



Unique Authentication for Door Lock system through Bio Scanning-Finger Print Security System

Dilshad Mahjabeen¹, Moshir Rahman Tarafder²,

^{1,2}. Electrical and Electronic Engineering, Stamford University Bangladesh

dilshad@stamforduniversity.edu.bd

Abstract: *In the present world security is highly concerned and supreme issue to humans at home, workplace, hotels or anywhere. Bio scanning gives new security-conscious climate. Bio scanning verifies individuals based on their intrinsic physical or behavioral traits. The main function of this paper is to call attention to one of the bio scanning security systems-finger print door lock system. This security mechanism aims to put a stop to the threat in the event of stealing and fraud. Human fingerprints door lock system is incredibly unique with various key advantages such as non-repudiation, not transferable, not guessable. Also comparative analysis on various types of mechanical, electronic and bio scanning door lock security system and that of different types of bio scanning system are presented. In this work Arduino uno3 as our microcontroller is used for generating code as a part of functioning procedure. This paper mainly works with Arduino uno3 microcontroller based fingerprint door lock system and focuses on the supremacy of fingerprint door lock security system.*

Keyword: Bio scanning, Physiological Access, Finger print door lock, Arduino uno3 microcontroller, Comparative Analysis

I. INTRODUCTION

A security system means the protection method which operates through the coordination of interworking components and devices. To reduce the risk of purloining valuable items, it is utmost essential to apply security controls. Efficacious and authentic security is supreme condition to any purpose in workplace, home etc. The security measures aims at safety and protection of individual himself and personal property from hostile actions like theft, acts of vandalism, etc. Security system basically conceives different types like monitored security system, unmonitored security system, self-monitored security system, electronic security system, wireless security system, scanning or biometric base security system. In this paper, our main concern is bio scanning or biometric – finger print door lock security system for any purpose. Biometric security is a security mechanism that is operated by using some unique sign or organ sample of the human body to protect against burglars and other potential home intruders. It is currently the strongest and most accurate physical security technique that is used for identity verification. Bio scanning security provides high security and

assurance by unique recognition of individual's physical properties like face, iris, palm, finger print or ultra sonic sound [1-2]. Here our paper sketches the various issues related to finger print scanning system for door lock. Finger print door lock system is one of the greatest advancements of the digital-technical age. Some key factors accelerating the effectiveness like Quick and Accurate identification and authentication, best accountability, highly efficient, convenience, ability to scale, security and profitability, small template size easy to operate and user friendly. Passwords and codes usage for security access is pretty straightforward but generic. Anyone can access with a card or hack password. But biometric security technologies like finger print refers to the biological pass codes that cannot be forged and when someone tries to do it, he/she will get blocked and you will be notified. Moreover scanning is a quick and easy process. It will lessen the pressure of losing keys of house, car, hotel and many more and with a fingerprint door lock veracious personality will be granted access to desired home, office, or a hotel room. Another favor is that once the finger print biometric verification system is integrated, there's no need to invest in additional capital. This significantly cuts upfront and ongoing investment costs. Managing, fitting and even analyzing finger print biometric verification is very user-friendly – providing technological and accurate results with minimal need for intervention. For this the global scenario of biometric smart door lock system is getting priority as better options for secured door lock system the finger print biometric verification system is integrated, there's no need to invest in additional capital. This significantly cuts upfront and ongoing investment costs. Managing, fitting and even analyzing finger print biometric verification is very user-friendly – providing technological and accurate results with minimal need for intervention. For this the global scenario of biometric smart door lock system is getting priority as better options for secured door lock system [3-4]. In this paper section II represents literature review, section III describes the theoretical background, section IV deals with hardware methodology and section V highlights comparative analysis.

II. LITERATURE REVIEW

Various literature are published on finger-print recognition security system. Among them some noticeable are reviews here. Fernando L. Podio in his paper "Personal authentication through biometric technologies" strongly expressed that finger print is one of best the solution to authentication at home among bio scanning security system, from intelligent doorknobs to access rights to a per-view payment operation. The author announced biometric security system as a unique advantageous one, Because tokens, such as smart cards, magnetic stripe cards, photo ID cards, physical keys and so forth, can be lost, stolen, duplicated, or left at home. Passwords can be forgotten, shared, or observed. But biometrics promise to serve fast, easy-to-use, accurate, reliable, and less expensive authentication for a variety of applications. He identified some common characteristics to make a biometric system usable like distinguishable trait, user-friendly, low cost, quick and easy manner. Highlighting the commercial aspect, he mentioned that evidence of the growing acceptance of biometrics is the availability in the marketplace of biometric-based authentication solutions that are becoming more accurate, less expensive, faster and easy to use [4].

