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Design and Implementation of Smart Lock by Using Near Field Communication Technique

A project

Submitted to the Department of Communication University of Diyala-College of Engineering in Partial Fulfillment of the Requirement for Degree Bachelor in Communication Engineering

BY

ZAHRAA SALIM HASSAN

THARYAT ABD ALLAH

Supervised by

Ass. Lect. ALI Mohammed Salih Mohammed Kadhim

2016

Supervisor Certificate

I certify that the preparation of this project entitled " **Design and Implementation of Smart Lock by Using Near Field Communication Technique "** was made under my supervision in the **Communication Engineering Department In The University Of Diyala** as a partial fulfillment of the requirement needed for the award of the **B.Sc** degree in **Communication Engineering.**

Signature

Name **:Ali Mohammed Salih**

Title : **Ass.Lecturer**

Supervised

Data : / /2016

SUPERVISORS CERTIFICATION

We certify that the preparation of this project entitled "**Design and Implementation of Smart Lock by Using Near Field Communication Technique**", was made under our supervision at Communication Engineering Department/College of Engineering in Diyala university by (**ZAHRAA SALIM &THAREAT ABDALLAH**) as a partial fulfillment of the requirements for the degree of B.Sc. in Communication Engineering.

Signature:Signature:

Name: **Ali Mohammed Salih**

Title: **Ass.Lecturer**

Date: / / 2016

In view of the available recommendations, I forward this project for debate by the examining committee.

Signature:

Name: **Dr.Montadar Abas Taher**

(Head of the Department)

Title: Lect.Doctor

Date: / / 2016

CERTIFICATION OF THE EXAMINATION COMMITTEE

We certify that we have read this project entitled "**Design and Implementation of Smart Lock by Using Near Field Communication Technique**" and as examining committee examined the students (**ZAHRAA SALIM & THAREAT ABDALLAH**) in its contents and that in our opinion it meets the standards of a project for the degree of B. Sc. in Communication Engineering.

Signature :

Name :

Title :

Date: / /2016
(Member)

Signature:

Name:

Title:

Date: / /2016
(Member)

Signature :

Name :

Title:

Date: / /2016
(chairman)

Approved for Communication Engineering Department.

Signature:
Name: **Dr.Montadar Abas Taher**
(Head of the Department)

Title: Lecturer
Date: / / 2016

قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ (32)

سورة البقرة

صدق الله العلي العظيم

Dedication

To

Our Parents

Acknowledgement

We Wish To Thank Our Family For Their Understanding And Support Including Our Parents , Siblings , Our Big Family And Our Friends Inside And Outside University. We Wish To Express Our Deepest Gratitude To Our Supervisor Ass. Lect. **Ali Mohammed Salih Mohammed Kadhim** For His Guidance And Friendship During Our Study. And At Last We Want To Thank The Department Of Communication For Giving Us The Chance To Work On As A Fine Project As This One.

ABSTRACT

Near field communication (NFC) technology lets smart phones and other enabled devices communicate with other devices containing a NFC tag. Contactless communication allows a user to wave the smart phone or an NFC tags over another NFC compatible device to send information without needing to touch the devices together or go through multiple steps setting up a connection. The Near field communication technology is used to manufacture a high-security smart electronic lock that allows only the authorized person who hold the smart electronic NFC key to access. The design of the smart NFC lock is implemented by using NFC Module that is compiled with Arduino microcontroller, NFC tags, LCD, and a high-robustness electric lock. The whole system is powered by a very efficient solar energy system to eliminate the need to use an external power source. The NFC smart lock can be employed as one of the concepts of implementing the security systems of the modern smart cities.

As a second important result of our project is the realization of the encryption system of the graduation documents data and then storing the encrypted data on smart NFC tags, this result is obtained by amending the design of the above-mentioned system. The NFC encryption system can be utilized as one of the measures to prevent the illegal counterfeit attempts of documents in Iraqi universities, institutes, and in future electronic government.

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LIST of ABBREVATIONS

Abbreviation	Abbreviated Words
NFC	Near Field communication
RF	Radio Frequency
RFID	Radio Frequency identification
API	Application Program Interface
IRDA	Infra-red Data Association
NDEF	NFC Data Exchange format
SPI	Serial Peripheral Integrated
IIC	Inter-Integrated Circuit
UART	Universal Asynchronous Receiver/Transmitter
LCD	Liquid-Crystal Display
SDA	Serial Data line
SCL	Serial Clock line
CRT	Cathode ray tube
NC	Normally Closed
NO	Normally Open

CHAPTER ONE

INTRODUCTION

CHAPTER TWO

THEORETICAL CONECPTS

CHAPTER THREE

EXPERIMENTAL WORK

CHAPTER FOUR

RESULTS AND CONCLUSIONS

1.1 Introduction

A smart lock system is an equipment that uses the digital information such as a secret code, semi-conductors, smart card, and fingerprints as the method for authentication instead of keys in the traditional lock systems. They are considered as high Security systems that used to secure buildings such as banks and security forces institutes. Specially the system which depends on a wireless communication technologies to transfer the authentication code through the air such as wireless Remote control system of cars. But the main drawback of these systems is the long distance between the controller and the target door; This long distance allows the eavesdropper to detect the authentication signal and to copy it to be used illegally later by using the modern detection technology, in contrast with the case of Near Field Communication (NFC) technology. The Near Field Communication technology is a short-range (for up to four centimeters) contactless RF (radio frequency) communication standard. The technology allows a simple, rapid, intuitive and easily securable communication between two electronic devices. NFC relies on RFID technology (radio frequency identification), which has been widely used for over 30 years and has reached a high level of maturity[1].

The first two letters, “NF”, stand for “near field” and correspond to physical notions of propagation of electromagnetic fields. Thus, the “near-field” merely reflects a technical choice for two devices to communicate over very short distances, for security reasons, ease of implementation and low power consumption. This choice was made on RFID HF (High Frequency) 13.56 MHz technology that has been used for contactless smart cards and met an acceptable compromise to meet the functional and technical requirements [2].

By 2000, the introduction of the first integrated circuits specifically designed for contactless card readers has led some experts to think of other possible applications then simple card & reader communication. Ideas rang out from all stakeholders, especially that to make communicate two readers together on short distances and bilaterally or peer to peer [1].

Then the proliferation of mobile phones and contactless payments and transportation cards led to thinking of smart services emulation or contactless connection functions, thus the need to make the coexist of the different techniques in one unit is emerged, capitalizing on the installed base of

contactless readers and existing applications. So, it is considered as the birth of NFC technology development [3].

The NFC technology defines three communication modes, as illustrated next:

- **Peer-to-Peer**:- this mode is defined for device to device link-level communication.

- **Read/Write** :- this mode allows applications for the transmission of NFC Forum-defined messages.

- **NFC Card Emulation** mode allows the NFC-handset behave as a standard Smartcard. This mode is secure. This mode is supported by the contactless communication API (Application Program Interface) [4].

NFC is the perfect solution to automate the personal and professional lives. It is an evolved version of radio-frequency identification technology. It enables various devices to participate in two-way communication to share information for the purpose of monetary transactions, programming functions and identity verification. This technology typically has a maximum operating range of a few inches, which allows it to be both versatile and secure [5].

NFC technology is very similar to the technique ofdata exchange using infrared radiation and Bluetooth technology, but it is much faster and safer than previous techniques, the NFC device works directly without the need to search for the target and the many powers required in Bluetooth technology and infrared rays device. The technology requires to bring the NFC devices just enough to complete the requested operation. The users must have the devices near from each other to transfer data-enabled NFC to not more than 4 cm and this gives greater security in data transfer and even overlap with any other nearby devices [4].

