Study conceptual design of biometrics technology in door lock security system.

دراسة مفاهيم التصميم للتكنلوجيا القياسات الحيوية في نظام باب قفل الأمن

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ABSTRAC

Biometric lock is a lock that uses fingerprint to grant genuine user an access to a building, an office, or a libratory. This device solve major problem faced by the conventional lock or electronic combination lock, by adding electronic technology as well as biological technology together, user is the key to the lock. So users do not have to memorize combination as it is in the electronic combination lock, or carry the key along all the time. However with these device users simply need to place their finger on the fingerprint module and the device itself will determine whether to give or deny the access. This project is divided into three parts, which are hardware design, software design, and prototype design. The hardware design includes the electronics circuits used to enrol, identify, and delete fingerprint to the fingerprint module, LCD that gives command to the user. Software design includes the development of the source code that enables the 8051 to control and interface with all hardware mentioned above.

الخلاصة :

القفل الحيوي هو القفل الذي يستخدم بصمة الاصبع ليمكن المستخدم الحقيقي من الوصول إلى المبنى ، المكتب ، وهذا الجهاز يساعد على حل المشكلة التي تواجه الاقفال التقليدية و الإلكترونية ، ويتم ذلك بإضافة تقنية الكترونية مع التقنية البيولوجية . مستخدم البصمة لا يحتاج لحفظ الارقام كما هو الحال في استخدام الاقفال الإلكترونية ، أو حمل مفتاح بصورة مستمرة . لذلك مستخدمي هذا الجهاز يحتاجون لوضع اصبعهم على وحدة البصمة فقط ,والجهاز بحد ذاته سوف يحدد ما إذا كان ينبغي الموافقة أو رفض الاستجابة للمعلومات , ويتكون هذا الجهاز المستخدم في المشروع من ثلاثة أجزاء ، و هي تصميم مادي ، وتصميم البرمجيات ، وتصميم النموذج . ويتضمن التصميم المادي الدوائر الإلكترونية المستخدمة لتسجيل وتحديد وحذف المعلومات إلى نموذج البصمة ، والشاشة البلورية تعمل على قبول او رفض المعلومات المستخدمة . ويتضمن تصميم البرمجيات تطوير المعلومات البرمجية من المصدر التي تمكن (8051) من السيطرة على واجهة جميع الأجهزة المذكورة أعلاه.

1. Background

Door lock is a very important device; especially in the world we living in today that has a very high crime rate. So locking your door is not enough to secure your safety. According to a study conducted by California crime technological research foundation, it was found that most burglars enter the door. The intruders were asked for the reason of using the door; different answers were obtained but all agreed that conventional lock is easy to get around; either by kicking or picking the lock. good door lock is one step of making your home or office more secure, so it is a small price to pay to ensure your family and your properties safety. Commercial locks available in the market are valued by their security, reliability and price as well. So the most important factor is security where, it only allows valid users .this is very hard to achieve with the mechanical lock available in the market, where the keyway makes the lock vulnerable to breaking in. When choosing a lock one very important factor is security ,when using a normal lock which operates using a key ,that is not very secure ,first because the key can be easily duplicated secondly this key has a keyway which also makes it susceptible to picking. So lock that operates with a key is not that secure .with the advancements of engineering now it is possible to control anything using the electric circuit .so it possible to have the loc that operate electronically[3].

Problems with the convention lock are; they are easy to pick if intruders don not have a key. If intruders have the key then it is very easy to gain an access anytime which lead to the change of the lock .further more it is very easy to duplicate. Having a combination door lock is a better idea; using this type of lock will eliminate the need of having a key but create other issues ,like forgetting People use human characteristics to identify each other such as face, voice and, gait for thousand years. Alphonse Bertillon, chief of criminal identification division of the police department in Paris, came up with the idea of using a number of body measurements to spot criminal in the mid-19 century .this idea started to gain popularity and it led the discovery of the human fingerprint. fingerprint is part of the science known today as biometrics. Biometrics is identification of a person based on the person's distinctive physiological, anatomical and or behavioral characteristics. Biometrics was invented to enhance security and reduce financial fraud [5].

fingerprint form the user using the fingerprint model. To explain the principles and operations of manufacturing processes for door lock security device. To recommend the most appropriate process for a given product design, application requirements and cost constraints. Furthermore this device also able to delete fingerprint after addition. Security systems are vital for protection of information, property, and prevention from theft or crime. From data centers to banks; security systems have become a necessity. Home security systems are also or commercial security system. Lock protects the life and properties of everyone in today's world. Where the rate of crime and theft are exponential increasing everyday everyone need to use the lock. Throughout history people used lock for the same reason people using it today, which is security. In this chapter will expose and demonstrate evolvement of the lock form a very simple piece of wood to an electronic lock and brief introduction to biometrics. growing in popularity. In this paper, we present a low-cost and easy to implement electro mechanical lock. The design focuses on reducing the number of components which helps in cost reduction and less maintenance requirements. The simplicity of design also makes it compatible in different scenarios such as a home. [3].

The objective of this paper is to develop a biometrics lock device, which is able to acquire the this paper focuses on having a secure lock .where only users with valid fingerprint can gain access, In this project, fingerprint module is used to verify fingerprint .this device should be able to perform three simple functions which are enroll and verify and delete fingerprint. This function is controlled by microcontroller which will send signals to the fingerprint module, this signals is translated by the fingerprint module to one of the above mentioned function. This paper deals with the design, development and testing of the device.

