STUDENT ATTENDANCE SYSTEM
USING RFID

By

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DISSERTATION

Submitted to the Electrical & Electronics Engineering Programme
in Partial Fulfillment of the Requirements
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CERTIFICATION OF APPROVAL

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Approved:

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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

May 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Muhammad Haekal Bin Md Haled

ABSTRACT

Radio Frequency Identification (RFID) is a new technology in communication system which can be define as a medium used to identify and track the special tag implanted into an object or a living thing by using radio frequency wave. It is a wireless mean of communication that use electromagnetic and electrostatic coupling in radio frequency portion of the spectrum to communicate between reader and tag through a variety of modulation and encoding scheme. Nowadays, most of universities used the conventional method of taking attendance by calling names or signing on paper is very time consuming and inefficient. From that, by integrating various components which are RFID reader, RFID card, microcontroller and Secure Digital Card (SD Card), a portable RFID based attendance system can be set up and become the solutions to address this problem. Uniquely identify each person based on RFID tag is one of its special ability that can make the recording attendance process become more faster and easier compared to conventional method.

ACKNOWLEDGEMENT

In the name of Allah, the Most Beneficent, the Most Merciful, I would like to express my gratitude to all person which contributes great experience and learning opportunities in working on my Final Year Project. I would like to express my deeply sincere gratitude and thank to my supervisor Mr. Abu Bakar Sayuti Bin Hj Mohd Saman for aiding me through this whole project with excellent support. Besides that, my appreciation goes to the Electrical & Electronic Engineering Laboratory Technician, Mr. Musa for sharing some technical knowledge regarding this project. Lastly, I also would like to thank my family member and friends for assisting me technically or mentally when I am working on this project. A warmth gratitude for everyone and may all the goodness and memories blessed by Allah.

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ABBREVIATION

The following abbreviations are used in this report:

RFID	Radio Frequency Identification
UTP	Universiti Teknologi Petronas
USB	Universal Serial Bus
SD	Secure Digital
UART	Universal Asynchronous Receiver/Transmitter
SRAM	Static Random Acces Memory
LCD	Liquid Cristal Display
IDE	Integrated Development Environment
SPI	Serial Peripheral Interface
SDO	Serial Data Out/ Error
SDI	Serial data in
SCK	Serial Clock
CSN	Chip Select Not
CPU	Central Processing Unit
ASIC	Application Specific Integrated Circuit
IC	Integrated Circuit
FPGA	Field Programmable Gate Array
UHF	Ultra High Frequency
ISR	Interrupt Service Routine

CHAPTER 1: PROJECT BACKGROUND

1.1 Backgroud Study

Recording the attendance of students using RFID cards requires a portable recording device to be designed and built. Several components need to be integrated into a robust portable device that can read the RFID cards and store key data on board which can be transferred to a personal computer later. The RFID system have two important features. First, the RFID card i.e the microchip having the capacity to store information with authentication and second is RFID module for reading and writing identity information from/to RFID card.

This portable device have a storage part which is Secure Digital (SD) card to store the data that can be prevent the data from damage. Attendance can be recorded by swiping student identification card onto a portable device that contain a microcontroller equipped with Radio Frequency Identification (RFID) reader and recorded into on-board memory. Then, the data will be transferred to a personal computer either using a memory card or through Universal Serial Bus (USB) cable.

1.2 Problem Statement

Universiti Teknologi PETRONAS (UTP) is one of educational instituition that use manual method in recording the attendance which is by writing name on paper. Basically, recording of student attendance can be tedious and time consuming if done manually, especially for large classes. There are a few latest technology that also involve in recording students attendence such as bar code system and fingerprint system but all of them are very high maintenance and costly. If a portable computer assisted system with affordable cost is used, data can be recorded and stored accurately, so that time consuming problem can be avoided.

1.3 Objectives

The objectives of the project are:

1. To design and build a portable RFID reader with data storage for the purpose of recording students attendance.
2. To enable the communication between ATmega 2560 and a computer via serial port Universal Asynchronous Receiver/Transmitter (UART)

3. To build a device that can be implemented in UTP in order to improve management system especially in recording student's attendance.

1.4 Scope of Study

In this project, there are several limitations that involve which are duration time to complete, the sources of knowledge and respondance contribution. A perfect planning must be created to eliminate all the limitations. From that, the first important step need to do is studying the fundamentals of RFID and embedded system from any trusted sources such as published articles, journals, books and conference papers. By doing that, deeper understanding especially in theory can be gained and practical studies can be made.

In order to set up the device, embedded system is used and also can be called as Hardware/Software Co-design. The main objective of the system is to uniquely identify and to mark attendance for a students. This requires a distinct feature having the capability of distinguishing different person uniquely. This is possible by the new emerging technology of RFID. The main parts can be divided into two. First, detection and storing the data that including RFID system and the second part is transferring data. **Figure 1 and 2** shows the pictorial representation of the both part.

Hence, a communication will be created to observe the interaction and relationship between the RFID system with the microcontroller. Based on the observation, the integration can be finalize and the final product will be set up.