NFC technology that makes it easy to connect the two devices is also helping this wonderful technology to share photos, music files, information, contacts numbers immediately and help to communicate more with the other

people. A comparison of specifications of NFC, RFID, IrDa (Infrared Data Association) and Bluetooth communication technologies is given in table (1.1).

Table 1.1:- Comparison of Communications technologies Specifications [4].

	NFC	RFID	IrDa	Bluetooth
Set –up time	<0.1ms	<0.1ms	~O.5s	~6 sec
Range	Up to 10cm	Up to 3m	Up to 5m	Up to 30m
Usability	Human centric Easy, intuitive, fast	Item centric Easy	Data centric Easy	Data centric Medium
Selectivity	High, given, security	Partly given	Line of sight	Who are you?
Use cases	Pay, get access, share, initiate service, easy set up	Item tracking	Control & exchange data	Network for data exchange, headset
Consumer experience	Touch, wave, simply connect	Get information	Easy	Configuration needed

1.2 The Aim of the Project:-

The project aims to design and to implement an electronic smart lock by utilizing the near field communication technique, Arduino microcontroller and a reliable electrical lock in order to manufacture a high security system that depends on the NFC technology to secure the future smart cities institutes and buildings.

2.1 Introduction

In this chapter, the Near Field Communication technique (NFC) and the Radio frequency identification (RFID) theoretical concepts will be explained, furthermore, the technical specifications and the physical description of the elements that are used to implement the smart lock project will be mentioned in the next pages.

2.2 NFC and RFID Technologies

Near Field Communications (NFC) is short-range wireless communication technologies, typically requiring a distance of 10cm or less, for two devices such as smartphones or the similar things like NFC devices and tagsto be very close to each other to establish communication as shown in figure (2.1). NFC is a communication technology that is developed from RFID technology, and the NFC technology is considered as a more up-close-and-personal type of wireless communication technology[6].

Fig. (2.1): NFC Communication of Money Transaction between Smart Phone and NFC Payment Machine [6].

By definition, RFID is the method of uniquely identifying items using radio waves. RFID enables a one way wireless communication,

typically between an unpowered RFID tag and a powered RFID reader. RFID tags can be scanned at distances of up to 100 meters without a direct line of sight to the reader and as such RFID is used globally for asset tracking in warehousing, airport baggage handling, livestock identification and much more. RFID operates at a range of radio frequencies each with their own set standards and protocols[3].At a minimum, an RFID system comprises a tag, a reader, and an antenna. The reader sends an interrogating signal to the tag via the antenna, and the tag responds with its information. RFID technology primarily operates at three frequency ranges [7]:

- Low Frequency (LF) 125 -134 kHz.
- High Frequency (HF)13.56 MHz.
- Ultra High Frequency (UHF) 856 MHz to 960 MHz.

Near-field communication devices operate at the same frequency (13.56 MHz) as HF RFID subset. The standards and protocols of the NFC format is based on standards outlined in ISO/IEC 14443, FeliCa, and the basis for parts of ISO/IEC 18092. These standards deal with the use of wireless communications for proximity cards [6].

As a developed version of HF RFID, near-field communication devices have taken advantage of the short read range limitations of its radio frequency. Because NFC devices must be in close proximity to each other, usually no more than a few centimeters, it has become a popular choice for secure communication between consumer devices such as smartphones [7].

Peer-to-peer communication is a feature that sets NFC apart from typical RFID devices. An NFC device is able to act both as a reader and as a tag. This unique ability has made NFC a popular choice for contactless payment, a key driver in the decision by influential players in the mobile industry to include NFC in newer smartphones. Also, NFC smartphones pass along information from one smartphone to the other by tapping the two devices together, which turns sharing data such as contact info or photographs into a simple task. Also, NFC devices can read passive NFC tags, and some NFC devices are able to read passive HF RFID tags that are compliant with ISO 15693 standard. The data on these tags can contain commands for the device such as opening a specific mobile application. In addition, NFC-enabled phones offer both businesses and day-to-day users slick and intuitive communication between mobile phones and between a

mobile phone and an NFC tag. Examples include file sharing via Android Beam, instant connection setups between electronic devices and the ability to link everyday objects such as posters to online content [3].Unlike RFID versions, NFC readers aren't always specialized devices. As a matter of fact, NFC chips is incorporated smartphone's circuitry. With the widespread reach of NFC phones, NFC tags could one daywillappear in a flood of products and promotional items where bits of digitized information might come in handy [4].

2.3 The NFC Smart Lock System Design

The NFC smart lock system is designed by using the following elements: NFC tag, NFC reader module, Arduino UNO microcontroller, solar energy supplier unit, relay and high reliability electrical lock as illustrated in figure (2.2), each of the above mentioned component will be explained in details in the next sections [8].

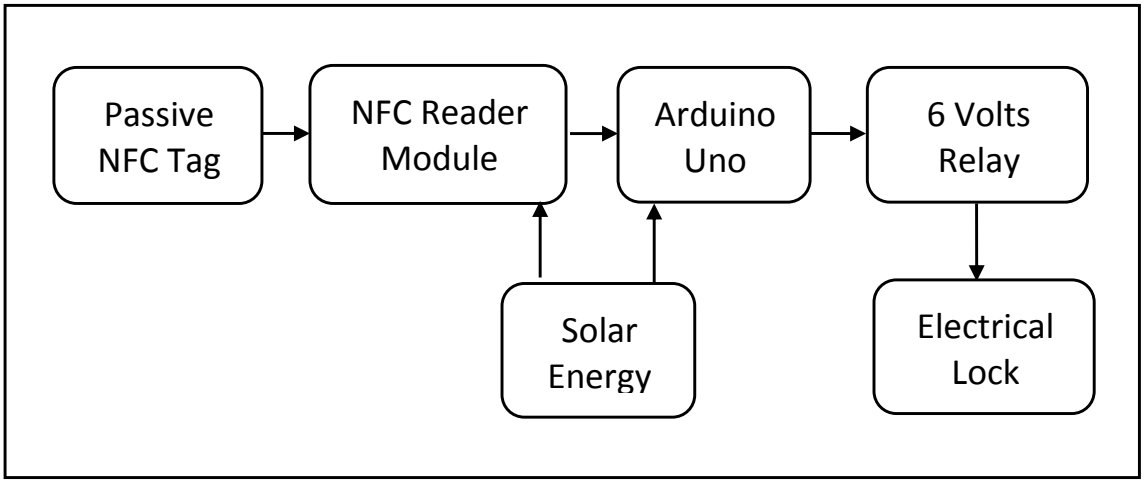

Fig. (2.2): The Electronic Elements Used to Implement The NFC Smart Lock.

