker to use the information of the users. To avoid such things and improve the security of the system there is a need for the high secure authentication system.

Jain et al., (2004) discussed some challenges of biometric units. While entering into applications like payment processing, the biometric payment technology has attracted in recent times more and more to decrease identity theft [1]. Bemmel and Mian [2] pointed out the system and method for point of sale transaction by authenticating the user through their mobile device. It may results in limitations because the mobile devices may be handled by any other person without knowledge of the user. Hence, the point of sale with Biometric authentication is implemented. Awotunde et al., [3] made a secure Automated Teller Machine (ATM) under fingerprint authentication which is the replacement of password methodology. Finger print based identification is an efficient and proven method when comparing with all other technologies. The limitation of the fingerprint is increased in cost wise because of high-resolution scanner requirement. Hence, to overcome such limitations and improve the security of the system this research focused on extending or following the traditional technologies. It is broadly classified into three, such as image acquisition module, embedded module, and a human-machine communication unit. The authentication and identification are the two major contributions focused on this proposed methodology. The proposed system performs the authentication function with the hand vein. The main advantage of selecting the biometric is it is very difficult to change. Hence, the system provides more security than conventional methods. In this proposed system, the image is captured and processed under several steps. These processes are made through MATLAB. Then it is implemented in embedded processor named as PIC16F877A with a high-security technology RFID.

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This method is implemented to avoid the ATM robberies and minimize the unauthorized access.

The upcoming work is organized as follows: In section 2, the traditional methods and its algorithmic statements are studied and reviewed.

The proposed research methodology is described in section 3 with neat block diagram. Section 4 presents the simulation modules and its test results. Finally, the paper is concluded in section 5 with its future extension.

II. LITERATURE SURVEY

Wayman et al.,[4] introduced some biometric authentication systems. As per the Miller [5] statement, the Biometric technologies is defined as the automated method to verify the identity of a person, the process depends on physiological characteristic of a person. Similarly, many survey and research works are made recently. In this section, we review some methods and characteristics of the biometric units. Generally, the biometrics is a Greek term defining metric as a measurement. It is basically a pattern recognition system that uses human characters for recognition.

Jain et al., [6] stated that biometric recognition works in verification mode either or in identification mode. The identification of a person is made by comparing the reference image or date with a real-time captured image or data. The author states that the basic biometric system operation modes as sensor level that is used here to capture the input data. Then the feature level extraction is made through the collected data. The process is combined and verified based on the match score level and the degree of matching between input data and stored data. The author represented some overview of errors that may occur in the biometrics as a false match and false mismatch. The author stated the major voting may solve if the process is made into biometric. There is a way to decrease or completely reduce the forgery in voting.

Khasawneh et al., [13] proposed one of the biometric based voting schemes. Similarly, the biometric based authentication module is fit for different applications like electronic banking, mobile phones, access to buildings, health and social services.

Mandelbrot [14] proposed a Gabor filtering based query sample. The image is reconstructed by enlarged matching technique caused by finger pose variations. Hence, the intra- class and inter-class distance will be reduced. The processed is based on the benchmark Poly U Finger-Knuckle-Print (FKP) database with improved FKP verification accuracy. Mandelbrot further extends the research [15] with a proposed algorithm namely robust alignment algorithm measures the uniqueness between them by considering both minutiae and orientation field information.

Michael McCabe [7] presented some standards for identifying the biometric accuracy. The author carried the entire work test namely, facial recognition vendors test, fingerprint verification etc., It gives a platform to indicate that a dual biometric system is to be compatible with the existing system.

Gamassi et al., [8] presented an analysis in terms of accuracy of a biometric system. The comparison is made with several approaches with a different database. The author also stated that the second source of which affects the accuracy must be considered. The accuracy depends on how information of the biometrics features is used, it does not depend on the complexity of a design. The author represented a typical accuracy metrics like symmetry, false match rate, false non-match rate etc.

Next biometric analysis is the extraction of facial features. It is an integral process that includes face detection, face modeling, face recognition, animation and facial expression determination. The featured-based concepts are processed with the provided image to identify and measure the distinctive facial features namely eyes, mouth, nose, etc. while measuring such aspects the pattern recognition techniques employed to match the faces. Breitenstein et al., extracted facial parameters matching with a Euclidean distance measurement [9]. Similarly, Jeon processed a rotation invariant face detection method which is based on clustering algorithm [10].

Huang et al identified two problems in practice [11]. The first thing is the quality of the vein image is completely reduced. Next drawback is that the irregular distortion of the image caused by the variance of the finger poses. These processes are raised due to the error ratios. Hence, the authors introduced a wide line detector for feature extraction that obtains some precise width information of the vein and low-quality image is extracted with increased information. The authors developed a new pattern normalization model to effectively reduce the distortion caused by the pose.