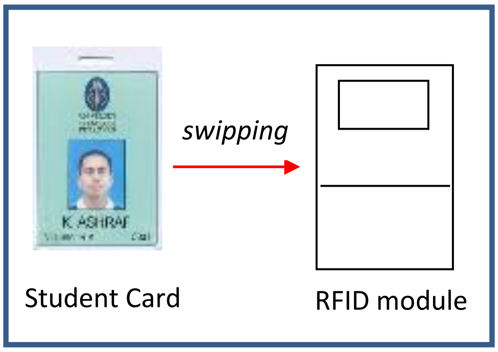


Figure 1: Detection and Storing Data Part

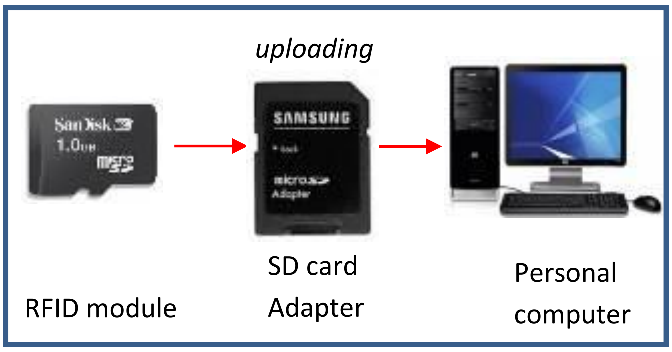


Figure 2: Uploading Data Part

CHAPTER 2: LITERATURE REVIEW

2.1 Radio Frequency Identification

In this world, there are a lot of methods can be used to transfer a data. One of them is using radio frequency electromagnetic field. The famous tool that use this method is Radio Frequency Identification (RFID). It is the wireless non-contact devices created for the purpose of automatically identifying and tracking the information inside programmable tags or card. The tags or card have an ability to read at a short range via magnetic field that also call as electromagnetic induction. Then, it will act as a passive transponder to emit microwaves or UHF radiowaves.

On the other hand, the limitation of other automatic identification approach which are used light to communicate (infrared and bar codes technology) can be overcomes from this technology. It is proven when the RFID tag or card are invisible to the eye and can be used in dirty environment. Without labor-intensive manual scanning, RFID readers can be set to remotely and automatically read [1]. Radio frequency of this system can be categorised into four basic range and are given in **Table 1** below:

Table 1: Basic range of RFID [1]

Symbol	Type of Frequency	Range	Uses
LF	Low Frequency	30 kHz to 300 kHz	125 kHz
HF	High Frequency	3 MHz to 30 MHz	13.56 MHz
VHF	Very High Frequency	30 MHz to 300 MHz	Not used for RFID
UHF	Ultra High Frequency	300 MHz to 3 GHz	866 MHz, 915 MHz

Basically, there are two components that involve in RFID system which are RFID reader and RFID tags. The system contain a coil that act as antenna for transmitting and receiving signal as shown in **Figure 3**. In the same time, the signal can store maximum 2 kilobytes of data [2]. Similar concept are implemented for all type of RFID system. At first, radio wave will be generated from RFID reader and after that, the RFID tag will reflect back the radio waves by using backscatter technology. From that, data has been sent to the reader by combining them with the radio waves through modulation [3].

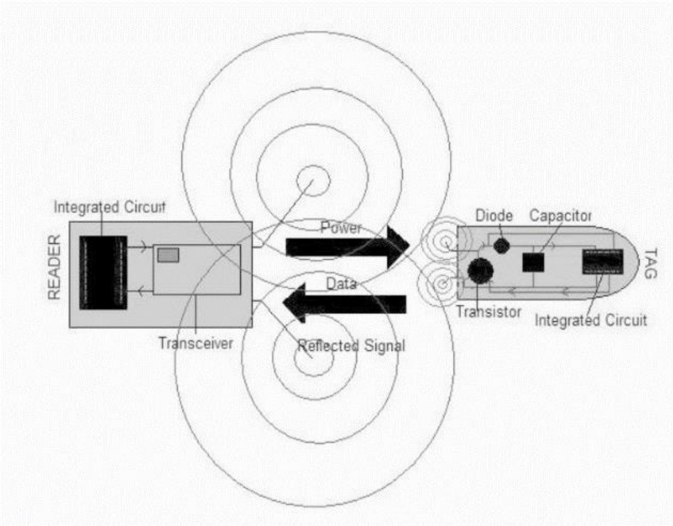


Figure 3: A Schematic of Power and Data Flow in a

The substances used to store some additional information and unique serial number is a silicon microchip that fabricate inside the majority of RFID tags or transponders. RFID system can be categories into two part which are passive (**Figure 4**) and active (**Figure 5**) [4]. There are a fundamentally different technologies in Active RFID and Passive RFID but both of them used the same medium to communicate between a reader and a tag or card which is radio frequency energy. Its different can be seen in the method of powering the tag or card. For Active RFID, internal power source are used to continuously power the tag and its RF communication circuitry, whereas Passive RFID totally used the RF energy transferred from reader to the tag. So that, stronger signal are required from reader for Passive RFID in order to increase the signal strength returned from the tag. So that, stronger signal are required from reader for Passive RFID in order to increase the signal strength returned from the tag. On the other hand, Active RFID have more effective tag that can generate high level-signal back to the reader and also continuously powered whether in reader field or not.

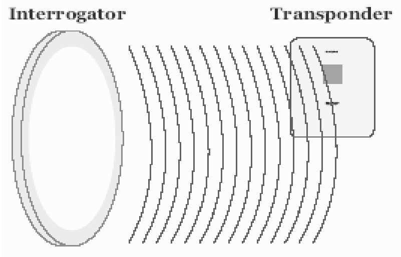


Figure 4: Passive RFID System [4]

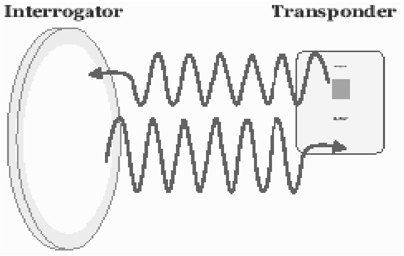


Figure 5: Active RFID System [4]

2.2 Embedded System

IC designers state that microprocessor based design is an important design discipline since 1990s. According to Moore's Law, 16-bits and 32-bits microprocessor chips that already had been used in board-level design have a large enough to include both a CPU and other subsystem. Resulting from that, two classes of problem have been identify which are the software must become a first class component in chip design and large predesigned of CPU must handled by the system design methodologies. Hence, the root of Hardware/Software Co-design had been formed from the development done by the researchers in basic approaches to the design of embedded software running on CPU [5].