2.4 NFC Tags

NFC (near field communication) is a wireless technology that allows for the transfer of data such as text or numbers between two NFC enabled devices. NFC tags as shown in figure (2.3), for example stickers or wristbands, contain small microchips with little coilthat can store a small

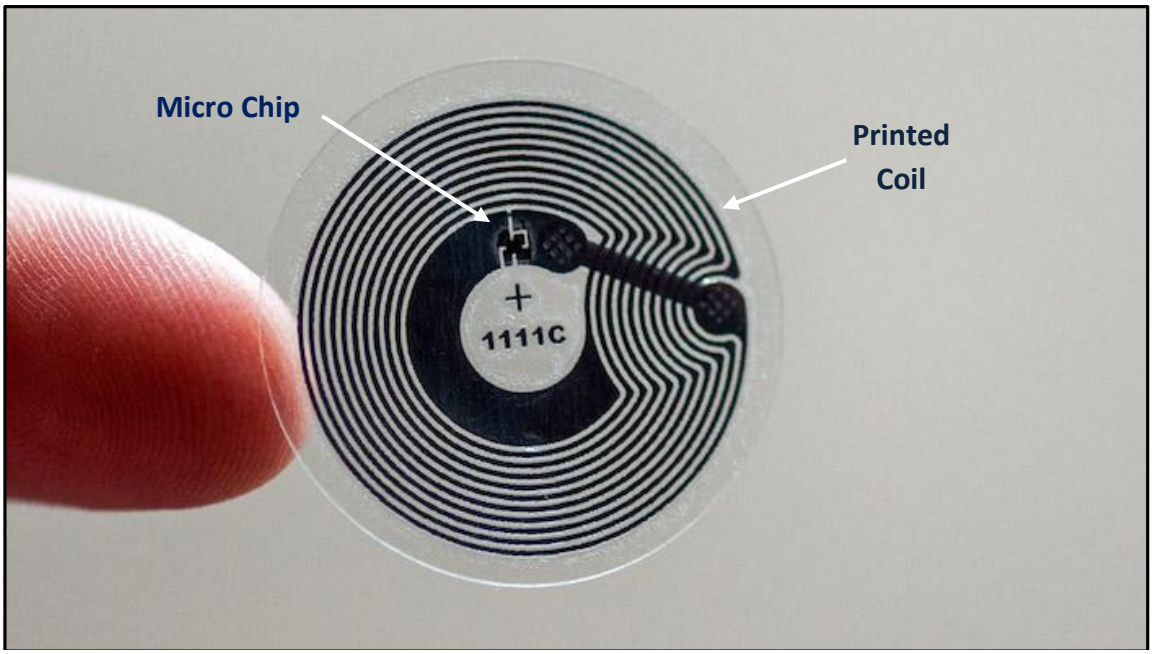

Fig. (2.3): The Contents of NFC Tag [9].

amount of information for transfer to another NFC device, such as a mobile phone or NFC reader module. The passive NFC tags is powered by the electromagnetic waves which radiated from the NFC reader module through the electromagneticinduction in the NFC tag printed coilas shown in figure (2.4).

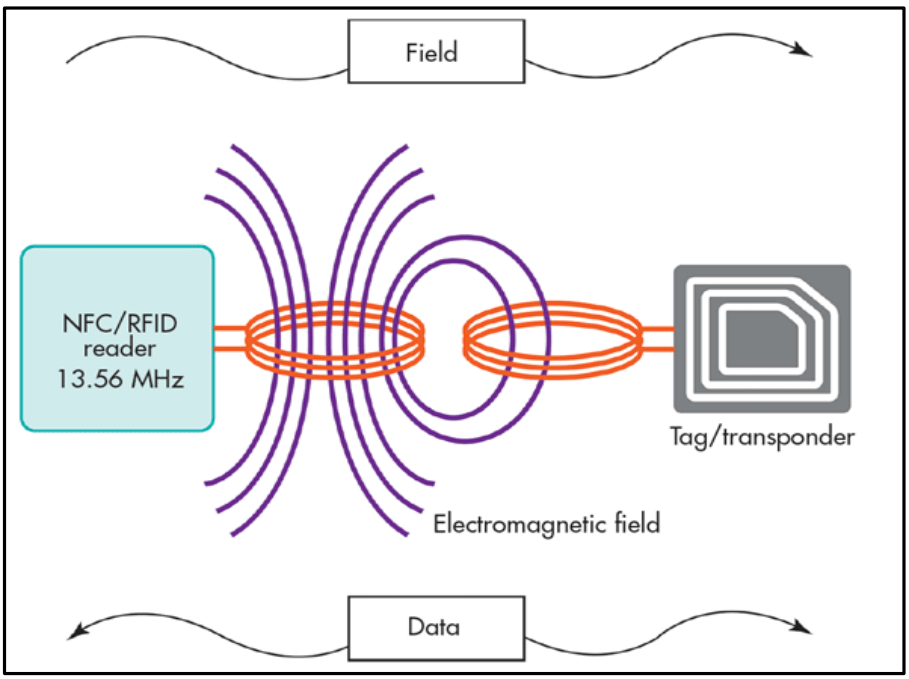

Fig. (2.4): The Electromagnetic Induction between The NFC reader and NFC Tag [9].

There's a whole set of different data types you can store on an NFC tag. The actual amount of data varies depending on the type of NFC tag used - different tags have different memory capacities. For example, you may choose to store a URL (web address) or a telephone number. A standard Ultralight NFC tag can store a URL of around 41 characters, whereas the newer NTAG213 NFC tag can store a URL of around 132 characters. Usually, this information is stored in a specific data format (NDEF - NFC data exchange format) so that it can be reliably read by most devices and mobile phones [9].

2.5 ITEAD PN532NFC Module

Near field communication is also possible between a NFC module and unpowered NFC chips such as tags, stickers, key fobs and cards which do not require batteries. The NFC module for Arduino is designed to extend this powerful feature for projects or applications based on Arduino. It integrates a PN532 NFC controller from NXP Company. On the other hand, for the applications with microcontroller, the module provides an event for the processor when detects the NFC tags, stickers, key fobs, or cards via high speed serial SPI connection [10].

TEAD PN532 NFC module as shown in figure (2.5), as its name implies, is based on PN532 chip and used for 13.56MHz near field communication. The module is equipped with onboard antenna, thus no external antenna coil is needed. It is compatible with SPI,IIC and UART interface for communication. With NFC library support for Arduino, it is quite convenient for development of products with NFC functions [10].

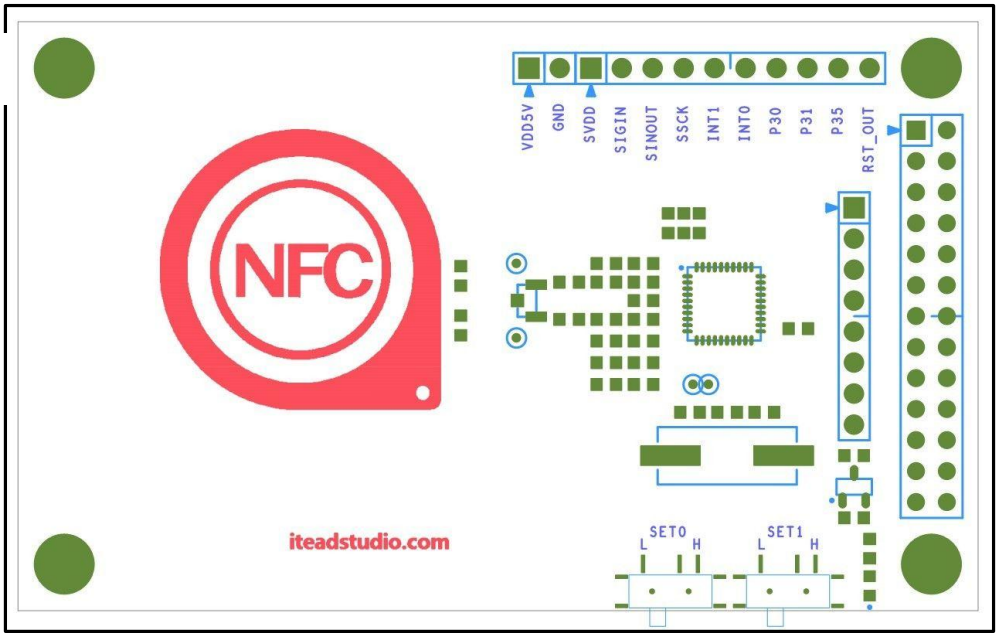

Fig. (2.5): ITEAD PN532 NFC Module [10].