Sun et al., proposed a digital signal processing based design with finger vein recognition [12]. The finger vein image is captured with infrared and hence normalized through the rotation. After completing the segmentation process the useless segments are wiped off. Finally, based on the feature extraction the vein points were obtained finger veins are matched based on the feature distance. These processes were completely followed by high-speed DSP called DM6437 of TI Corporation.

Wang et al., presented a new user identification system framework that follows finger-vein technology for consumer electronics devices [16]. Its main aim is to provide the high security and reliability than other identification technology. The algorithm follows Radon transform and Singular Value Decomposition (SVD) for extraction and a normalized distance measure for classification. Finally, the comparison is made to achieve improvement by False Acceptance Rate (FAR) and the False Rejection Rate (FRR).

George et al., developed efficient biometric recognition algorithms which are totally based on fingerprint and face. It is based on cropping the original fingerprint and resized it to apply the Dual Tree Complex Wavelet Transformation (DTCWT) [18].

Finally, the Performance Comparison of Face Recognition using Transform Domain Techniques (PCFTD) is proposed with wavelet to compare the FRR, Total Success Rate (TSR) and Equal error rate (EER). Jemaa et al., focused a new approach for the multimodal biometric system. It is based on the features Regularized Direct Linear Discriminant Analysis (RD-LDA) features used for identification [17].

patterns such as the face, iris, fingerprint, palm print, hand shape, voice, signature, and gait. With all the biometrics several applications are developed but still some limitations like high cost and low accuracy. It may not develop that is perfectly reliable or secure. While considering fingerprints and palm prints are frayed. In voice, hand shapes and iris images may easily get forged. There is a possibility of low accuracy in face recognition because it may affect by occlusions or face-lifts. These cases result in susceptible to spoofing attacks. To overcome these limitations there is a need to invent the secure model.

B. Proposed research methodology

In this method, a new biometric scheme based on hand vein is considered by replacing the ATM password. The usage of card type transactions needs more secure and safe. The attack or security issues are a major issue that creates complex problems. The security measures at ATM plays a significant role in preventing attacks on user's money. The replacement of existing fingerprint module with the introduced hand vein module is tested to improve the security level.

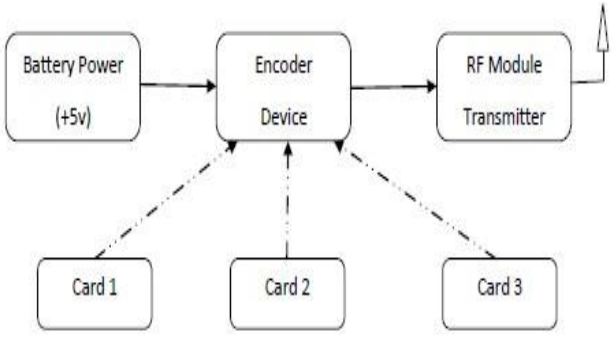

Fig 1: Card Section of Transmitter Unit

As shown in figure 1, the transmitter unit is constructed with the encoding unit and an RF module. In this unit, a 5- volt power supply is used to provide power to the encoding unit and make the transmitter unit active. This module is simple and easy to use with different type of card at the input side. The RF

III. RESEARCH METHODOLOGY

A. Problem identified in Existing System

In conventional methods, the information is traditionally provided only by passwords or Personal Identification Numbers (PINs). This type of implementation is easy to implement but result in terms of password forgotten or creates misuse. Hence, the biometrics concept is used to encode the human physiological or behavioral features instead of passwords. Since, there are many biometric Transmitter is used here to transmit the card information in an encoded format.