M. I. Efunbote, in his paper "Development and Experimentation of A Security Door Lock System Using Biometric Fingerprint Architecture" focused on the use of a biometric fingerprint sensor in creating a security platform door lock. A relay control unit was incorporated which served as a switch in controlling the door lock system. A PIC168F77A microcontroller was connected to the transistor that regulated the relay control unit. The system verified whether the scanned fingerprint was enrolled or not, it add and delete fingerprint functions for registered fingerprints. Their achievement performed as expected and the response time of the microcontroller unit was prompt, reliable, secured and accurate [5].

Volodymyr Rusyna, Sergey Subbotin and Aceng Sambasc in their paper "Simple Autonomous Security System Based On Arduino UNO Platform and Fingerprint Scanner Module: A Study Case" presented a simple autonomous security system. This security system is based on the Arduino Uno and fingerprint scanner module. The Arduino was connected to a computer through the USB port and programmed using a language similar to C++. Programming code (sketch) was uploaded into Arduino using program software ArduinoIDE. Their experimental realization results in fingerprint recognition more accessible and easy to make fingerprint collection, search, registration and comparison for different projects. This fingerprint

sensor module can be added to security systems, door locks, time attendance systems, and much more [6]. Arkajyoti Poddar, Somrup Roy, Subhasish Raha, Kusal Thakur, Tamojit Dasgupta, Dr Saikat Maity in their paper "Fingerprint Door Lock System with Temperature Sensor", proposed an advanced security system designed for the purpose of door locking. Arduino UNO, a fingerprint sensor, a servo motor, and some other hardware devices were used for implementing this project. Considering the rapid spread of coronavirus throughout the world, they had e tried to add a cost-effective LM-35 Temperature Sensor which would instantly check the body temperature while granting access. If the temperature is higher than the normal range then the person will not be able to enter but if it is alright then the person can enter. This door lock has dual purpose use: security and as well as for protection against covid-19 [7].

Kawser Wazed Nafi, Tonny Shekha Kar, Sayed Anisul Hoque, in his paper "An Advanced Door Lock Security System using Palmtop Recognition System" presented minutiae based palmtop recognition system for automatic door open and locking system by taking an image of the person, partitioning it, processing it and finally verifying the person using an electric circuit [8].

Salam Abeed Dahe, in his paper "Study conceptual design of biometrics technology in door lock" worked on finger print door lock system with 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 [9].

III. THEORY

Generally mechanical, electronic and bio scanning security system are used for security purposes at home, hotel or workplace. The distinguishing features of bio scanning security system are given in table 1 [10-11]. Bio scanning security system offers a well-protected means of accessing sensitive areas by identification of different parts of the body are thumbs, hand palm, faces, ears, fingers, iris etc. It eliminates the necessity of carrying a card or trying to remember different types of passwords. There are 2 types of biometric security system such as [12]:

1. Physiological access type security system: This type of system is also known as the Scanning base security system.
2. Behavioral access type security system: This type of system operates by using the unique behavior of humans

Table1: Comparison of Different Types of Security System

Types	Mechanical Lock System	Electronic Lock system	Bio scanning Lock system
Interface	Lock and Key	RFID card readers or pin code system	Key pad\Retina\Face etc.
Operational element	By the Key or puzzle combination	by means of an electric current	By the Key pad\Retina, Finger &Face Scanner etc
Function	Unlock by key or puzzle matching	Unlock by key or puzzle matching	Unlock by scanner& Keypad
Performance	LOW	HIGH	VERY HIGH
Strength	Moderate	High	Very High
Efficiency	Less Effective	Effective	Very High Effective
Cost	Low	Moderate	Expensive

The identification techniques of various physiological access type security systems are described in Table2 [13].