Embedded system can be define as 'hardware embedded with software'. All the hardware components are controlled by a microcontroller with a special software. Traditionally, there are three phases on designing an embedded systems. First, decomposing and allocating the system into two part which are hardware and software. Second, separate hardware and software design team according to their specialization and lastly, integrating both hardware and software simultaneously. This separation of design task can prevent any mistakes in designing until integration phase happen where each mistakes are very costly and difficult to correct [6].

Based on the paper written by Claudio Talarico, Aseem Gupta, Ebenezer Peter, and Jerzy W. Rozenblit with title Embedded System Engineering Using C/C++ Based Design Methodologies, for describing hardware and software, they had addressed this issue by using the same high level language which are C and C++ in order to keep both design activities tightly coupled. Moreover, a lot of complex systems can be built by using hardware/software co-design technique. In any co-design tool or platform, the important thing need to do and sometimes called as primary task is divided a given application specification between hardware (typically ASIC or FPGA) and software (mapped to the CPU). From that, the application at hand blends best with the ideal custom architecture will be obtained [7]. **Figure 6** shows a summary of embedded system design process [8].

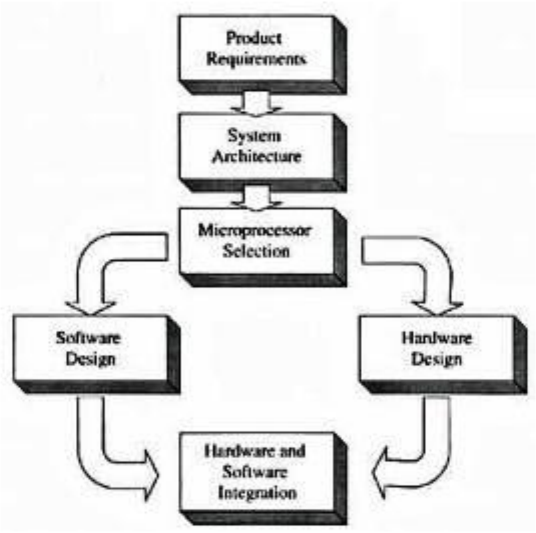


Figure 6: Embedded System Design Process [8]

In this project, technique used for the software part is event-driven programming where finate state machine act as its tool. Basically, in event-driven model based program contains two types of objects which are passive and active object. Both of them have different function and characteristics. For passive objects, they run and generate message only when receiving some messages, whereas the actives objects are always running and can generate message without receiving any messages. Usually, hardware supported interrupt service routine can be categorized in active objects. If there is a case of external or internal interrupt event, the interrupt service routine will be called by the processors interrupt periphery. One of internal hardware event is a timer end analog-digital conversion. Using a program based on traditional event-driven model will gives an advantage which is automatic control of processor power consumption included in the model. From that, the response time of program will become the message processing plus the answer generation time if the message comes when the event queue is empty [9].

2.3 Storage On SD

In data storage application, flash memory which is one of non-volatile devices are most widely used today. Its abilities in fast accesing, multiple write characteristics, low-power consumption and also compact are the reasons why this type of memory have been chosen. Based on a comparison between flash memory and mechanical magnetic or optical media was carried out by researcher in the past, flash memory is much better because they do not have all of these desired features [10]. Besides, due to its portable design, stored data in flash memory can be transferred to a personal computer easily. It is also capable on storing sensitive data because of its security features inherent in the SD card [11].

MicroSD is one of removable flash memory card with smallest size (about the size of fingernail) that used for storing data. Its size also can be equated as quarter size of a normal SD card and have a read/write speed between 3 to 5 MBps. In application, transflash and microSD are in the same proceedings but microSD has support Secured Digital Input Output (SDIO) mode. From that, non-memory card like near field communication (NFC), bluetooth and Global Positioning System (GPS) devices to use the card also.

Normally, Serial Peripheral Interface (SPI) is used by SD card as its communication protocol with embedded microcontroller because it supports only a 3.3-volt interface and also does not require a host license. This protocol communicate in master/slave mode where the master initiates the data frame. The presence of individual slave select lines can allowed the functioning of multiple slave devices. Occasionally, four-wire serial bus, contrasting with three-, two-, and one-wire serial bus also referred to SPI. There are a few numbers of standard SPI interface structure used which are SDO (Serial Data Out/ Error), SDI (Serial data in), SCK (Serial Clock) signal line and CSN (Chip Select Not) [12]. **Figure 7** shows SPI bus with single master and single slave.

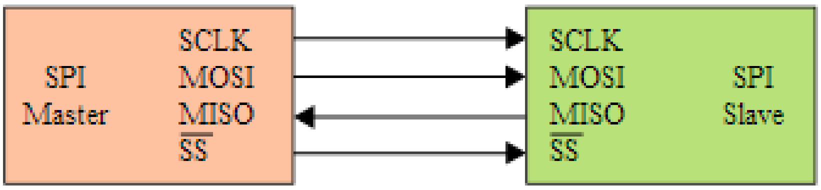


Figure 7 : SPI BUS (single master and single slave)

CHAPTER 3: METHODOLOGY

3.1 Project Flow

A specific approach of executing is required in this project like any other software hardware integrated project. This approach emphasizes on step-by-step development by finishing one step before advancing to the other until it reaches the final stages of prototyping. **Figure 8** shows the project flow chart.