2.5.1NFC Module Features

- Longest effective communication distance of 3 cm.
- Supports switching of Serial Peripheral Interface (SPI) ,Inter-Integrated Circuit(I^2C) and Universal Asynchronous Receiv/Trans(UART) interface.
- Can be used for 13.56MHz non-contact communication.
- Compatible with ISO14443 Type A and Type B standards [10].

2.5.2 NFC ModuleSpecifications

The NFC Module has the following specifications which are listed in Table (2.1) as shown below :-

Table (2.1): TEAD PN532 NFC Module Specifications [10].

IC	NXP PN532
Operating Voltage	3.3V
Power Supply Voltage	3.3~5.5V
Max Supply Current	150mA
Working Current(Standby Mode)	100mA
Working Current(Write Mode)	120mA
Working Current(Read Mode)	120mA
Indicator	PWR
Interface	SPI Interface, Std Raspberry Pi 20pins Interface

2.6 Arduino Uno Microcontroller

The Uno is a microcontroller board based on the ATmega328P microcontroller IC. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Arduino UNO as shown in figure (2.6) is robust microcontroller and it can be used without worrying too much about doing something wrong, worst case scenario is to replace the ATmega328P chip for a few dollars and start over again [11].

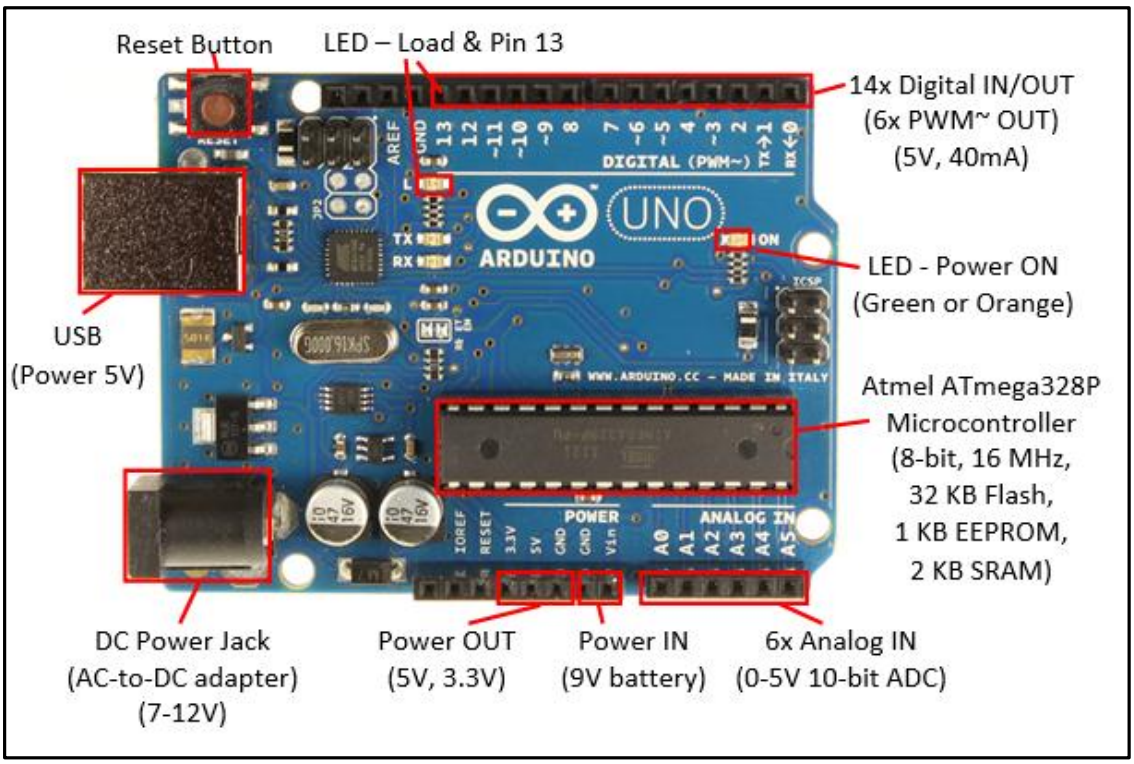

Fig. (2.6): Arduino Uno Microcontroller [11].

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform [11].

The Uno has a number of facilities for communicating with a computer, another Uno board, or other microcontrollers. The ATmega328

provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). The ATmega328 also supports I^2C and SPI communication. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer [11].

2.7 A Liquid-Crystal Display (LCD)

A liquid crystal display (LCD) is a flatpanel display or other electronic visual display that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly [12].

LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements [12].

LCDs are used in a wide range of applications including computer monitors, mobiles, televisions, instrument panels, aircraft cockpit displays, and signage. They are available in a wider range of screen sizes, and since they do not use phosphors, they do not suffer image burn-in.The LCD screen is more energy-efficient and can be disposed of more safely than acathode ray tube(CRT). Its low electrical power consumption enables it to be used in batterypowered electronic equipment more efficiently than CRTs. It is an electronically modulated optical device made up of any number of segments controlling a layer of liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome [12].

A compatible Arduino LCD are often used to display a required data and status information on the screen. In this project the 2*16 (2 lines * 16 Character) Arduino I^2C LCD as shown in figure (2.7) is used to display a programed messages.

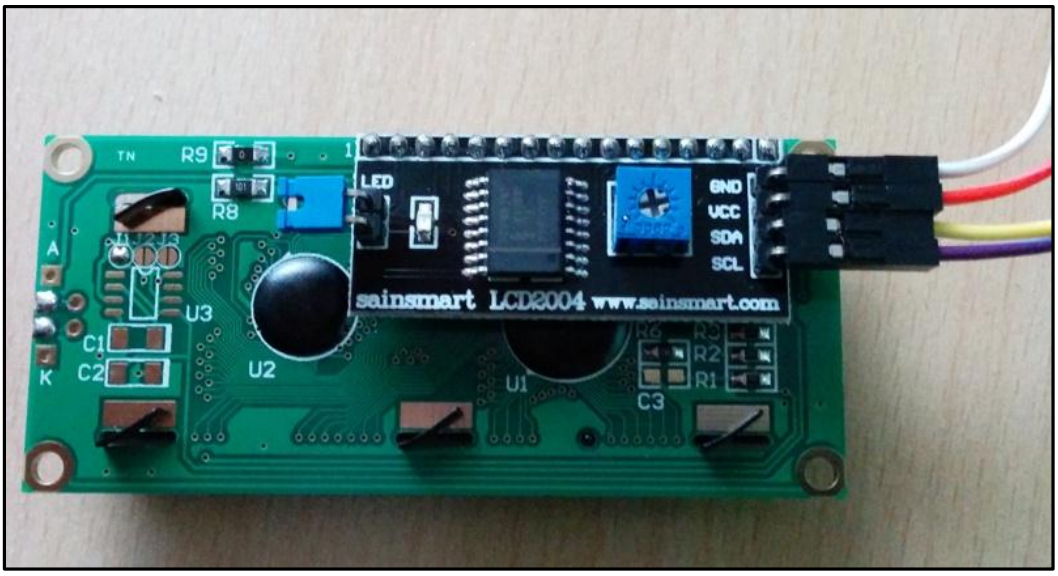

Fig. (2.7): Arduino I²C Liquid Crystal Display [12].

2.8 Solar Cell Power Supply

Photovoltaic modules, commonly called solar modules as shown Figure (2.8), are the key components used to convert sunlight into electricity. The solar cell is used to supply the electronic circuit of the project with continues power in order to eliminate the need of using 5V DC battery or charger. Solar modules are made of semiconductors that are very similar to those used to create integrated circuits for electronic equipment. The most common type of semiconductor currently in use is made of silicon crystal. Silicon crystals are laminated into n-type and p-type layers, stacked on top of each other. Light striking the crystals induces the "Photovoltaic effect", which generates electricity. The electricity produced is called direct current (DC) and can be used immediately or stored in a battery [13].