Table2: Identification Techniques of different types of Bio scanning system

Types	Identification
1.Face Recognition	By capturing face images by means of a video camera while image database investigations may require static intensity images taken by a standard camera
2.Iris recognition	Iris scanning detects the unique patterns in irises, the colored circles in people’s eyes, a set of pixels containing only the iris by illuminating the iris with visible and near-infrared light and finally compared to stored templates in a database for verification.
3.Fingerprint recognition	Fingerprint systems analyze the locations of "minutiae" – the endings and bifurcations of the friction ridges on the pad of your finger.
4.Palm\ Hand recognition	By using infrared light to map the unique vein structure of your palm, capturing over 5 million data points. The palm vein scanner then converts these data points into a unique encrypted code that becomes biometric ID.
5.Ultrasonic scanning	By using ultrasonic sensor technology it detects the intruders on their physical presence. An ultrasonic sensor can measure the distance to an obstacle within its conic beam

Biometric systems are great wherever identification and authentication are critical. Most typical use cases of biometric technologies [14]:

1. Law enforcement and public security (criminal/suspect identification)
2. Military (enemy/ally identification)
3. Border, travel, and migration control(traveler/migrant/passenger identification)

4. Civil identification (citizen/resident/voter identification)
5. Healthcare
6. Physical and logical access (owner/user/employee/contractor/partner identification)
7. Commercial applications (consumer/customer identification)
8. Law enforcement and public security (criminal/suspect identification)

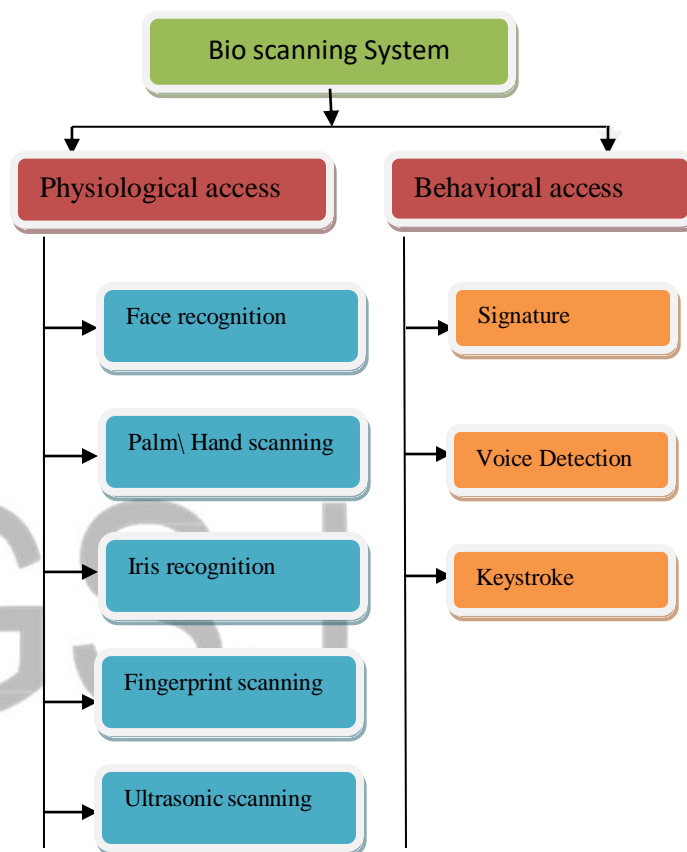


Fig. 1: Classification of Bio scanning system

9. Military (enemy/ally identification)
10. Border, travel, and migration control(traveler/migrant/passenger identification)
11. Civil identification (citizen/resident/voter identification)
12. Healthcare and subsidies (patient/beneficiary/healthcare professional identification)
13. Physical and logical access (owner/user/employee/contractor/partner identification)
14. Commercial applications (consumer/customer identification)
15. Having been an integral part of forensic operations for more than a century, fingerprint recognition always received more attention of technology experts than any other biometric modality. [14].

Fingerprint door lock is one of the promising bio

scanning door lock security system. Fingerprint door lock operates by scanning and converting your fingerprint data into a numerical template (Minutiae system). When someone places a finger on the sensor, it matches the data obtained through the finger with the pre-saved values. If a match is found, access is granted and the door opens [15].