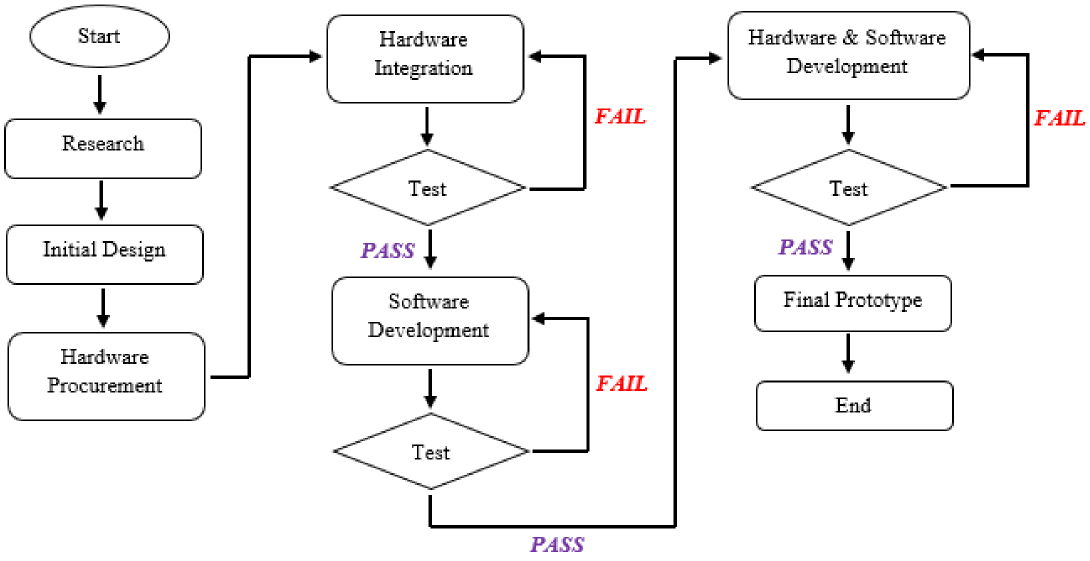


Figure 8: Project Flow Chart

1. ***Project Start***: In this phase, the project title had confirmed and then specify the problem statement work will be done. The problem statement for this project is 'How to create a device that used RFID system to record student attendance efficiently ?'

2. ***Research***: After done the specifying problem statement, research on the theory and concept from any trusted sources will be made. Deeper understanding is very important to make sure the project follow all the basic theory.

3. ***Initial Design***: There are several designs had listed down such as RFID attendance design stick at the wall, RFID attendance design using bluetooth and many more. Then, the final design had decide which is portable RFID attendance design that can store data and using USB as a medium in transferring data to personal computer.
4. ***Hardware Procurement***: In this phase, the list of components used had finalized. Then, all the components will be bought from the manufacturer.
5. ***Hardware Integration***: Hardware Integration can be divided into four part which are integration between Arduino Mega with RFID shield, Arduino Mega with MicroSD card shield, Arduino Mega with USB shield and combination three of them.
6. ***Software Development***: Each part of the hardware integration need to be completed with the presence of software development that also called as coding part.
7. ***Hardware & Software Development***: This is the crucial part in this project where author need to combine all the modules become one device and also adjusting coding simulteneously. In the same time, testing and troubleshooting work must be done repeteadly.
8. ***Final Prototype***: After the combined module integration completed, a marketable prototype will be setting up in the form of permanent circuit board.
9. ***End of Project***: In this phase, the report will be submitted

3.2 System Architecture

The system architecture of this project based on hardware-software codesign which can be subdivided into two distinct category i.e. is Software and Hardware.

HARDWARE ARCHITECTURE

The system hardware is based on a Atmega2560 microcontroller. This microcontroller has 256 KB of which 8 KB used by bootloade Flash program memory & 8KB Static Random Acces Memory (SRAM). The entire hardware can be divided into four parts like Liquid Cristal Display (LCD) display interface section, RFID module interface section, real time clock interface section and SD Card interface section. All these sections are controlled by the ATmega2560 microcontroller and the required software to control the sections are Arduino Integrated Development Environment (IDE). The basic building blocks are shown in the diagram below (**Figure 9**).