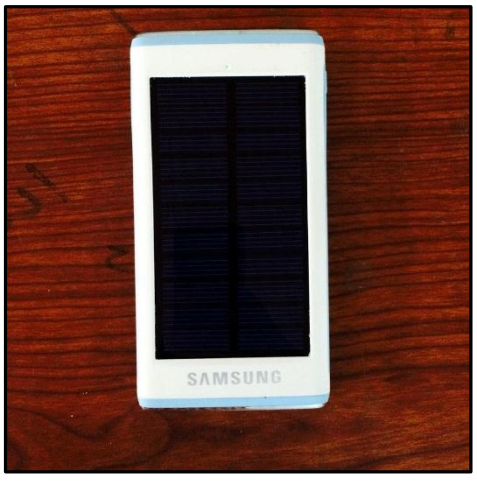

Fig. (2.8): The Solar Cell Used as a Power Supply in This Project.

2.9 The Relay

Relays are switches that open and close circuits electromechanically. Relays control one electrical circuit by opening and closing contacts in another circuit. As relay diagrams show in Figure (2.9), when a relay contact is normally open (NO), there is an open contact when the relay is not energized. When a relay contact is Normally Closed (NC), there is a closed contact when the relay is not energized. In either case, applying electrical current to the contacts will change their state [14].

Relays are generally used to switch smaller currents in a control circuit and do not usually control power consuming devices except for small motors and Solenoids that draw low amps. Nonetheless, relays can "control" larger voltages and amperes by having an amplifying effect because a small voltage applied to a relays coil can result in a large voltage being switched by the contacts as in the case of our project [14].

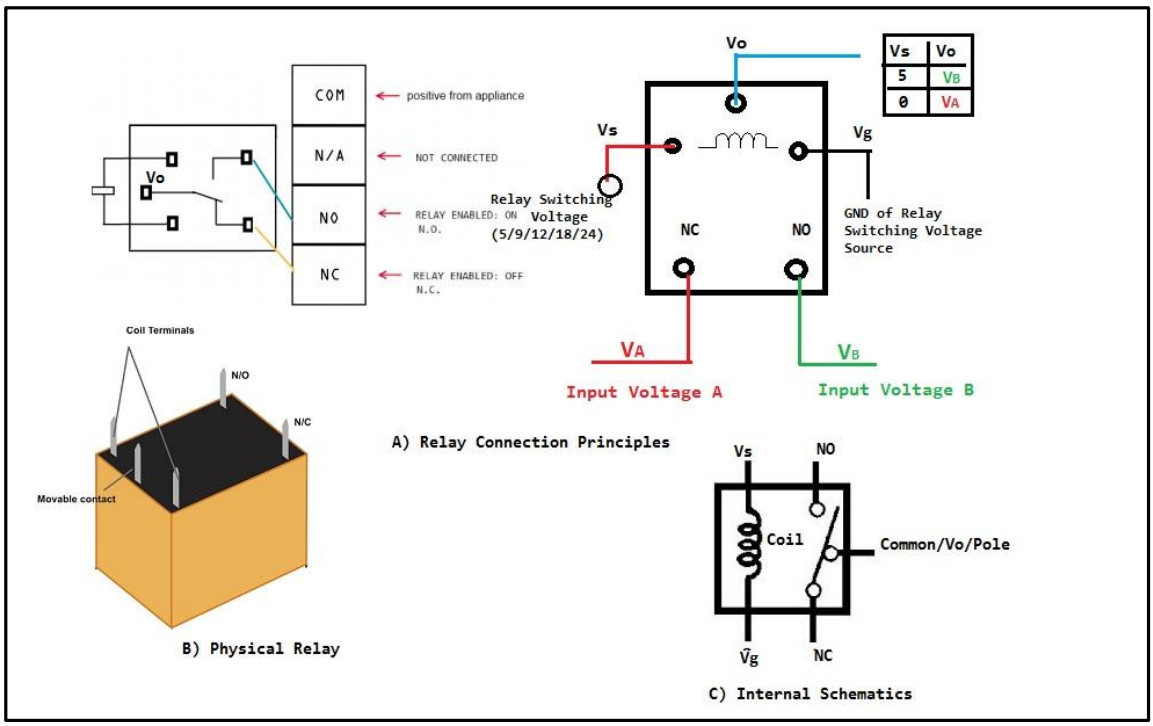

Fig. (2.9): The 6V DC Relay: (a) Relay Connection Principle, (b) Physical Relay (c) Internal Schematics [14].

2.10 The Electrical Lock

The electrical lock is a locking device which operates by means of electric current flows in electrical magnets as shown in Figure (2.10). Electrical locks are sometimes stand-alone with an electronic control assembly mounted directly to the lock. Electrical locks may be connected to an access control system, the advantages of which include: key control, where keys can be added and removed without re-keying the lock cylinder; fine access control, where time and place are factors; and transaction logging, where activity is recorded. Electronic locks can also be remotely monitored and controlled, both to lock and unlock. Electric locks use magnets, solenoids, or motors to actuate the lock by either supplying or removing power. Operating the lock can be as simple as using a switch, for example an apartment intercom door release, or as complex as an access control system based on biometric or wireless communication techniques.

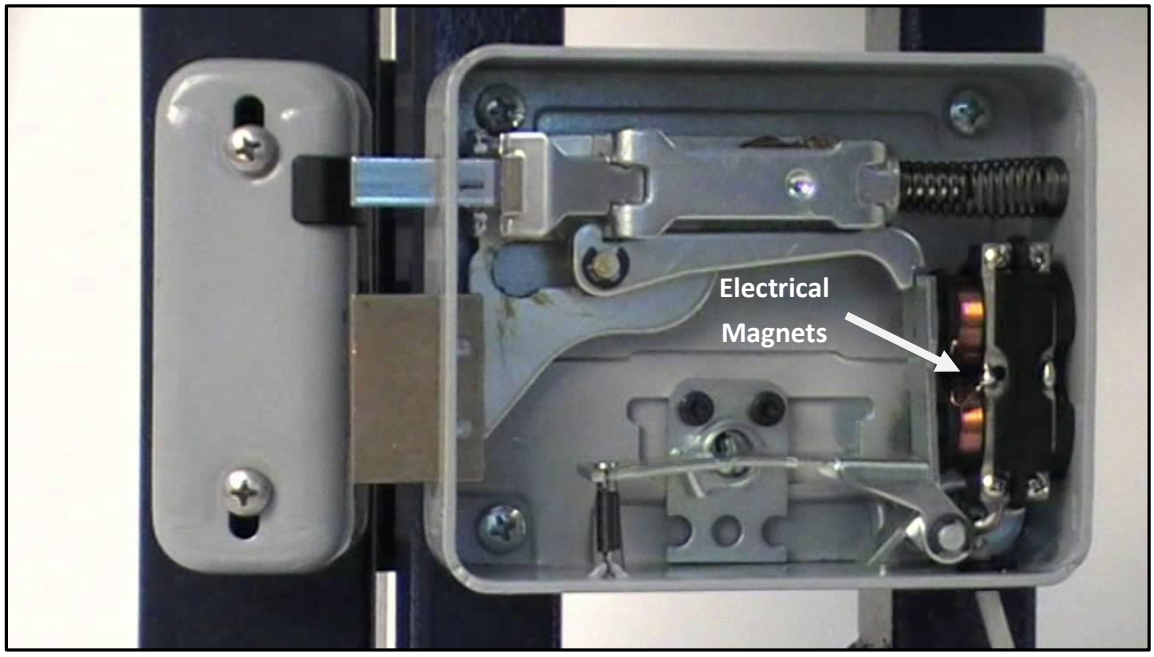

Fig. (2.10): The Internal Contents of the Electrical Lock

3.1 Introduction

As mentioned in chapter one, the target of the project is to design a system of smart electronic lock by utilizing the Near Field Communication (NFC) technology. The designed system is implemented by connecting electronic circuits as will be explained in this chapter, the main elements of the smart NFC lock system are shown in Figure (2.2).