IV. HARDWARE METHODOLOGY

The main sections that work in a fingerprint door lock system and the functionalities of each section are given below [16] –

Power unit: 12v DC (it can run via AC using a converter) supply is used for supply to Fingerprint reader, Microcontroller, LCD, Door lock and motor also.

Fingerprint reader: An optical scanner works by shining a bright light over your fingerprint and taking a digital photo (Minutiae system). Also capacitive scanner, ultrasonic scanner, and thermal line sensors can be used in fingerprint reader.

Computer: It generates code for microcontrollers so that it could be run according our way and could be modified in future. Then it is sent through a USB cable in the microcontroller.

USB serial converter: USB serial converter is a small electronic device which can convert a USB signal to serial data signals.

LCD display:: LCD display are used for see output message either the input is ok or there is some problem in the device or inputs.

Slide door: 12V DC supply driven electromagnet solenoid lock door is used. In this case, it holds the strike opening closed or allows the strike opening to swing open, thus allowing the door's lock latch to open without the lock latch being retracted.

The block diagram of working procedure a fingerprint door lock system is given in figure 2.

This technique relies on capturing an optical image, essentially a photograph, and using algorithms to detect unique patterns on the surface, such as ridges or unique marks, by analysing the lightest and darkest areas of the image. Then the output of scanner sends to microcontroller. In this system, input and output devices combined work by the fingerprint reader/sensor and the microcontroller. The user will enter a fingerprint in the fingerprint scanner which is connected to the door latch through the microcontroller. Optical scanner works is by shining a bright light over your fingerprint and taking a digital photo. The light-sensitive microchip makes the digital image by looking at the ridges and valleys of the fingerprint, turning them into 1's and 0's, and creates the user's own personal code. Arduino uno r3 as our microcontroller is used in this work for

generating code. The code is used for enrolled the users fingerprint for fingerprint door lock system.

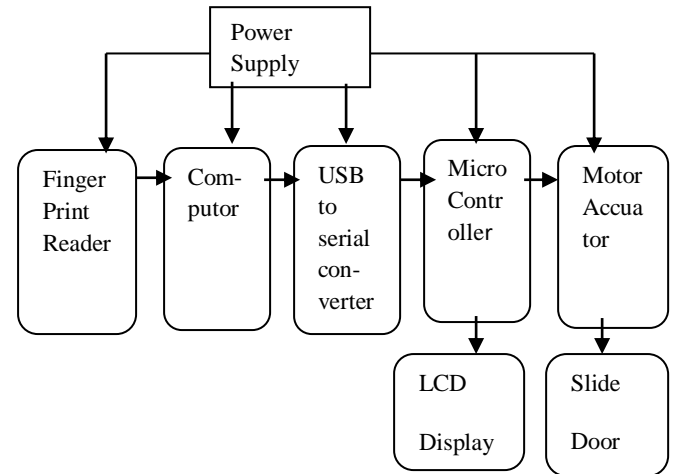


Fig. 2: Working procedure a fingerprint door lock system

After scanning the print, the system runs its database and looks for a match with the saved finger print to another which it wants to input, then it is authorized by matching with saved once by using minutiae system. If it matched, then it sent two signal ones in the LCD, another in the motor to open the door. If not matched, then it will send two signals: one to the LCD display to show that it is not matched and other to buzzer for alarm [16].

Connectivity issues: Functioning of smart locks will depend entirely on the connectivity having available. In most cases, the important thing that is needed to consider before buying smart locks is their connectivity. It may be of the following types:

i) Wi-Fi

Wi-Fi network and pairing it with a smart destination hub will enable to track who's coming and going, as well as lock or unlock of doors remotely from anywhere in the world.

ii) Bluetooth

A Bluetooth option has the same functionality as a Wi-Fi system, but using a Bluetooth connection doesn't drain your battery's charge as fast. So, batteries should last at least a year or more. Also, when using Bluetooth, locks will be directly connected to mobile device, so no smart destination hub is required to get them to work. Having a smart home hub will allow to centralize all smart destination equipments so that all can be accessed, monitored, and controlled everything from one app versus having to use multiple apps.

iii) Z-Wave

Z-Wave is another popular type of smart device connection method. A Z-Wave connection uses a compatible smart destination hub to communicate with a smart device's signal, then turns that signal into a readable command that your router understands. The only difference is that a Z-Wave connection doesn't connect directly to mobile device. However, once the

connection happens, it can be accessed, monitored, and controlled smart locks remotely from anywhere in the world [17].