Figure 1 Fingerprints [3]

2 . EVOLVE MENTS OF LOCK
2.1 ANCIENT LOCK

The usage of lock started long time ago, it approximately started in 445 B.C, in Jerusalem when they were repairing the old gates, lock at that time made of wood, but they share the same principle of working as pin tumbler lock. The oldest lock found today is in the ruin of the palace of Khorasabad in Niveveh.this type of lock were known as the Egyptian lock, it was made to allow user to open the door from outside, it was made out of wood, firstly it was opened using the hand, where there is a hand size hole in the door, and using the hand to lift up the bar or the bolt. Later on they started to use a smaller hole, where the bar or the bolt left it up using a long wooden or metal

prodder. This device further improved by adding wooden pegs in the lock that fell into the hole ,thus bolt can be moved unless pegs is lifted out [7].
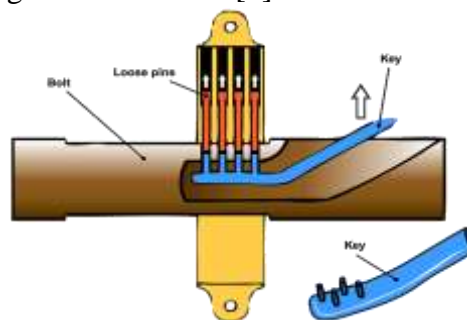

Figure2. Egyptian Lock [7].

The ancient Romans were the first to build the metal lock; they took the Egyptian wooden lock and improved it by adding ward projection or obstructions inside the lock. In other word the key must be bypass in order to open the lock [7].

3.   TODAY S LOCK
3.1 MECHANICAL LOCK

Today Mechanical lock uses more or less the same techniques. Key normally consists of two main parts which are the Blade and the Bow. The blade is the part of the key which slides into the key way of the lock, this part what make each key different. Revolution in electronics led to the application   electronics in the lock system, instead of one key which can be lost or duplicated, they used electronics lock which operates by the mean of electric current. Electric door lock used in conjunction with authorization device such as electronic key or   Radio frequency identification technology uses radio waves to identify personal by getting data stored in the RFID tag. It is a wireless technology that utilizes radio waves to get back information from the tag. Each user has exclusive serial number that identify or differentiate each tag user from one another. The RFID system consists of two parts; the tag and the tag reader, and both attached to its own antenna .identification information are stored in the tag .while in the other hand the tag reader is the part responsible for getting back the data from the tag. This how this system normally works, electromagnetic waves emitted by the antenna attached to the tag reader, once it receives back authorized responses it will allow the access. Figure 3. shows simple block diagram of the RFID[2].
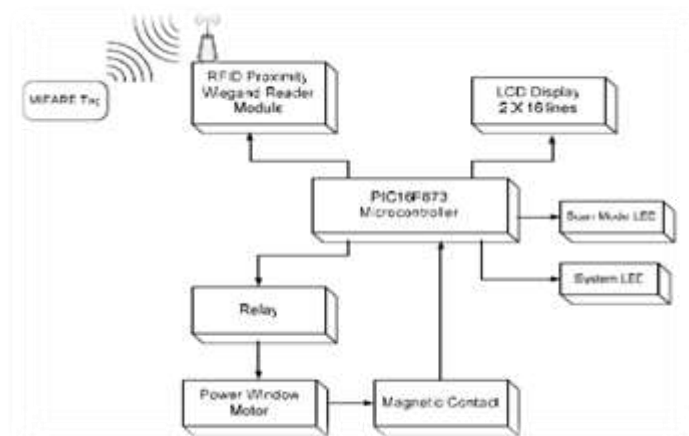

Figure 3. Block diagram of RFID [2]

Smart card access system is a card with the same size as the credit card, used for gaining access to a building. Unlike the credit card which is a plastic, the inside of the smart card contains anembedded microprocessor .this embedded microprocessor is there for security purposes. It is used

to communicate with card reader microprocessor to give access to the holder of the smartcard[How stuffWorks5the hardware part of the smart card consists of a microcontroller, RAM,ROM,and EEPROM memory unit and finally input and output interface[13]As shown in figure 3.
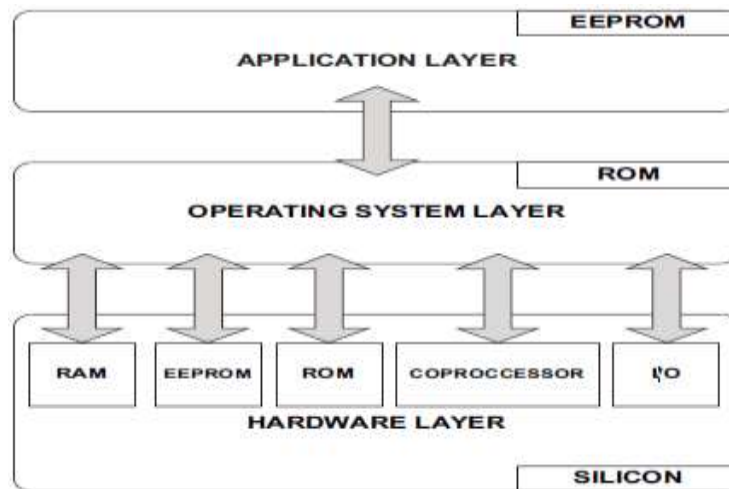

Figure 4 Smart card basic system[13]

Electronic combination lock or password lock is very common in access control especially for house front door or building. It is a keyless door lock, where the user needs to memorize the access code which is normally consists of six digits. The authorized users are given this code and are required to enter beforeentry. It also consists of microprocessor and Keypad to enter the access code[8].
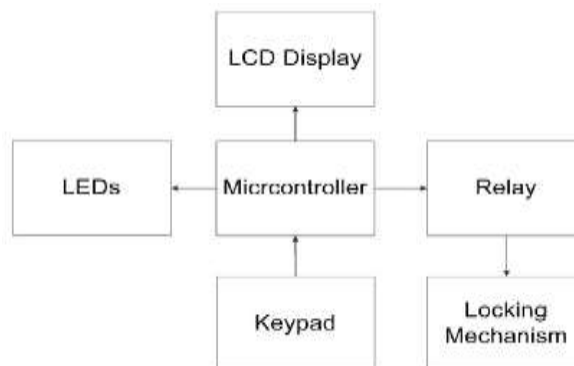

Figure 5. Block diagram [8]