3.2 Connection of NFC Module to Arduino Uno

NFC Module is a Near Field Communication interface for Arduino build around the popular NXP PN532 integrated circuit and Serial Peripheral Interface (SPI) communication between Arduino and NFC Module. In order to implement the connection between NFC Module and the Arduino, six pins of NFC module will be used to realize the SPI connection as shown in Figure (3.1).

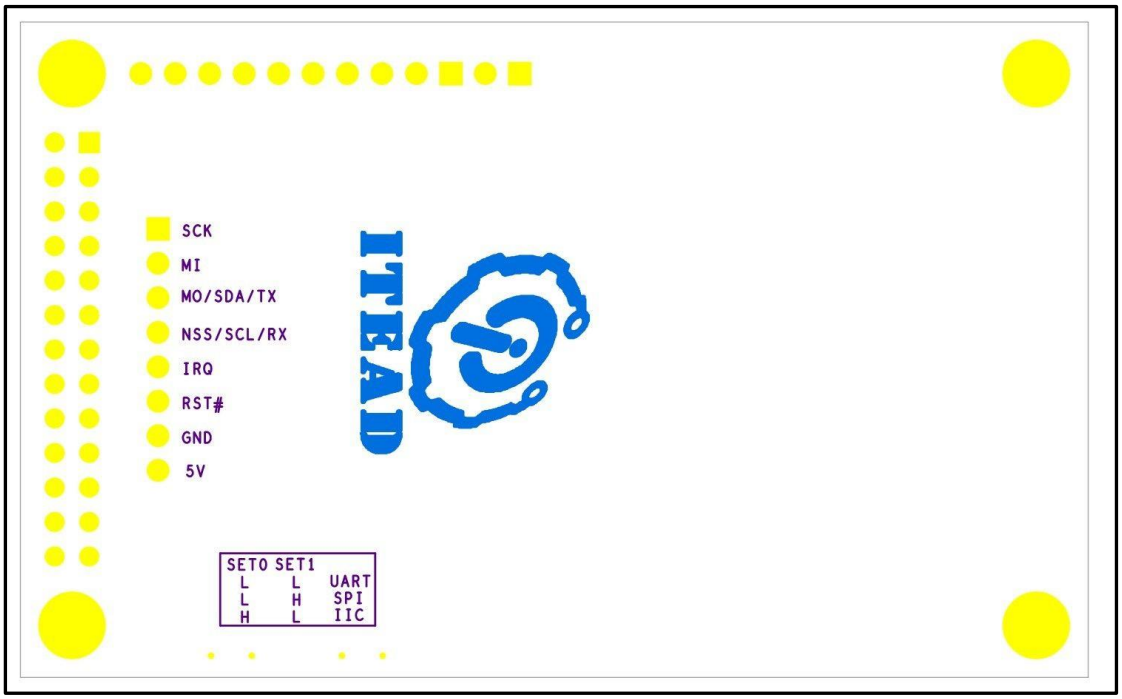

Fig. (3.1): ITEAD PN532 NFC Pin Configuration [10].

The Arduino UNO and NFC Module is assembled with Jumper Wires as follows : 5V to 5V in Arduino, SCK to Digital pin No.13, MISO to

Digital pin No.12, MOSI to Digital pin No.11 SCL to Digital pin No.10 GND to GND pin of Arduino as shown in Figure (3.2) .

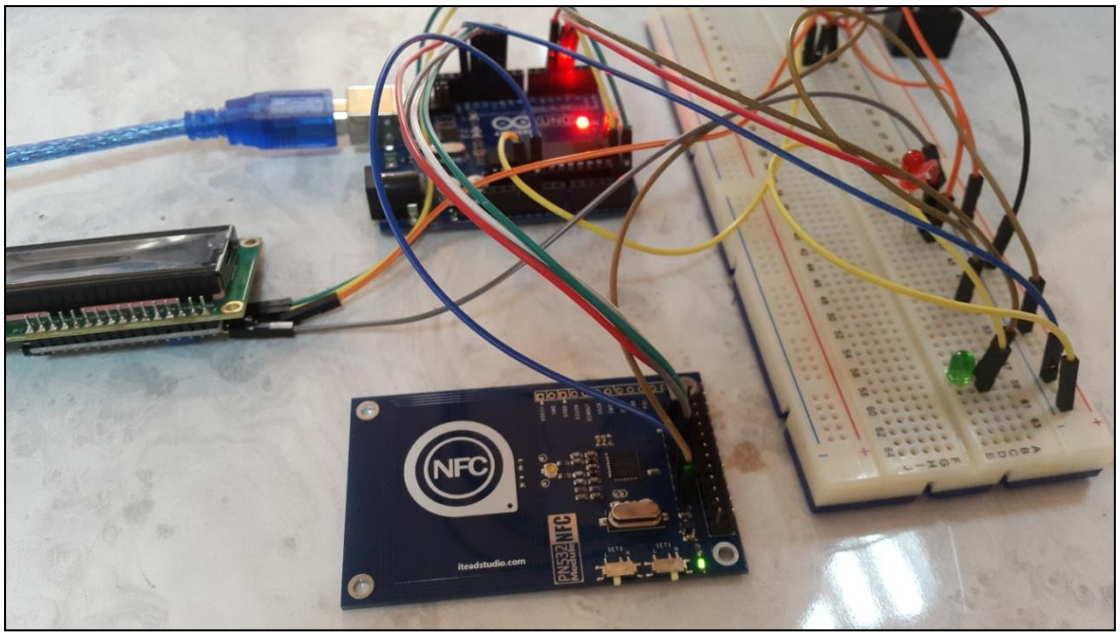

Fig. (3.2): Connection of Arduino and NFC Module through Jumper Wires

Then to inter The SPI Mode, the SET0 switch of NFC Module board isset to (L) Side and the SET1 switch of NFC Module board isset to (H) Side as shown in Figure (3.3).

Fig. (3.3): The Setting of SET0, SET1 Switches of NFC Module

After the above mentioned connections, the Arduino board and the NFC module are supplied by 5V from the Solar cell power supply to eliminate the need of using battery or a 5V charger as shown in Figure (3.3).The program of Near Field Communication smart lock is written in Arduino IDE program (Version 1.6.7) by using Arduino C language. Furthermore, A green led is connected to digital pin No.3 to indicate for correct NEC key, A red led is connected to digital pin No.4 to indicate for incorrect NEC key and digital pin No.5 is used to activate the 12V AC electrical lock through activating the 6V DC relay.

3.3 Connection Serial I^2C 1602 16×2 LCD with Arduino

Theserial I^2C blue backlight LCD displayis used to display welcome and incorrect NFC key notifications. I^2C blue backlight LCDdisplay is utilized because it requires only 4 pins of Arduino board to work successfully.As the pin resources of Arduino controller is limited, project may be not able to use normal LCD shield(which require 16 pins to be soldered and used) after the connection with a above quantity ofpins mention in 3.2 . However, with this I2C interface LCD module, the data display via only 4 wires is realized as shown in Figure (3.4). This LCD module actually cost no more resources at all. In order toconnect an Arduino with 1602 I^2C LCD module. The following table is describing which pins on Arduino should be connected to 1602 I2C LCD module.