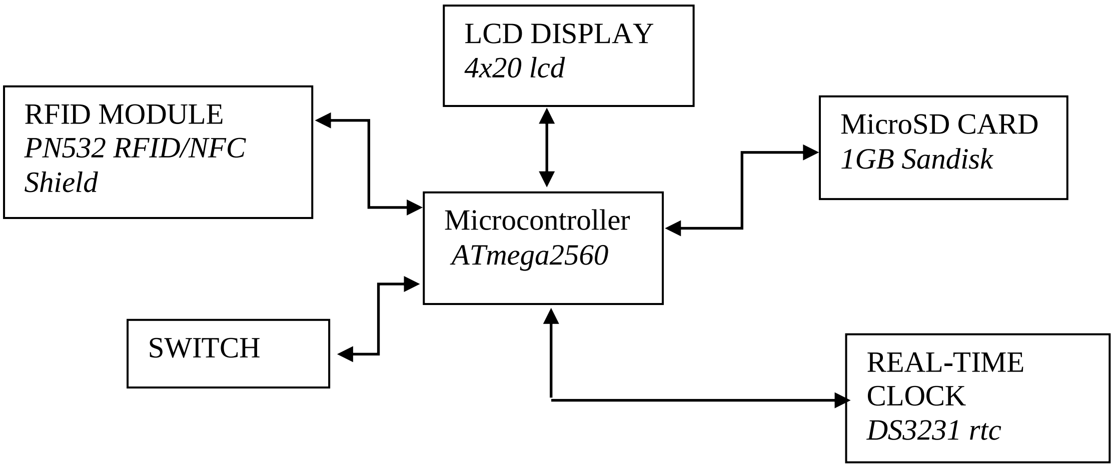


Figure 9: Basic Block Diagram of the system project

RFID Reader Module

The main function of RFID reader module is to read the data installed inside the card. Its working flow started by sending a command from Arduino Mega 2560 (microcontroller) to the reader module together with authorization key where UART interface is used as a medium. In addition, the presence of authorization key can avoid any unauthorized access. If there are two possible cases happen which is involve an authorized card and another unauthorized card, the reader will sent the data to the microcontroller for the authorized card only. The rest, ‘’card error’’ will display at the serial monitor.

LCD Display Interface

Liquid Cristal Display (LCD) is an electronic display module that provide 4bit user interface with 5x7 pixel matrix. This LCD has two registers which are command and data where SPI protocol is used to connect it with microcontroller. In this project, if the authorized RFID card was swiped, LCD display will shows the identification number and student's name with date and time whereas "CARD ERROR" will shows when the system unable to detect the card. For the case of unauthorized card, the system shows "UNKNOWN CARD" on the LCD display.

MicroSD Card Interface

A 1GB Micro SD Card is used as a storage part which is connected together with microcontroller through SPI protocol powered by 3.3v power supply. Its format is FAT32 file system and this routine implemented on the microcontroller. Due to the different power supply required for Micro SD card and microcontroller, voltage divider network inserted between them. Besides, the database stored inside this card is in text file called database.txt and templog.txt. Normally, microcontroller stored data in the templog.txt file temporarily and in this project, it stored all the card punched records which is student's name and identification number. Microcontroller will erase all the temporary templog.txt file database right after it receives acknowledgment from remote computer and also when the database completely save the database into Micro SD card in form of database.txt file.

Real-Time clock

The DS3231 serial real-time clock (RTC) is a module that provide I2C interface with standard and fast integration. It is so easy to connect with microcontroller due to its simple behaviour and powered by onboard coin cell battery which can make it run for years. The time at +- 2ppm accuracy will be kept constantly from the presence of integrated temperature compensated crystal of the clock. Furthermore, this RTC not only for the time saver but it also stored the years, months, weeks, and days. From that, it will automatically correcting for month with less than 31 days, including correction for leap year. It provide AM/PM indicator with format used either 24-hour or 12-hour.

SOFTWARE ARCHITECTURE

Making the hardware is not sufficient for proper utilization of the system. The embedded Software also plays a major role for proper functioning of the hardware. In this project, the computer programming used is Event-Driven Programming. The language used is C programming which is followed the type of microcontroller, Atmega2560. After completing design and development of the embedded system, an application software will be developed. There are two main group of application software need to considered. First, the swiped card process on the portable device and the other one is uploading the swiped data into the PC [13]. **Figure 10** shows the event driven flow for the swipping card process. At first, the system is in idle state. After the RFID card swiped onto the RFID reader, the state change to the read mode. Then, the reader will identify the card and store the information in the MicroSD Card which can be called as write mode. The state return back to idle mode after done in storing data. In updating part, the data stored will be first check and then new file will be created. After that, the updated data will be save so that they can be transferred to the personal computer in the readable form. Finally, the system will be closed.

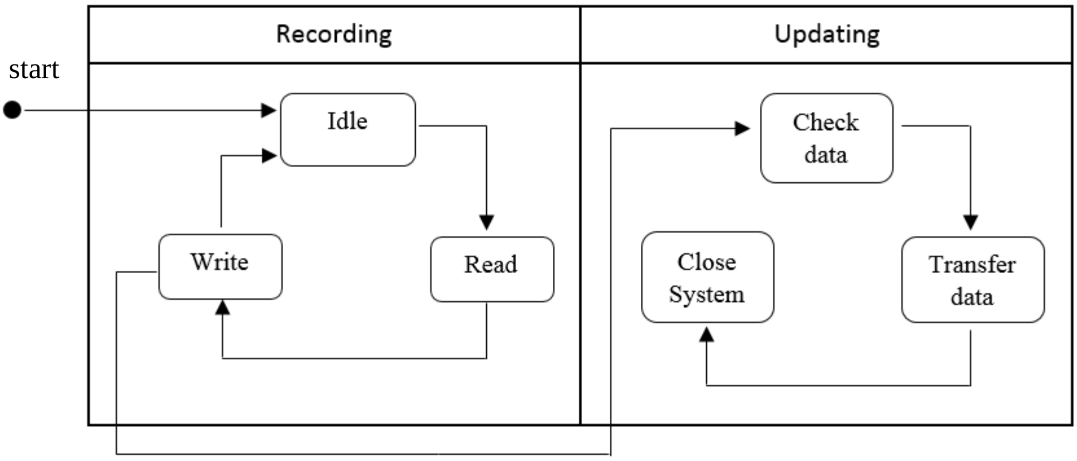


Figure 10: Even-Driven Flow

3.3 Key Milestones

Table 2: Key Milestone of Final Year Project 1

FINAL YEAR PROJECT 1 KEY-MILESTONE															
No.	**ACTIVITIES**	**WEEKS**													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	**Title Selection**		x												
2	**Preliminary Research & Literature Review**					x									
3	**Initial Design**							x							
4	**Hardware Procurement**								x						
5	**Hardware Integration**														x
6	**Software Development**														x