3.2. GENERAL OVERVIEW OF BIOMETRIC RECOGNITION SYSTEMS.

Biometric recognition refers to the automatic identification of a person based on his/her anatomical or behavioral traits. This method of identification offers several advantages over traditional methods involving ID cards or PIN numbers (passwords) for various reasons. First, the person to be identified is required to be physically present at the point-of-identification. Second, identification based on biometric techniques obviates the need to remember a password or carry a token. With the increased integration of computers and Internet into our everyday lives, it is necessary to protect sensitive and personal data. Using biometrics in addition to PINs, biometric techniques can potentially prevent unauthorized access to ATMs, cellular phones and laptops . figure 4 Biometrics Traits [5].
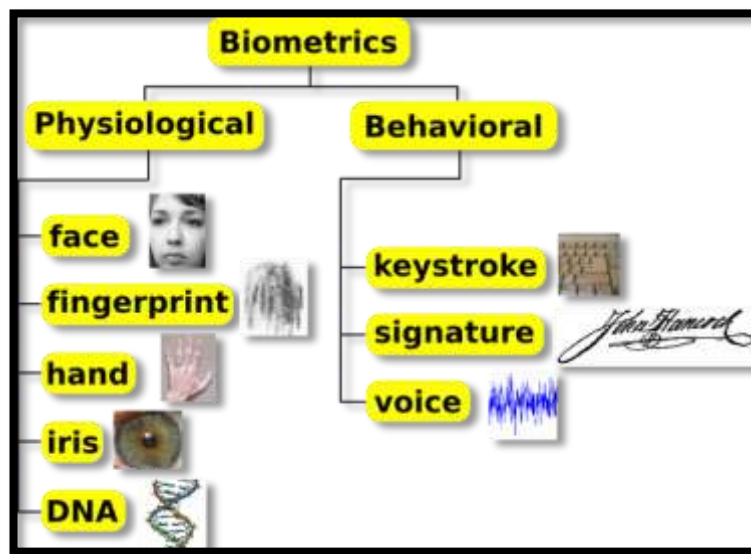
figure 6. Biometrics Traits [5]

3.3. Biometrics traits

This Door Lock Security System will also be introduced as a stand-alone module, where a password check becomes mandatory; such as in use for the access a wireless control of conveyer operating in an industrial environment or to operate a motor by using password. Biometrics traits can be divided into two part; physical and behavarial .physical traits are fingerprint ,face , iris ,vein pattern ,retinal scan , hand and finger geometry,DNA pattern , ear , palm print body odor. In the other hand behavarial traits are voiceprint gait signature, handwriting , keystroke dynamics ,acoustic emission. It is possible to understand if a human characteristic can be used for biometrics in terms of the following parameters or requirement[1]:

- Universality–everyone must have it.
- Uniqueness
- Permanence–time invariance.
- Collectability–can be measured quantitatively.
- Performance–high accuracy.
- Acceptability–user must accept.
- Circumvention–how easy to spoof

Table 1 Comparing various biometrics traits .

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Biometrics	Universality	Uniqueness	Permanence	Collectability	Performance	Acceptability	Circumvention
Face	High	Low	Medium	High	Low	High	Low
Fingerprint	Medium	High	High	Medium	High	Medium	Low
Hand Geometry	Medium	Medium	Medium	High	Medium	Medium	Medium
Iris	High	High	High	Medium	High	Low	High
Retinal Scan	High	High	Medium	Low	High	Low	High
Signature	Low	Low	Low	High	Low	High	Low
Voice	Medium	Low	Low	Medium	Low	High	Low
Facial Thermogram	High	High	Low	High	Medium	High	High

Material and Methodology 4.
Overview . 4.1

In this section the design of the papert biometrics lock, electronics components used, prototype design, and software used will be discussed and explained in further details. The main idea of the this device is to make sure that only authorized user, only those with valid fingerprint will be given the access, by using different techniques that depends on the software as well as the hardware. the device will be depending on the fingerprint module, where user will be instructed through an LCD display to input his fingerprint, and depending on the output of the fingerprint to the microprocessor, the door will be opened or not and further instruction will be given. This device is very easy to use, simple, and cheap compare to other biometrics door lock devices available in the market.

4.2 **DEVICE OPERATION**

Biometrics lock is simple and it is the electronic version of the conventional lock, it does the same job the conventional lock dose except it is more secure ,and it does not need the any kind of key or remembering the pin code to open the lock. It just needs the fingerprint of the user to open the door, simple the user fingerprint operate as the key for this lock; However when device in use, the first thing users have to do is to enrol themselves in to fingerprint module memory. This simply done by placing the user fingerprint in the fingerprint module simultaneously with pushing the enrol button. If enrolment is successful the user's fingerprint is in the memory but if not correct the user will be asked to place his fingerprint to enroll again. Hence to verify your fingerprint and open the door, fingerprint placed on the fingerprint module simultaneously with pressing the verification button, when the fingerprint is for a valid user, fingerprint will be verified and the door will open. However when fingerprint belong to an impostor or invalid user door will not be opened[6].

4.2.1 PROTOTYPE DESIGN

Biometrics lock has many features that require hardware design, software design, and prototype design, where each type of design needs to be linked to the other types. For software design, it needs hardware to be completed in order for the software to run successfully, similarly; the hardware needs mechanical design to be able to operate in a correct manner. This prototype design is to show the biometrics lock in an application. The prototype made of wooden material just to show the functionality of the biometrics lock. This biometrics lock is applicable to any door.