Table (3.1): The Connection of I^2C LCD Pins with Arduino Uno Microcontroller

1602 1^2C LCD Module	Arduino Uno
VCC	5V
GND	GND
SDA	A4
SCL	A5

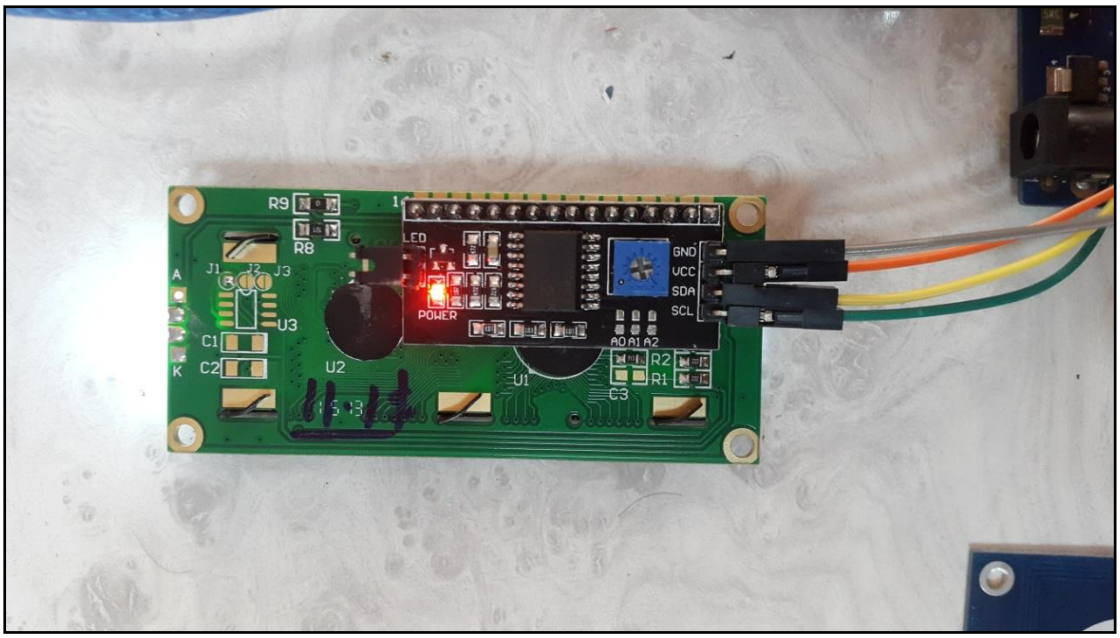

Fig. (3.4): The Connection of I^2C LCD Display

3.4 The Connection of the Electrical Lock with Arduino

The electrical lock is a locking device which operates by means of electrical current. The work of the AC electrical lock that is supplied by 12V AC through using 220V-12V ACtransformer is controlled by using NFC module, Arduino microcontroller and relay as shown in Figure (3.5).

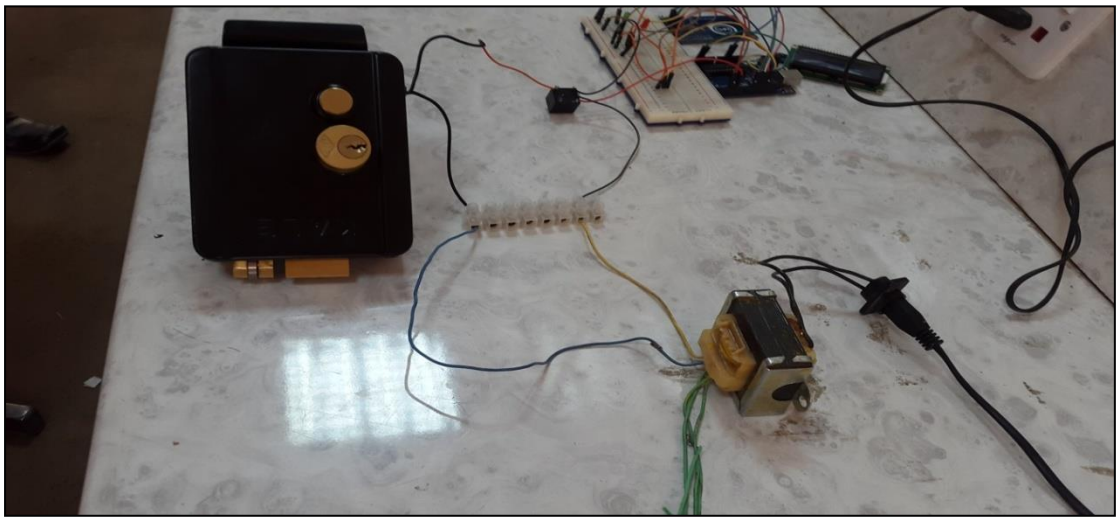

Fig. (3.5): The Connection of Electrical Lock with 220V-12V AC Transformer.

After completing the connections of electronic circuits of the project, the experimental results of the experimental work are obtained as it will be explained in the next chapter.

4.1 Experimental Results

In this chapter, the performances of the project circuits are tested to study their behaviors when they are connected together in order to realize the system of NFC smart Lock. The tests of the NFC Module, Arduino UNO microcontroller and electrical lock are done in communication department laboratories of our college.

4.2 The Experimental Results When an Authorized NFC Key is Scanned

When a correct password is read wirelessly from NFC Key by NFC module, The Arduino microcontroller sends a High logic level (5V DC) instruction to relay to activate it to complete the circuit of the electrical lock to make it work. Also, The Arduino sends instructions to I^2C LCD to display the "Welcome Dr. ABD ALMOUNEM" message and to green led to light as shown in Figure (4.1).

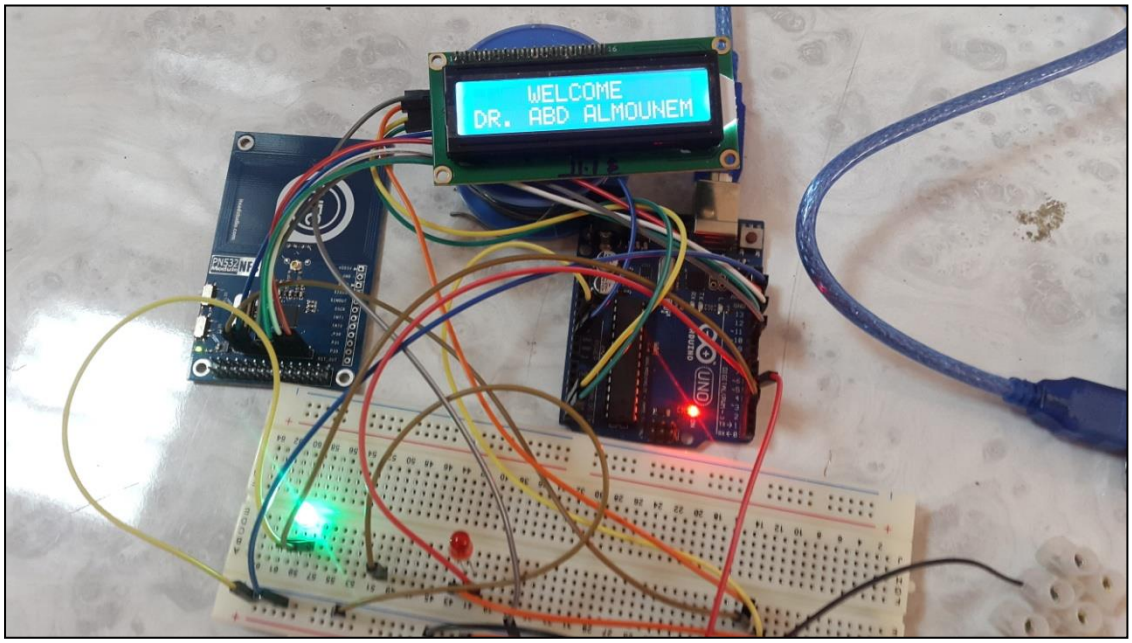

Fig. (4.1): The State Electrical Lock with Arduino when a Correct NFC Key is Scanned

4.2 The Experimental Results When an Unauthorized NFC Key is Scanned

When a incorrect password is read wirelessly from unauthorized NFC Key by NFC module, The Arduino microcontroller sends a low logic level (0V DC) instruction to relay, so the electrical lock will not work. Also, The Arduino sends instructions to I^2C LCD to display "invalid NFC key, No Access" message and to red led to light as shown in Figure (4.2).