Table 3: Key Milestone of Final Year Project 2

FINAL YEAR PROJECT 2 KEY-MILESTONE															
No.	**ACTIVITIES**	**WEEKS**													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	**Prototype Development and Testing**							x							
2	**Troubleshooting and Improvement**									x					
3	**Completing Final Prototype**													x	
4	**Electrex**										x				
5	**Preparing Report/ Thesis**													x	
6	**Final Viva**														x

3.4 Gantt Chart

Table 4: Gantt Chart of Final Year Project 1

FINAL YEAR PROJECT 1 GANTT CHART															
No.	**ACTIVITIES**	**WEEKS**													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	**Select & Confirmation of Project Title**	🟨	x												
2	**Preliminary Research & Literature Review**		🟨	🟨	🟨	🟨	🟨								
3	**Preparing and Submitting Draft Extended Proposal**				🟨	x									
4	**Submission of Extended Proposal**						x								
5	**Initial Design**					🟨	🟨	x							
6	**Hardware Procurement**							🟨	x						
7	**Set Up The Initial Prototype**									🟨	🟨	🟨	🟨	🟨	🟨
	Hardware Integration									🟨	🟨	🟨	🟨	🟨	🟨
	Arduino with RFID									x					
	Arduino with SD card										x				
	Arduino with USB														x
	Software Development									🟨	🟨	🟨	🟨	🟨	🟨
8	**Proposal Defence**									x					
9	**Preparing and submitting interim draft report**										🟨	🟨	🟨	x	
10	**Submission of Interim Report**														x

Table 5: Gantt Chart of Final Year Project 2

FINAL YEAR PROJECT 2 GANTT CHART															
No.	**ACTIVITIES**	**WEEKS**													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	**Prototype Development and Testing**	🟨	🟨	🟨	🟨	🟨	🟨	x							
2	**Submission of Progress Report**	🟨	🟨	🟨	🟨	🟨	🟨	🟨	x						
3	**Troubleshooting and Improvement**							🟨	🟨	x					
4	**Completing Final Prototype**									🟨	🟨	🟨	🟨	x	
5	**Electrex**										x				
6	**Submission of Technical Paper**	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	x		
5	**Preparing Final Report/ Thesis**	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	x	
6	**Final Viva**														x

3.5 Tool & Software Required

Tools & softwares that will be used throughout the project are:

- Microcontroller board (Arduino Mega 2560)
- RFID reader module (Adafruit PN532 RFID/NFC Shield)
- RFID cards (Mifare card)
- Memory card module (Sparkfun MicroSD shield)
- 1GB Sandisk MicroSD card
- 4x20 LCD screen
- DS 3231 Real Time Clock
- Arduino Integrated Development Environment (IDE) software

CHAPTER 4: RESULT AND DISCUSSION

4.1 Module Testing

Module testing is one of important phase in this project. The main objective on running this testing is to ensure that all the module are in good condition and working as expected. The module involes are RFID module, MicroSD card module and LCD module.

Arduino Mega 2560 with PN532 RFID/NFC shield

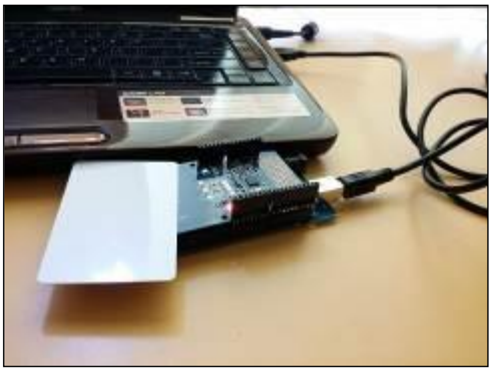
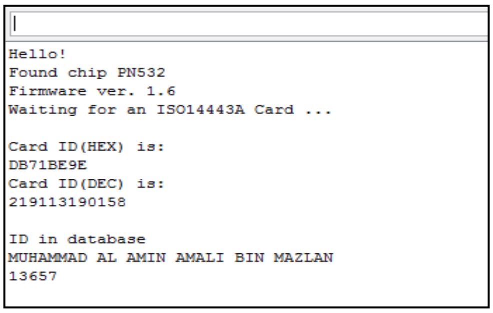


Figure 11: Arduino Mega and RFID



```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...

Card ID(HEX) is:
DB71BE9E
Card ID(DEC) is:
219113190158

ID in database
MUHAMMAD AL AMIN AMALI BIN MAZLAN
13657
```

Figure 12: Serial monitor Display

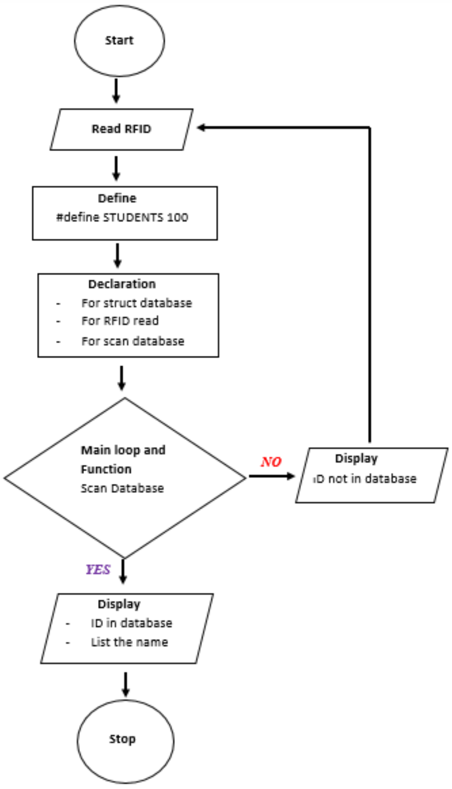


Figure 13: Flow chart of RFID integration (coding)