Figure 7. Prototype design

4.2.2 COMMAND DESIGN:

The communication between host and module must be coded as communication packet one communication packet include; packet head (2bytes),packet flag (1 byte),packet length (1 byte),packet content (N bytes),and checksum (1 byte).module waits for commands from host after it powered on Module will respond by a Rx correct packet after receiving the correct command. Module will perform operations according to the command and will return corresponding information after the operation is successful. When the Module is performing operation, it will not respond to other command given by HOST. If the check sum for the received command is wrong, the module will send back receive error response as follows in Fig. 7. shown below[9]:
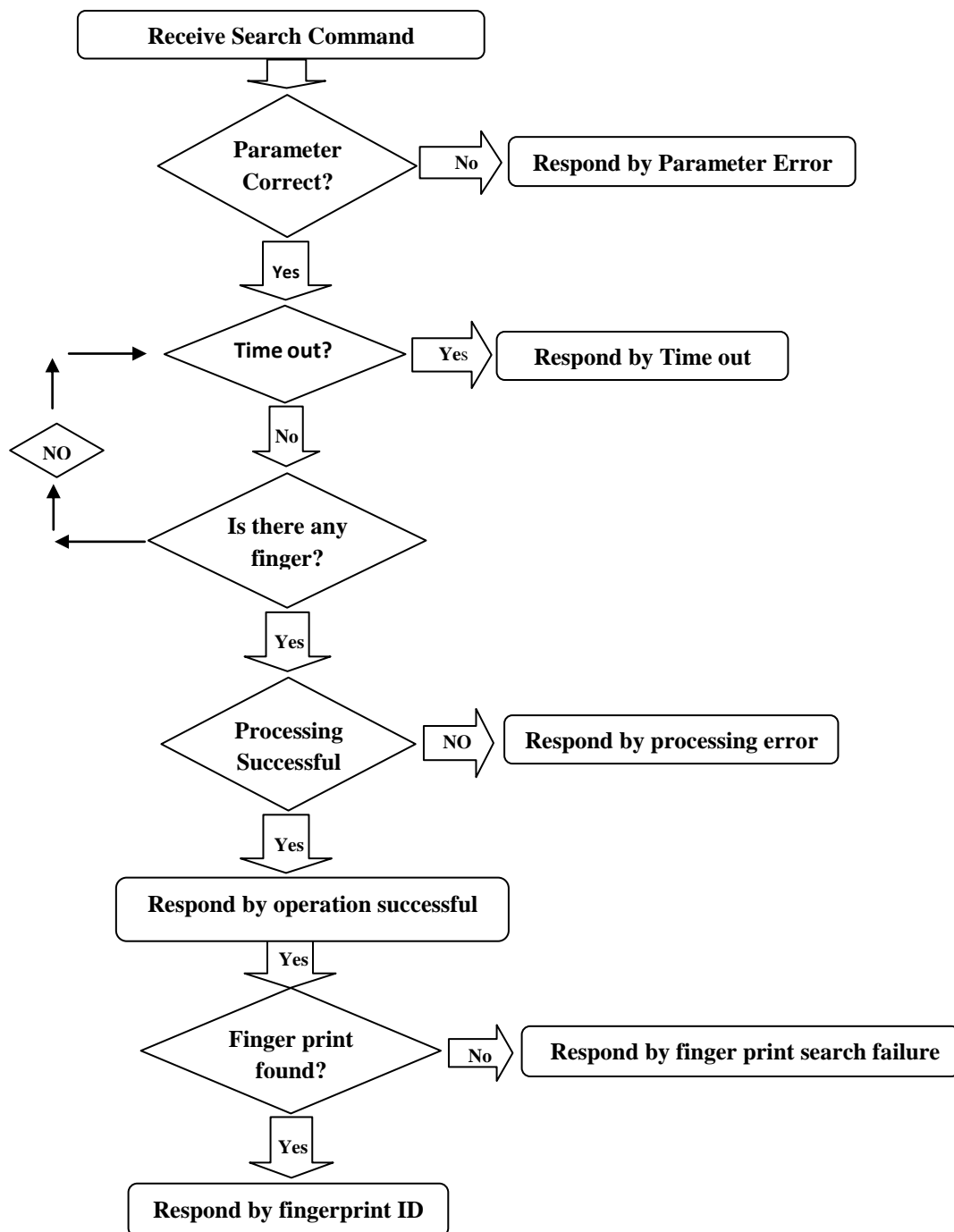
```
                    ┌─────────────────────────┐
                    │  Receive Search Command │
                    └────────────┬────────────┘
                                 ▼
                    ◇ Parameter ───No──▶ ┌──────────────────────────┐
                    ◇ Correct?  ◇         │ Respond by Parameter Error│
                                           └──────────────────────────┘
                                 │Yes
                                 ▼
              ┌──▶ ◇ Time out? ◇ ───Yes──▶ ┌────────────────────┐
              │                              │ Respond by Time out │
              │                  │No         └────────────────────┘
           ◇ NO ◇               ▼
              │         ◇ Is there any ◇
              └──────── ◇   finger?   ◇
                                 │Yes
                                 ▼
                    ◇ Processing ───NO──▶ ┌───────────────────────────┐
                    ◇ Successful ◇        │ Respond by processing error│
                                           └───────────────────────────┘
                                 │Yes
                                 ▼
                    ┌───────────────────────────────┐
                    │ Respond by operation successful│
                    └───────────────┬───────────────┘
                                 │Yes
                                 ▼
                    ◇ Finger print ───No──▶ ┌──────────────────────────────────┐
                    ◇    found?    ◇        │ Respond by finger print search failure│
                                             └──────────────────────────────────┘
                                 │Yes
                                 ▼
                    ┌───────────────────────────┐
                    │ Respond by fingerprint ID  │
                    └───────────────────────────┘
```