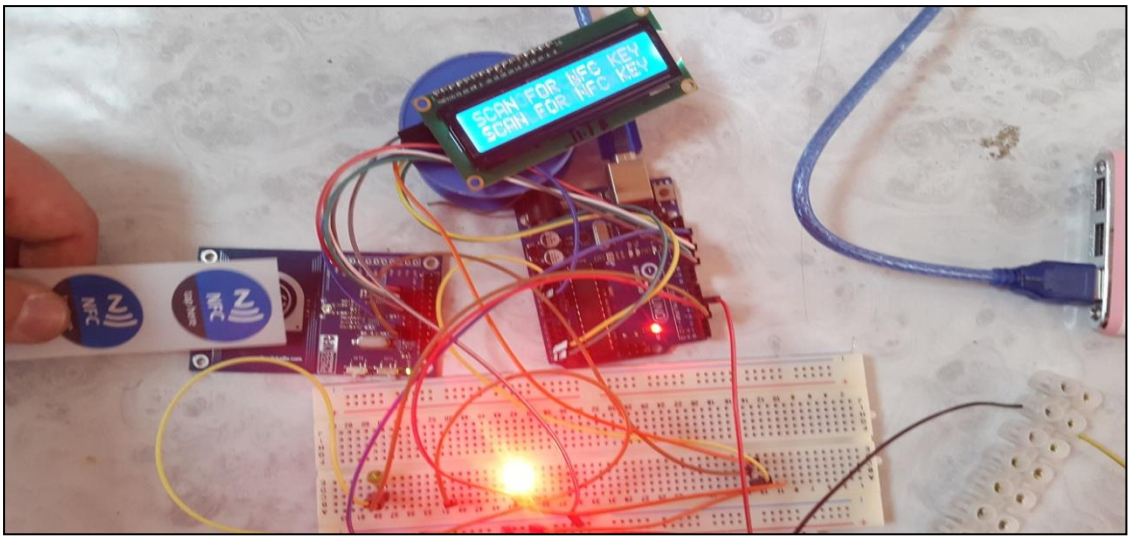

Fig. (4.2): The State of Electrical Lock with Arduino when a Incorrect NFC Key is Scanned

4.3Data Encryption System of the Graduation Documents

As a second important result of our project is the realization of the encryption system of the graduation documents data and then storing the encrypted data on smart NFC tags as shown in Figure (4.3), this result is obtained by amending the design of the above-mentioned system. The NFC encryption system can be utilized as one of the measures to prevent the illegal counterfeit attempts of documents in Iraqi universities, institutes, and in future electronic government.

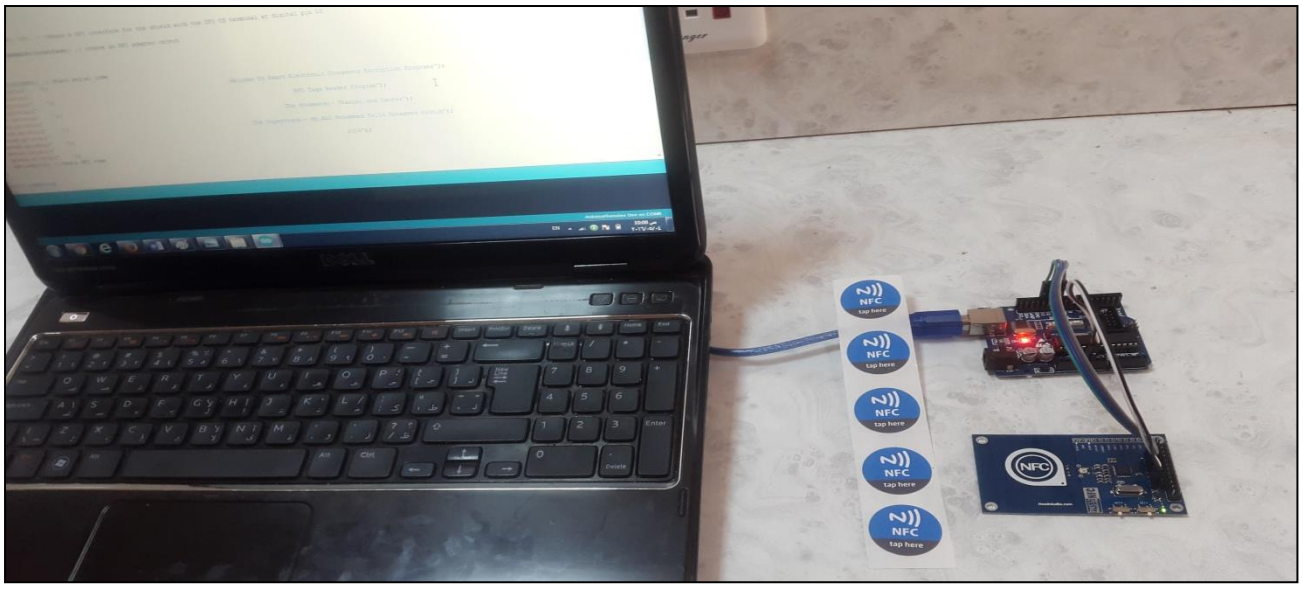

Fig. (4.3): Data Encryption System of the Graduation Documents

4.4 Conclusions

The Designed Near Field Communication Smart lock works successfully. The password is transmitted wirelessly between the NFC key and the NFC Moduleby using HF RF signals at 13.56 MHz.Also the received password is analyzed successfully by using Arduino microcontroller, therefore when the password is correct the system works and open the electrical lock. On the other hand, if the received signal is incorrect the smart lock system doesn't open the electrical lock. Additionally, a second important result is obtained successfully by using the NFC module, NFC tags and the Arduino Uno microcontroller and they are utilized to encrypt the data of the graduation document successfully.

4.7 Future Work

This project is part of a larger project that will includenew techniques, these techniques are hoped to be designed next years. the entire project can be developed by:-

1. Using a 5V electrical lock, so the smart lock system willbe totally powered by the solar cell .
2. Using the Bluetooth technology to make smart lock systems.
3. Using sounds messages to welcome the authorized persons and to warn unauthorized persons.

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وزارة التعليم العالي والبحث العلمي
جامعة ديالى
كلية الهندسة
قسم هندسة الاتصالات

تصميم وتنفيذ قفل الكتروني ذكي بواسطة تقنية الاتصالات قريبة المدى

البحث مقدم إلى كلية الهندسة قسم الاتصالات وهو جزء من متطلبات نيل درجة

البكالوريوس في هندسة الاتصالات

إعداد

زهراء سالم حسن

ذاريات عبد الله وهيب

إشراف

م.م علي محمد صالح محمد كاظم

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