The hardware integration between PN532 RFID/NFC module and Arduino Mega 2560 start by reading and understanding the datasheet of both items. Every i/o stack have different function. If there is a wrong connection, the possabality of the components to be broken very high. So, safety precaution must be taking carefully. In order to configure these components, RFID module will stack on the arduino and then USB B type cable is used to connect them with personel computer (**Figure 11**). Arduino Integrated Development Environment (IDE) is a software used in configuring any Arduino product. **Figure 13** shows a coding flow of scanning database inside the Arduino and **Figure 12** shows the serial monitor display after swipe a card.

Arduino Mega 2560 with sparkfun MicroSD CARD shield

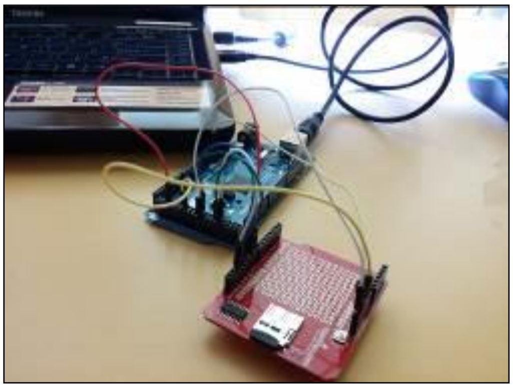
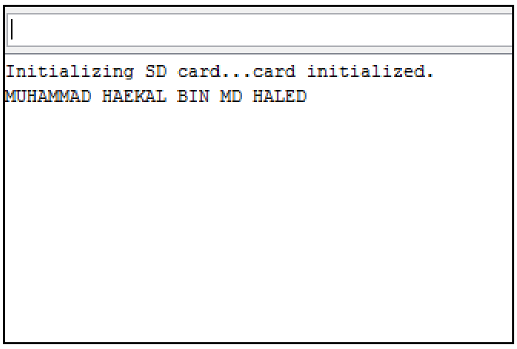
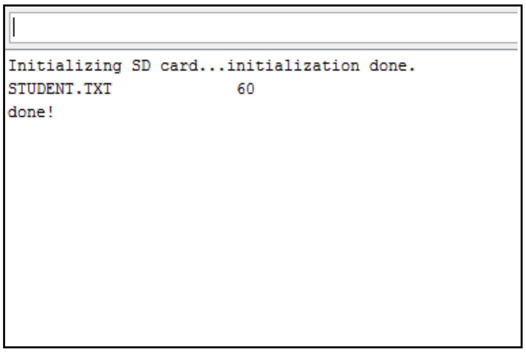


Figure 14: Arduino Mega with MicroSD card shield



```
Initializing SD card...card initialized.
MUHAMMAD HAEKAL BIN MD HALED
```

Figure 15: Serial Monitor Display for write task



```
Initializing SD card...initialization done.
STUDENT.TXT            60
done!
```

Figure 16: Serial Monitor Display for List File

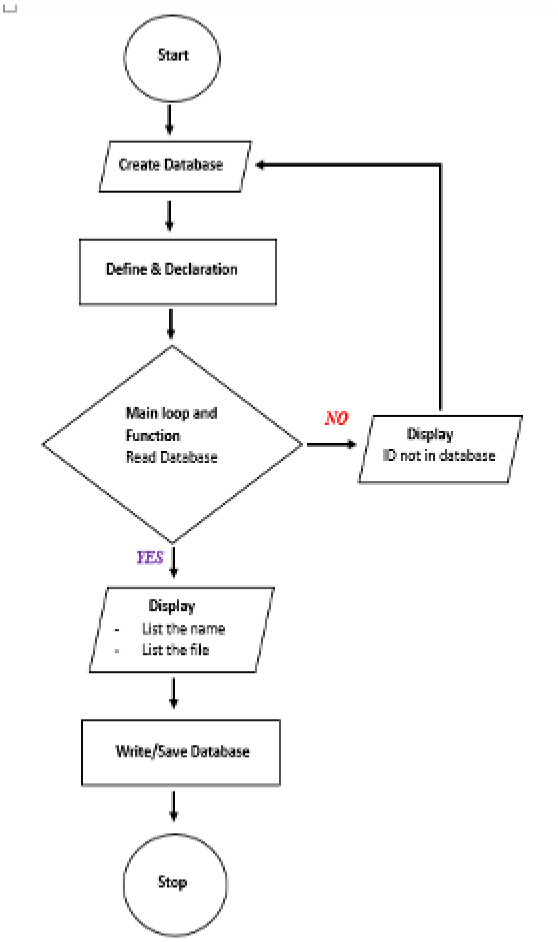


Figure 17: Flow chart of MicroSD card integration (coding)

The integration between MicroSD card module with capacity 1GB and Arduino Mega 2560 involve in a different i/o stack with RFID module to ensure there is no overlap coding. In order to configure these components, MicroSD card shield does not stack on the arduino but using male to male jumper and then USB B type cable is used to connect them with personel computer (**Figure 14**). 7-pin involve in this integration which are SD 8 chip select to digital 8, SD 12 MOSO to digital 50, SD 11 MOSI to digital 51, SD 13 CLK to digital 52, SD 10 to digital 53, SD ground to digital ground and SD +3.3v to digital +3.3v. Figure 17 shows coding flow whereas **Figure 15 and 16** shows the serial monitor display (output).