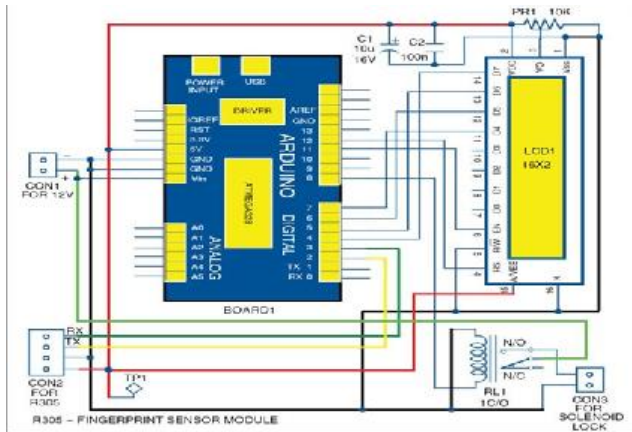


Fig.3: Connection diagram of fingerprint door lock system

The connection diagram of fingerprint door lock system is shown in figure 3. The above connections work in the following manner-

- The 14 digital input/output pins used as input or output pins by using pin Mode (), digital Read () and digital Write () functions in Arduino programming. Each pin operates at 5V and can receive a maximum of 40mA current. Out of these 14 pins, some pins have specific functions as listed below:
- Serial Pins 0 (Rx) and 1 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- External Interrupt Pins 2 and 3: These pins are configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM Pins 3, 5, 6, 9 and 11: These pins provide an 8-bit PWM output by using analog Write function.
- SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK): These pins are used for SPI communication.
- In-built LED Pin 13: This pin is connected with a built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off. Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference () function. Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library. Arduino Uno has a couple of other pins, AREF Used to provide reference voltage for analog inputs with analog Reference () function and Reset Pin Making this pin LOW, resets the microcontroller.

- Arduino used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a (.inf) file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the Arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer. A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. As the Arduino uno r3 microcontroller needs a code to run the program, a coding software called Adafruit is used because it is easy to understand and flexible for doing work [18]

V. COMPARATIVE ANALYSIS

The comparative analysis of various bio scanning security systems [19-20] is given in Table 3.

Table 3: Comparative Analysis of Various Bio scanning Security Systems

Features	Face	Iris	Palm	Voice	Finger Print
Precision	L	H	H	M	H
Covenient	H	M	H	H	M
User accaeptance	H	M	M	H	M
Distinctiveness:	M	H	M	M	M
Complexity	M	M	H	H	L
Ubiquity	H	H	H	H	H
Perceptiblity	H	H	H	M	H
Comparison	H	H	L	L	H
Collect capacity	H	H	L	L	H
speed,	M	H	H	M	H
stability	l	M	H	L	L
Size	Large	S	M	S	S
Authentication levelLevel	L	M	H	L	L
Cost	H	H	M	M	L

*L=Low, *H=High, *M= Medium, S=Small

In Table 3, comparison of bio scanning types is based on the characteristics of biometric entities. All these techniques are easy to use. Also the management issue factors are simple and cost effective. The key

issues that are considered for a smart bio scanning door lock security system [21] are

1. Best for security.
2. Best smart features
3. Best keyless touch screen
4. Budget connectivity
5. Economical

Considering the above issues, among all bio scanning security system, from table3, Finger Print is considered one of the safest key to lock or unlock any system because

1. Best of security: It can recognize any person uniquely and can't be copied easily. It is the most accurate details of any person and is the easiest and convenient way of identifying a person. It remains the same for a person throughout his/her life, making it an infallible method of human identification.
2. Best smart features:
 - i. In this technique, data can be collected and quantified at high speed
 - ii. It is easy to use.
 - iii. It uses of small storage space
 - iv. It has longer stability and fairly has slower rate of invariant
 - v. It has a quick and easy installation process