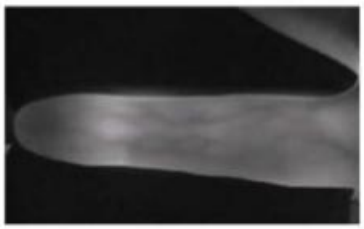

Fig 2: Model Vein Finger

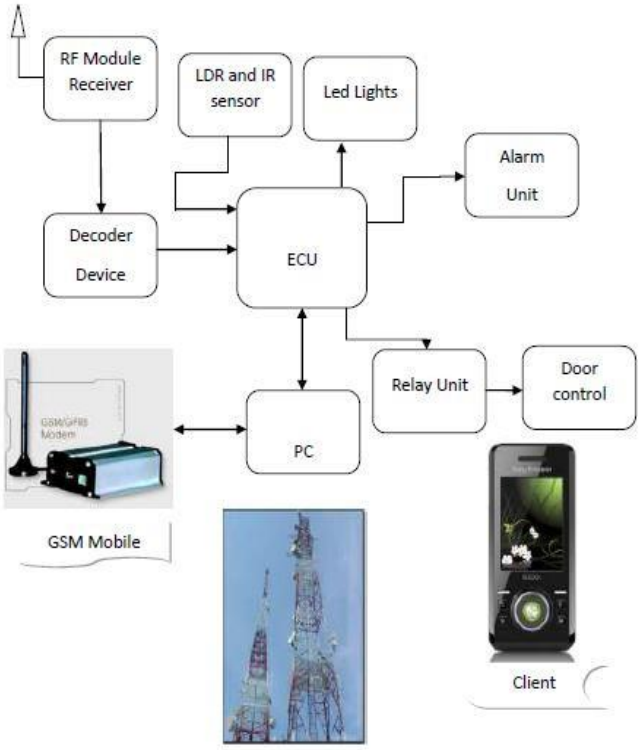

Fig 3: Receiving Unit

As shown in figure 3, the Electronic Controlling Unit (ECU) uses PIC16F877A for controlling all the process and maintains the receiving unit active. The Transmitted data is retrieved from the RF receiver module. The received data is decoded and transferred to ECU.

The +12 v power supply used in the proposed system to activate the LCD, RTC, GSM and buzzer. The hand vein system is initially processed by MATLAB and stored in the database. To verify the functionality of the proposed design, the stored database is compared with the real-time biometric hand vein through hardware part. Hence, in this research work, the hardware part consists of sensors units that are used to collect and store the data externally. The collected information is processed and stored in the PIC microcontroller. Based on the program each unit may turn ON and OFF. In emergency conditions, the DC motor is used to open and close the door of ATM. It is operated in 12v. If an ATM robber trying to broke the ATM machine, the door is to be closed automatically with the help of DC motor. Hence, the power consumption will be very less.

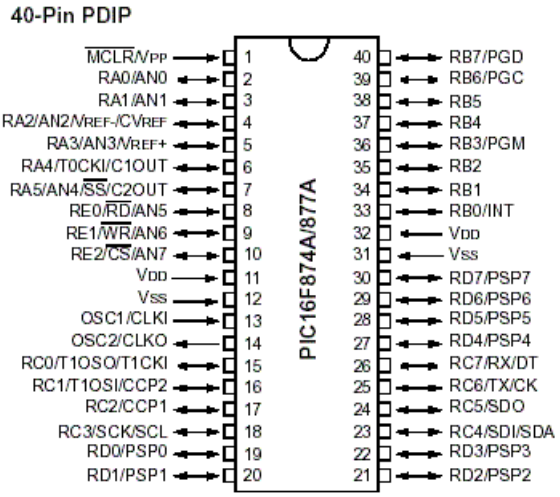

Fig 4 Pin diagram for PIC16F877A

For controlling the exact data and retrieve the stored data the coding is written and its process is controlled by GSM
900 Module. The client receives proper messages when there are any fluxations. The unwanted access may indicate through message, alarm and LED lights. The pin diagram for PIC16F877A is shown in figure 4. The GSM module is shown in figure 5, it supports all types of processor interfacing and used for communication. The baud rate is to be configured from 9600 to 115200 bps through Attention (AT) commands based on the requirements. The hardware requirements are listed below:

- Power supply
- Processing unit
- RF Module
- Encoder/Decoder
- Alarm unit
- Serial communication

Similarly, the software requirements are listed as follows

- MPLAB IDE
- MATLAB
- PICKIT2
- Visual basic 6
- Language: Embedded C

The communication between programming unit and the system is in UASRT format. The Receiver (RX), Transmitter TX) and ground pins are used to connect devices with GSM module. The programming system, Microcontrollers, should connect on RXD (Receive Data) to TXD (Transmit Data) of other device and GND (Ground) should be connected to other device's GND pin to make a closed loop. The frame format for UART is illustrated in the table I.