Figure 8. Command Design & Flowchart

4.2.3   ELECTRONICS DESIGN:

To start with the hardware part, the components must be studied to have a clear understanding about how they operate. The criteria of selecting the electronic components and how it affects the project will be discussed in this section, as well as the whole process of constructing the biometrics lock device. In our design we can see that the biometrics device consists of a fingerprint module, microprocessor, electromagnetic lock, push buttons, LCD display, transistors and relay. These electronic components complete each other. It is analogous to the conventional lock, where fingerprint act like the key, and fingerprint module acts like the bow which turns the lock to open. here in Figure 9. explains the block diagram for the device. [11].
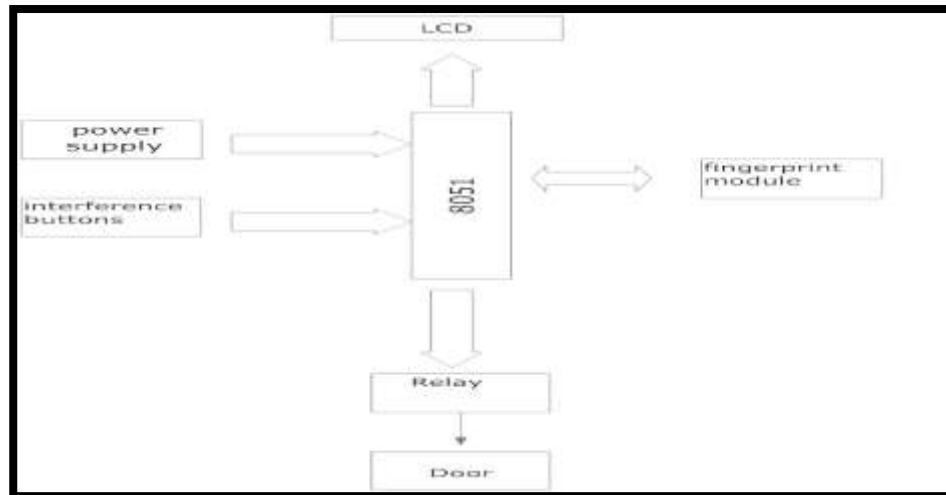
Figure 9. Block diagram of the door lock

4.3 FINGERPRINT MODULE:

It is an optical fingerprint verification module SM-630 Maxis; it consists of an optical fingerprint sensor, high performance DSP processor and flash. It has high adaption to fingerprint so that when capturing the fingerprint image, the image will automatically adjusted, hence image quality improved in case of dry or wet finger. It is a low cost sensor. This module operates with a low current <80mA, so low power consumption. The size of the module is small comparing with other types as shown in Figure below[10].

Figure 10 Fingerprint Module Miaxis SM-630

4.3.1 MICROCONTROLLER

AT89s52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. this device made by Atmel and it is compatible with the industry standard 80C51 instruction set and pin-out .this microcontroller can be reprogram because of the on chip flash .This microcontroller contains 40 pins which are divided into four ports, which are port0, port1, port2, and port3.Analog-to-Digital Converter (ADC) that converts the analog signal to digital signal in order for the microcontroller to be able to understand those signals. In this study, only three ports have been used as shown below in Figure 11. [12] .
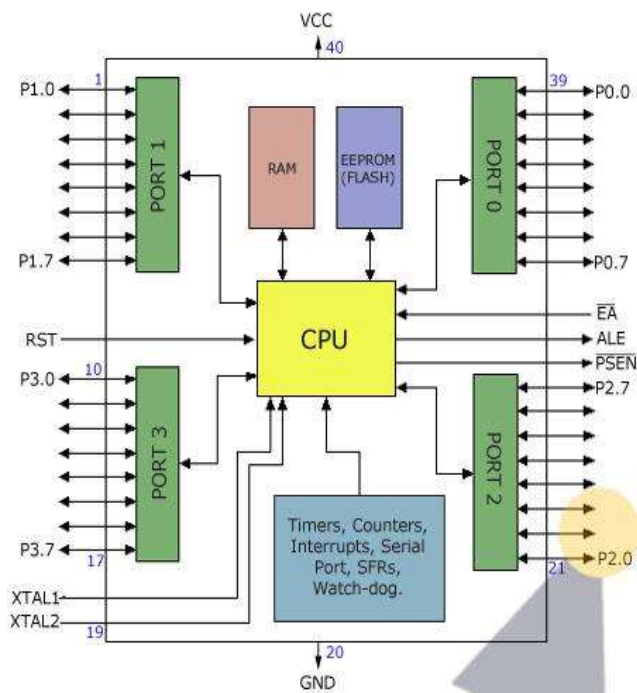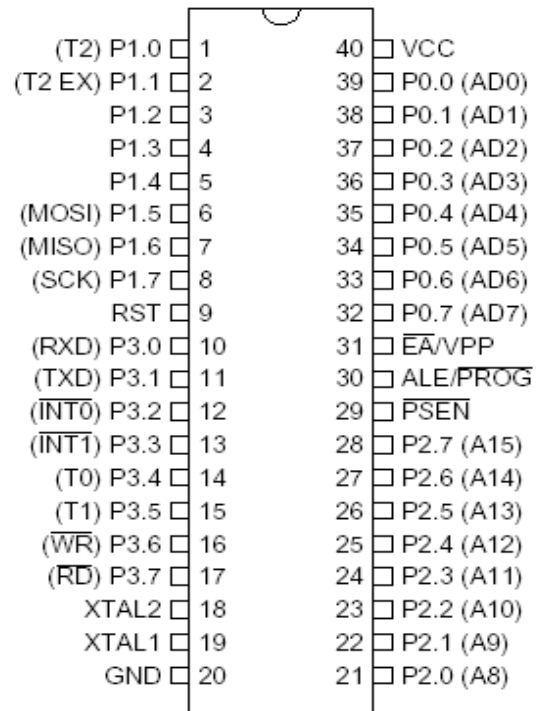
Figure 11. Block diagram AT89S5

Figure 12. AT89s2 Pin Configuration

AT89S2 microcontroller has been used to control the main operation of the circuit; it is considered the heart of the whole device. Figure above demonstrates the pin configuration of the AT89S2. It's connected to a 20MHz Crystal (pin 18 and 19) which works as an oscillator that regulate the clock inside the microcontroller, also it is connected to a reset button (pin 1) that allows resetting the microcontroller. However the main role for theAT89S52 microcontroller in this device is to control and coordinate the performance of the biometrics lock. For example when user want to open the door ,verify button will be pushed, thus microcontroller sends a signal to the fingerprint module asking for the verification of the fingerprint, now microcontroller will wait for the fingerprint module to verify the fingerprint .once fingerprint verified ,fingerprint module will send a signal to the microcontroller saying that this fingerprint is valid, microcontroller will allow enough current to pass to the relay, thus enough voltage to the electromagnetic lock, thus door will open [1].

4.3.2 LCD UNIT

LCD stands for liquid crystal display; it is made of slim, plane device made up of any number of color or monochrome pixels arrayed facing a light source or reflector. It is very good for these types of devices because of the low consumption of electrical power, so battery sources can be used [4].