3. Best Keyless touch screen: It is an excellent choice of keyless touch screen.

4. Budget connectivity: It provides best connectivity through WiFi, Bluetooth and Z-wave.

5. Economical: Finger print bio scanning is undoubtedly economical for the following reasons

- i. While price can vary significantly depending on the type of scanner, fingerprint is generally a very cost-efficient technology. This makes it particularly suitable for mass-production, hence its popularity as the go-to biometric in virtually all modern smartphones.
- ii. Taking in to account the factors: styles, materials, size, automation, detail treatment and surface treatment, fingerprint door lock system is undoubtedly economical.
- iii. Biometric access control systems can save companies money by reducing the need for dedicated security staff to man access points.
- iv. Access control systems that use physical tokens such as keycards and fobs incur an extra hidden cost: lost token replacement rate.
- v. The cost of potential security breaches outweighs the previous costs by an order of magnitude.

VI. CONCLUSION

There are several key reasons why fingerprint door lock security system is such a popular choice for access control. Traditionally, there is a tradeoff in convenience when switching to more secure technologies, but fingerprint door lock security system one of the few examples of a security upgrade that also increases convenience. It's the best of both worlds. fingerprint door lock security system is quickly becoming the go-to choice for access control purposes. Military-grade security combined with increased convenience and reduced costs make it an obvious choice over traditional access systems. Now-a-days multimodal biometrics combines several biometric sources to increase security and accuracy. The most well-known techniques include fingerprints, face recognition, iris, palm, and DNA-based recognition. Multimodal biometric systems usually require two biometric credentials for identification, such as face and fingerprints, instead of one. They can overcome limitations commonly encountered in uni-modal systems.

FUTURE SCOPE

The future of Fingerprint based locks is likely to lie in simplicity. Improving modern methods is the easiest way to provide a high level of protection. In future, following scopes are open to prove finger print door lock system the best candidate among all bio scanning security system

- Introduction of scan a 3D image of a fingerprint and analyze all of its minutiae.
- A fingerprint mismatch can be conveniently regarded as an attempt of illegal access In the wake of such unratified event, an adjunct siren alarm may be initiated to reveal possible theft.
- Mobile biometrics and cloud biometrics in finger print door lock system may prove fingerprint technology as one of the prominent biometric recognition methods.

REFERENCES

- [1] Sheikh Imroza Manzoor; Arvind Selwal, " An Analysis of Biometric Based Security Systems" 2018 Fifth International Conference on Parallel, Distributed and Grid Computing (PDGC) DOI: 10.1109/PDGC.2018.8745722
- [2] Ujwalla Gawande, Yogesh Golhar "Biometric security system: a rigorous review of unimodal and multimodal biometrics techniques", International Journal of Biometrics 10(2):142, January 2018 DOI:10.1504/IJBM.2018.10012749
- [3] Kavita Gupta, "Review Paper on Biometric Authentication", International Journal of Engineering Research and Technology (IJRET), VIMPACT-2017, Vol.5, Issue 23.
- [4] Biometrics - Technologies for Highly Secure Personal Authentication, NIST publication, May, 2011.