Start	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Stop

Table I Frame Format of UART

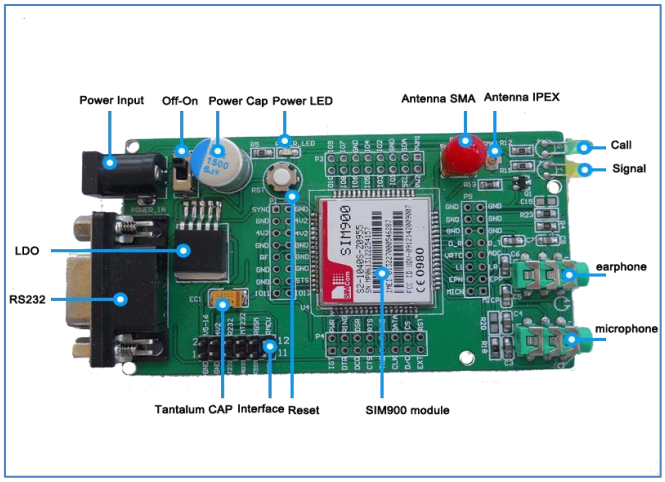

Figure 5 GSM SIM 900 Module

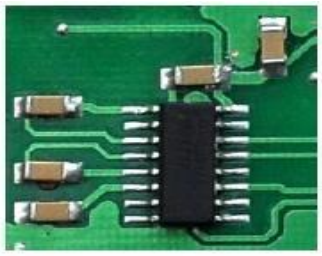

Figure 6 Diagrammatic view of RS232 IC

The pin diagram of RS232 is shown in figure 3.5. The last flow control signal present in DTE/DCE communication is the CD carrier detect. It is not used directly for flow control, but mainly an indication of the ability of the modem device to communicate the link between two modems devices.

Table II Specification of PIC16F877A

Device	Program Flash	Data Memory	Data EEPROM
PIC16F877A	8K	368 Bytes	256 bytes

IV. EXPERIMENTAL RESULTS

The proposed system coding is framed in embedded C and compiled in MPLAB, which is an integrated development environment. It is selected because of its flexibility. The view image is processed in MATLAB under a different process. Initially, the image acquisition process is made afterthat the images samples are segmented and aligned based on the requirement. Then the image enhancement is made with extraction to find out the clear vision of vein access. It is analyzed under two categories, namely, matched access vein and unmatched access vein. If the image is matched then the image is acquired and stored in a database. If the image mismatch occurs then the prediction is made by means of an alarm, door lock or by sending a message to the police or respective user. As shown in figure 7, the matched access vein image screen shots are viewed. If the image mismatch occurs then it is shown as shown in figure 8.

Fig 7: Matched access vein

Fig 8: Unmatched access vein

In the existing system, the biometric fingerprint reorganization results in several limitations, but our proposed hand vein reorganization system cannot be stolen or forgotten. The comparison table III shows that similarity between fingerprint and finger vein biometric parameters.

Table III Fingerprint vs. Finger-vein biometric comparison

Criteria	Finger Vascular biometrics	print Biometric
AR	High	Low Accurate
	Medium	High
Template	Small	Medium
price	Low	High
Authentication	Low	High

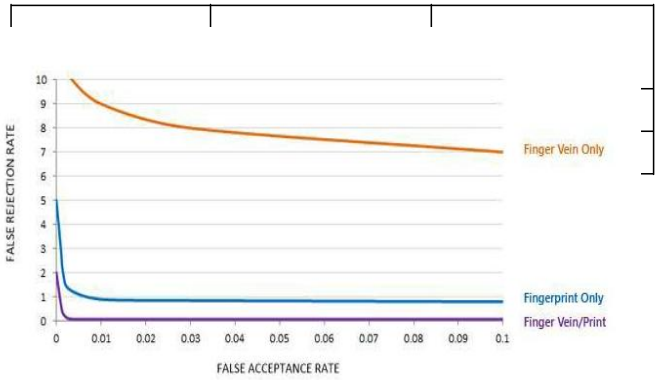

Fig 9: Comparison Chart

The false rejection rate is shown in fig 9, for the proposed method and existing fingerprint modules. The false rejection rate is very minute for finger vein. The accuracy is improved when comparing with the existing module. The false rejection rate is reduced if the false acceptance rate increases.

V. CONCLUSION

In existing research methodology, security level models are presented based on firmware. Merging real time parameters and controlling the hardware unit is complex in nature. Likewise, identification and authentication system plays a major role in maintaining the safety and security to keep more privacy or confidential. In traditional methods, the user needs to register each time while accessing the application. It happens due to the programming nature or man-machine interface lagging. Hence, while going to biometric each time the user is going to use the system by just pressing or scanning the real-time image and compare it with the previously registered image. It reduces the time and prefers easy access. Finger vein recognition is very effective when compared with pattern recognition and pin number security.

Hence, different surveys are analyzed and a new hand vein based user identification system is developed that overcomes the limitations of existing authentication systems. The proposed system is very convenient to the users in the banking sector. The testing of proposed system is made by

Criteria	Finger print Biometric
Vascular biometrics	

interfacing PIC16F877A with RF module. The prototype model is developed and it proves that it is best fit for several

AR	High	Low
Accurate	Medium	High

applications such as authentication in banking, consumer electronics, and defense applications. Finally, the prototype model is shown in hardware. It is concluded that the overall models show that the process is unique and simple to implement.

In future, implement this system in a real time environment with the help of commercial clients for customer services. Also, extend this research to implement the same hand vein biometric with real-time applications. The quality of this work is to be improved in the case of accessing the public database. The matched and mismatched data need to store and process it for further levels to improve the existing methods.

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