Figure 13. LCD Display 2*16

4.3.3 RELAY AND RESPONSE

Relay is the component that makes low power circuit to turn a high current on and off, or control signals that has to be electrically isolated form controlling circuit, relay operate only when enough pull in and holding current passes through its energizing coils, current passing should be DC. Relay normally operates with low power supply, generally it varies between 5VDC to 12VDC and this is very suitable for small devices, which makes it suitable for biometrics lock. Basically the coils resistance will drive the pull in and holding current once it is connected to the power supply [10].
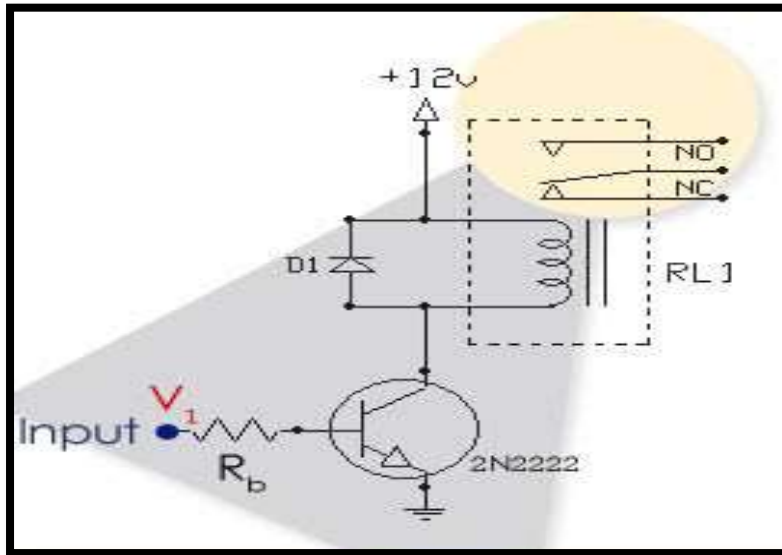
Figure 14. Driving Circuit for the Relay System[10]

4.4 . Device Manufacturing
Manufacturing of Printed circuit board (PCB)   4.4.1.

When it comes to manufacture process for this device, it's very necessary to determine how much access system is required to be produced depends on the market, this determination will help to chose what kind of advanced manufacturing process is required to complete the job, however in this system and after bearing in mind the measurements, we have used Trax-Macker, Eagle, Express PCB Cad soft to design the schematic diagram and the layout for this access system; [6].
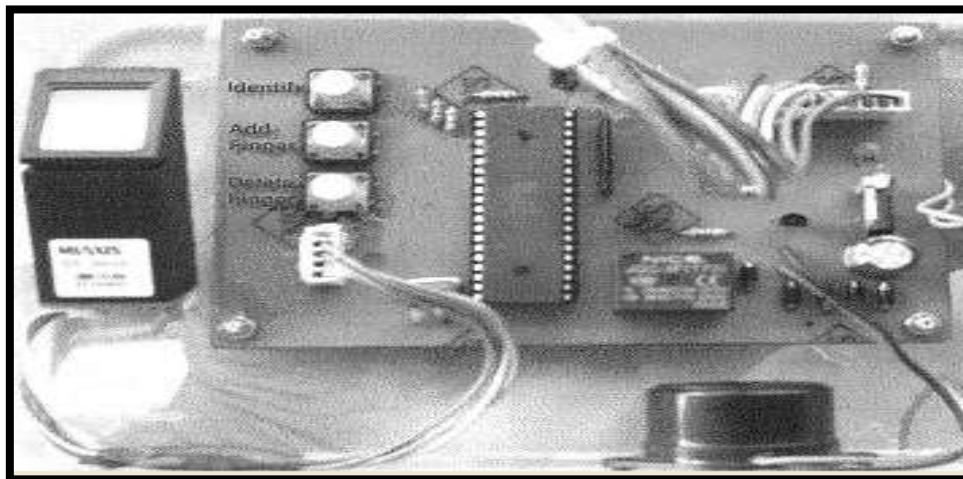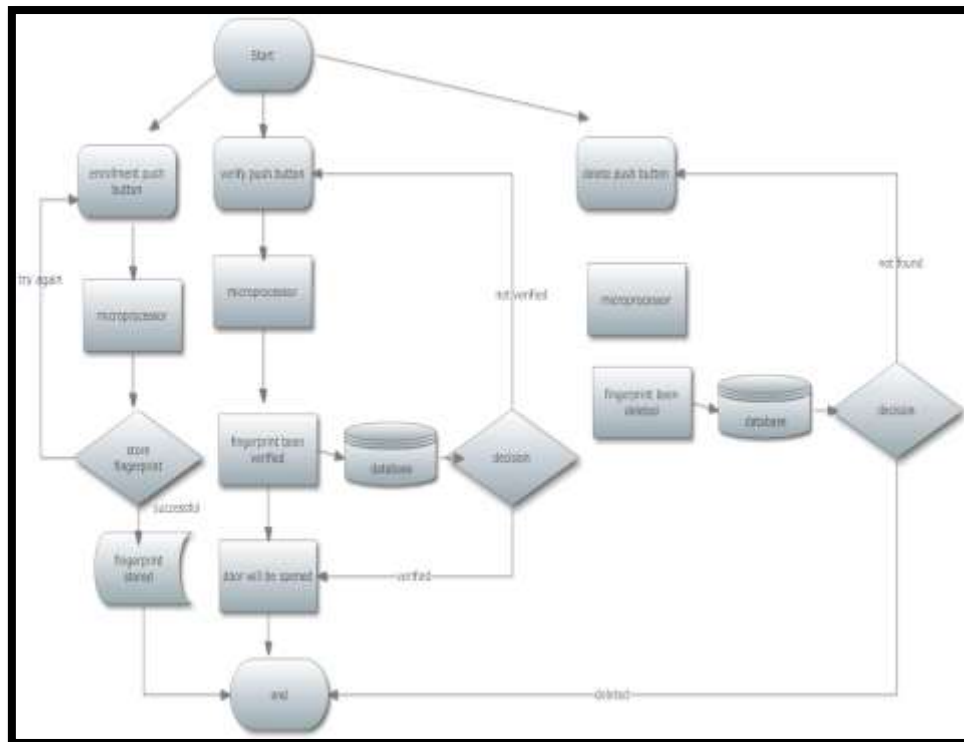

Figure 15. Fully Assembled PCB Circuit

4.5. SOFT WARE

The figure 16. shows the flowchart of the program .