- [5] M. I. Efunbote, M.B. Adeleke, O. Fagbemi, O. A.Orelaja,R.A.Jokojeje,” Development and Experimentation of a Security Door Lock System using Biometric Fingerprint” ,International Journal of Recent Research in Electrical and Electronics Engineering (IJREEE), Vol. 5, Issue 3, pp: (6-15), July – September, 2018.
- [6] Volodymyr Rusyna , Sergey Subbotinb and Aceng Sambasc,”Simple Autonomous Security System Based on Adrino UNO Platform and Fingerprint Scanner Module: A Study Case”,CMIS-2021: The Fourth International Workshop on Computer Modeling and Intelligent Systems, April 27, 2021]
- [7] Arkajyoti Poddar1,Somrup Roy2,Subhasish Raha3,Kusal Thakur4,Tamojit Dasgupta5,Dr Saikat Maity6, “Fingerprint Door Lock System with Temperature Sensor”, IOCER 2020, Journal of Physics: Conference Series 1797 (2021)
doi:10.1088/1742-6596/1797/1/012052]
- [8] Kawser Wazed Nafi , Tonny Shekha Kar , Sayed Anisul Hoque, “An Advanced Door Lock Security System using Palmtop Recognition System”, International Journal of Computer Applications (0975 – 8887) Vol. 56, Issue No.17, October 2012.
- [9] SA DAHE, Study conceptual design of biometrics technology in door lock security system” “Journal of Kerbala University, Vol.13,Issue No.3 Scientific, 2015 .
- [10] S. O. Anaza , J. D. Jiya , Y. S. Haruna, “A Review of Intelligent Lock System, American Journal of Engineering Research (AJER) , Vol.6, Issue-6, pp-09-15,2015
- [11] Nayana , Shashidhar ,”Smart Door Lock System”, International Journal for Modern Trends in Science and Technology,Vol.05,Issue-02, February, 2019.
- [12] Shilpa Shrivastava, “ Biometric: Types and its Applications”, International Journal of Science and Research (IJSR), (NCKITE), 10-11 April 2015.
- [13]Israa Alsaadi,Physiological Biometric Authentication Systems, Advantages, Disadvantages and Future Development : A Review” December 2015,International Journal of Scientific & Technology Research, Vol.4,Issue12,,December 2015.
- [14]Biometrics: definition, use cases and latest news – Thales
- [15] Hashem Alnabhi, Yahya Al-naamani, Mohammed Al-madhehagi, Mohammed Alhamzi, Enhanced Security Methods of Door Locking Based Fingerprint, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Vol.9, Issue-3, January 2020.
- [16] Malabika Sarma, Amlanjyoti Gogoi, Rahul Saikia, Dibya jyoti Bora, “Fingerprint Based Door Access System using Arduino”,International Journal of Scientific Research in Engineering and Management (IJSREM),Vol.4,Issue-8, August 2020.
- [17] Ilkyu Ha, “Security and Usability Improvement on a Digital Door Lock System based on Internet of Things” ,International Journal of Security and its Applications 9(8):45-54,Augusr,2015.
- [18] Connection Diagram of Finger Print Door Lock System.

<https://www.electronicsforu.com/electronics-projects/hardware-diy/arduino-fingerprint-door-unlock-system>.

- [19] Mohammad Al Rousan, Benedetto Intrigila, A Comparative Analysis of Biometrics Types: Literature Review,Journal of Computer Science,Science publication,2020

DOI: 10.3844/jcssp.2020.1778.1788

- [20] T.Sabhanayagam , V. Prasanna Venkatesan, and K. Senthamaraiannan, “A Comprehensive Survey on Various Biometric Systems”, International Journal of Applied Engineering Research ISSN 0973-4562 Vol. 13, Issue- 5 (2018) pp. 2276-2297.

- [21] Wencheng Yang, Song Wang, Jiankun Hu , Guanglou Zheng and Craig Valli ,”Security and Accuracy of Fingerprint-Based Biometrics: A Review”, Symmetry 2019, 11, 141; doi:10.3390/sym11020141



Dr. Dilshad Mahjabeen was born on December 23, 1978 in Dhaka, Bangladesh. She received her Bachelor of Science (B.Sc), in Applied Physics and Electronics, from the University of Dhaka, Bangladesh, in 2000. She completed her Master of Science (M.Sc), in Applied Physics and Electronics, from the University of Dhaka, Bangladesh, in 2001. She was awarded Doctor of Philosophy (PhD) with the title” “Interoperability between 3G and 4G: Design and Deployment of WiMAX and LTE (Long Term Evolution)” in 2012.

In 2006, she joined the Department of Electrical and Electronic Engineering in World University of Bangladesh, as a Lecture. Then she became the faculty member of Department of Electrical and Electronic Engineering in Stamford University Bangladesh in 2007 and is continuing till now as Associate Professor. Her research interests lay in the area of advanced areas of wireless communication specially WiMAX and LTE, renewable energy, smart electronic technology. She has more than 20 journal papers, out of which six are international and many conference papers.



Muhammad Moshir Rahman Tarafder was born in Khulna, Bangladesh in 1985. He received the B.Sc Engineering degree in Electronics and Communication Engineering from Khulna University, Bangladesh in 2007. Currently he is pursuing M.Sc. in Electrical and Electronic Engineering from Dhaka University of Engineering and Technology.

In 2007, he joined the Department of Electrical and Electronic Engineering at Stamford University Bangladesh as Lecturer and in 2010 he became Assistant Professor. His current research interest includes power electronics, electrical drives, smart power management, and renewable energy.