4.6. SOFTWARE DESIGN

As mentioned earlier, the device uses AT89S51 microcontroller which need to be programmed in order to operate in a correct way. Certain elements are needed to accomplish this task, these elements are:

  a) -AT89S51Microcontroller.
  b) -Microcontroller Programmer.
  c) -Integrated Development Environment; or Compiler.
  d) -Source Code or Software generation.

AT89S51 has been described in details earlier, it's considered the heart of the whole paper, where it's the main component that process the user minutiae of fingerprint – and it's the main part that send the signal response to the relay, that's why it is considered the most important component in this device.

The Microcontroller Programmer is a device used to install the source code generated by the compiler into the microcontroller chip. The programmer used is standard handmade Programmer designed by the aid of AT89S51 datasheet, it consist of 2 parts which are the main board and ZAF-40 pins socket board where the microcontroller is attached, Figure 17 below shows both parts[13]:
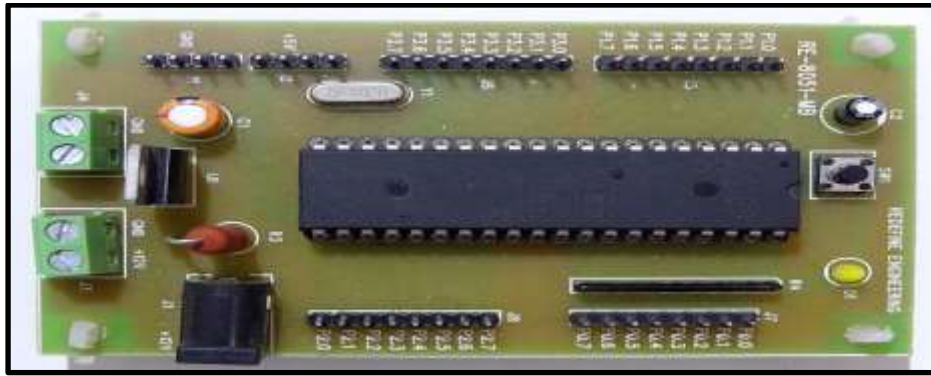
Figure 17: AT89S51 ISP-PORT Programmer [13]

Integrated Development Environment (IDE) or Compiler is computer software used to transfer the source code written by the user in computer language; into a different computer language (target language), it's also used to generate an executable code and free of mistakes. In this paper; the source code is written in assembly language which is a low-level language, and the compilers used are ISP- pgm3v0, and AT89Sxx Ks-Technologies which is plugged trough ISP Series LPT- Printer cable, each program have their own libraries, where in some cases they share the same library and compile the same code, and in other cases they totally differ in libraries and codes [13].
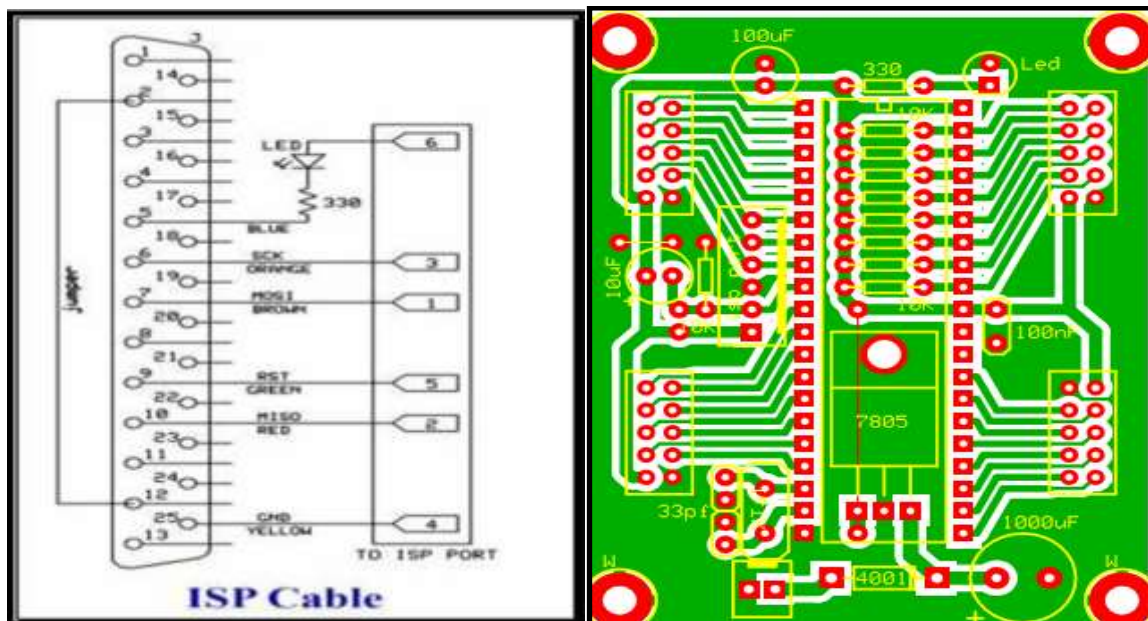

Figure 18: The ISP-Cable Connections & 8051 Simulation Board [13].

The main function of the needed source code is to control the Optical sensor and to interface the code with LCD registers. To write a source code correctly, generating an algorithm could be very useful, which allows the programmer to understand the steps sequence that should be written in the source code, also; the main parts of the program should be stated in steps. The steps of writing the source code for this paper are as following:

a) Include all of the needed libraries.
b) Define the Functions prototype and the variables
c) Write Interrupt prototype.
d) Start the main function.
e) Write other functions.
f) End of program.

5. RESULT AND DISCUSSION
An experiment is conducted for this project to test the functionality of the device. Testing the coordination of the components together .the functionality of the code and microprocessor and fingerprint module, and the relay.
5.1 TESTEING HARDWARE
In this section the hardware results and problems will be discussed, also the way of testing the circuit will be demonstrated, where before connecting the hardware parts in PCB, the hardware must be tested and made sure it works correctly.
5.2 MICROPROCESSOR TESTING
In microcontroller testing, there are few ways to make sure that the microcontroller is working. The first way is to connect the microprocessor to the microprocessor programmer (UIC main board) and start the installer software that installs the hex-file inside the microprocessor after starting the software; the software will automatically check if there is a microprocessor connected.

Figure 19. Integrated programmer environments

5.3 . TESTEING FINGERPRINT MODULE
Fist to ensure the functionality of the fingerprint module ,fingerprint module will be connected to power source ,make sure this power source does not exceed 6.5V,and should varies between 4.3 to 6V.make sure that the power connected properly to avoid an accidents. Fingerprint module's LED should light up.
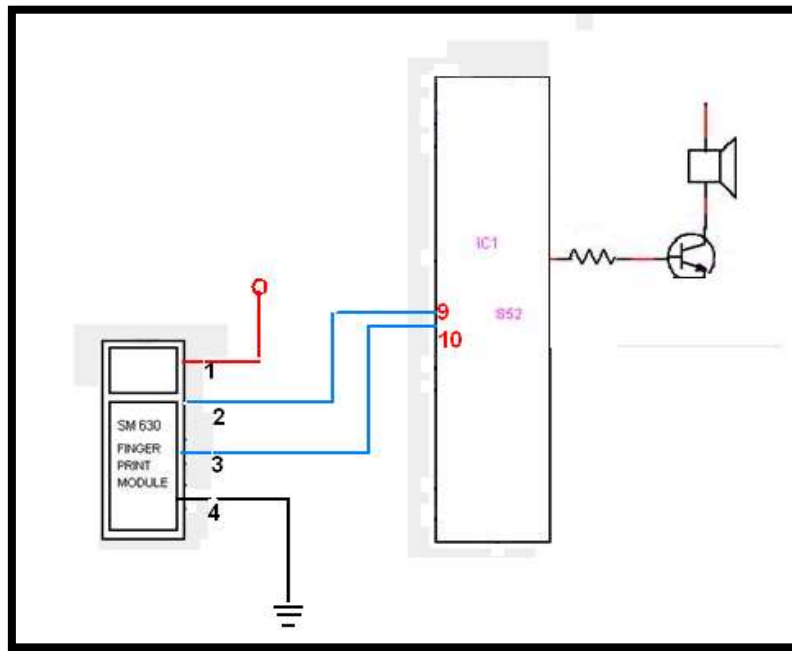
Figure 20. Fingerprint module testing

6. CONCLUSION AND RECOMMENDATION
6.1 CONCLUSION

Nowadays, there are two main types of lock, which are, the mechanical and the electronic lock. The conventional mechanical lock is limited and has a lot of downside compare to the electronic one .the mechanical one is limited with its keyway, where any lock with a keyway is susceptible to picking . There are many type of electronic lock with different way of operating method like, RFID, combination code, smart card, and biometrics. Each has its advantages and disadvantages. All of them user has to have a mean like a key in the case of mechanical lock or the card in the case of the smart card, or user need to remember a code for the case of the combination lock. However in this project biometrics locks overcome all the above limitation. And has better security compare to those locks.

6.2 Recommendation

The above developed system is quit versatile in nature. So many applications can be added with the same system by just little modification required. Attendance system module can also be interfaced with the same existing system which keeps the record (Identity, Time, Date etc.) of that person and corresponding data base can be maintained. example. Where there lot of students, and staff. This will help the students as well as the stuff or lecturers Same system can be implemented at high security area, where only selected Persons are allowed.

References :

[1]. Atmel.AT89S52 Datasheet. *Atmel* Corporation - Industry Leader in the Design and Manufacture http://www.slideshare.net/estherkakani/at89-s52 .

[2]. Gilbert Thio, Tham Kok Foong, Rajparthiban Kumar, L.K. Moey. "Design of RFID Proximity Security Door" School of Engineering, UCSI. (July 2007).

[3]. Grayson Robinson (2004).on crime prevention tips locks and burglary preventions available :www.co.arapahoe.co.us/.../Crime%20Prevention20Tips/Locks%20and%20Burglary%20Prevention .pdf.

[4]. Ixsuns.The Liquid Crystal Display. avaliable:http://www.ixsuns.com/matrix_pixel.htm.

[5]. Jain, A.K.; Ross, A.; Prabhakar, S. "An introduction to biometrics recognition" Dept. of Comput. Sci. & Eng., Michigan State Univ., USA.ISSN: 1051-8215 .(JAN 2004).

[6]. Jain, Prof. Anil K. Selected Topics in Biometrics avaliable:

http://www.cse.msu.edu/~cse891/Sect001/.

[7]. J.mesad (1995) on lock and key history   available: http://science.jrank.org/pages/3989/Lock-Key-History.html.

[8]. Mehmood, Muhammad Owais and Khawaja, Attaullah. "Firmware and Hardware Design of a Novel Door Locking System" Dept. of Electron. Eng., NED Univ. of Eng. & Technol., Karachi, Pakistan(2009).

[9]. Natalias.Biom426 avaliable :http://www.csee.wvu.edu/~natalias/biom426/

[10]. omron.PCb Relay avaliable: http://ecb.omron.com.sg/pdf/relay/power/G5LE.pdf

[11]. Public site (2000)on lock bumping available : http://lockbumping.org/#3 .

[12] . Pulford, Graham W. "Thumbler locks" in High-Security Mechanical Locks. san diego california , elsevier academic press,(2007,pp 31-138).

[13]. Selimis, G. Fournaris, A. Kostopoulos, G. Koufopavlou, O. "Softeare & hardware issues in smart card technology" Ultra Low Power DSP Group, IMEC Netherlands, Netherlands .(2009).

Appendix

Schematic Diagram for the Fingerprint Security Device