Arduino Mega 2560 with 4x20 LCD

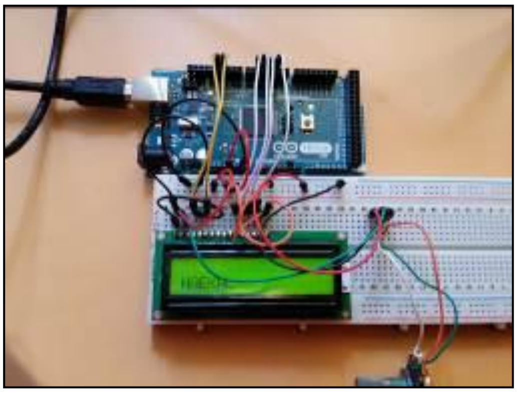


Figure 18: Arduino Mega with 4x20 LCD

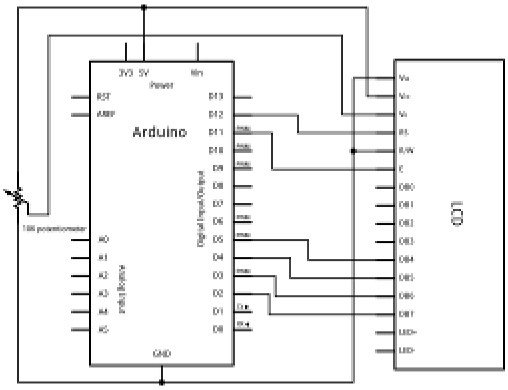


Figure 19: Schematic Diagram of LCD wiring

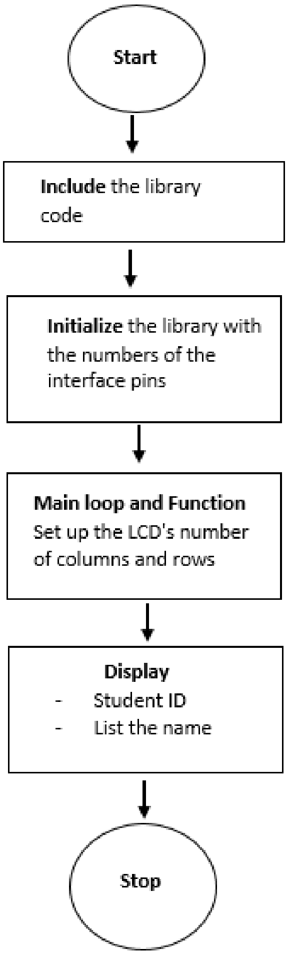

Start
Include the library code
Initialize the library with the numbers of the interface pins
Main loop and Function
Set up the LCD's number of columns and rows
Display
- Student ID
- List the name
Stop

Figure 20: Flow chart of 4x20 LCD integration (coding)

4x20 LCD module is a simple module that have 16-pin with 5x7 pixel matrix display that compitible for most microcontroller including Arduino Mega. In this test, there are only 12 pin involve and one variable resister to control the LCD brightness. Each pin have their own function which are LCD RS pin to digital pin 12, LCD Enable pin to digital pin 11, LCD D4 pin to digital pin 5, LCD D5 pin to digital pin 4, LCD D6 pin to digital pin 3, LCD D7 pin to digital pin 2, LCD R/W pin to ground, LCD 2 and 15 to digital +5v, and lastly LCD 1,5,16 to Ground. In **Figure 16** shows the pictorial wiring integration arrangement of Arduino Mega and LCD module where the schematic diagram in **Figure 17** as a reference. For the software part the flow of LCD system can be visualized in a form flow chart (**Figure 18**). All module test coding are attached in **Appendix A**.

4.2 Prototype Development

Initial Phase

Development of prototype is a most important part in this project. All module (Sparkfun microSD shield, PN532 RFID/NFC shield, and 4x20 LCD) will be combine together under a single coding which is started just after finish on module test work. The hardware installation must be done simulteneously with software development in order to avoid any faulty. Before running the installation, as a safety precaution, every single specification for each module must be obeyed especially for the amount of power source. In the initial prototype, jumper wire is used as a bridge between module instead of stack on the main microcontroller (Arduino Mega 2560). This is because all connection need to be cleared so that troubleshooting can be done easily. From that, the summary of module arrangement can be created as in **Table 6**. **Figure 21** shows the initial prototype of hardware installation which is forcusing more on software development of this project.

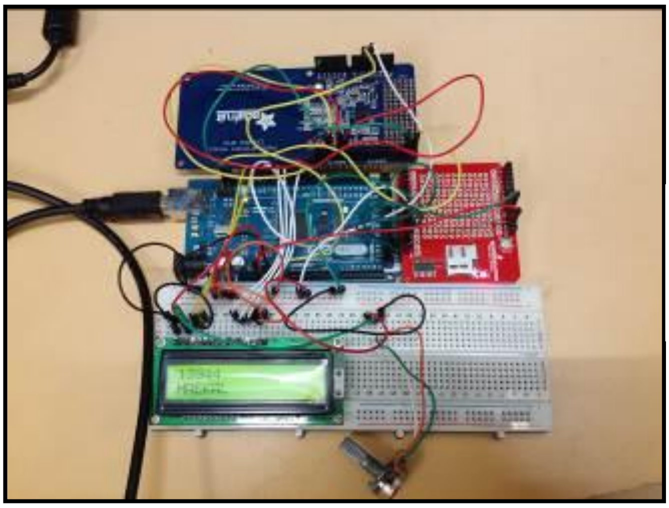
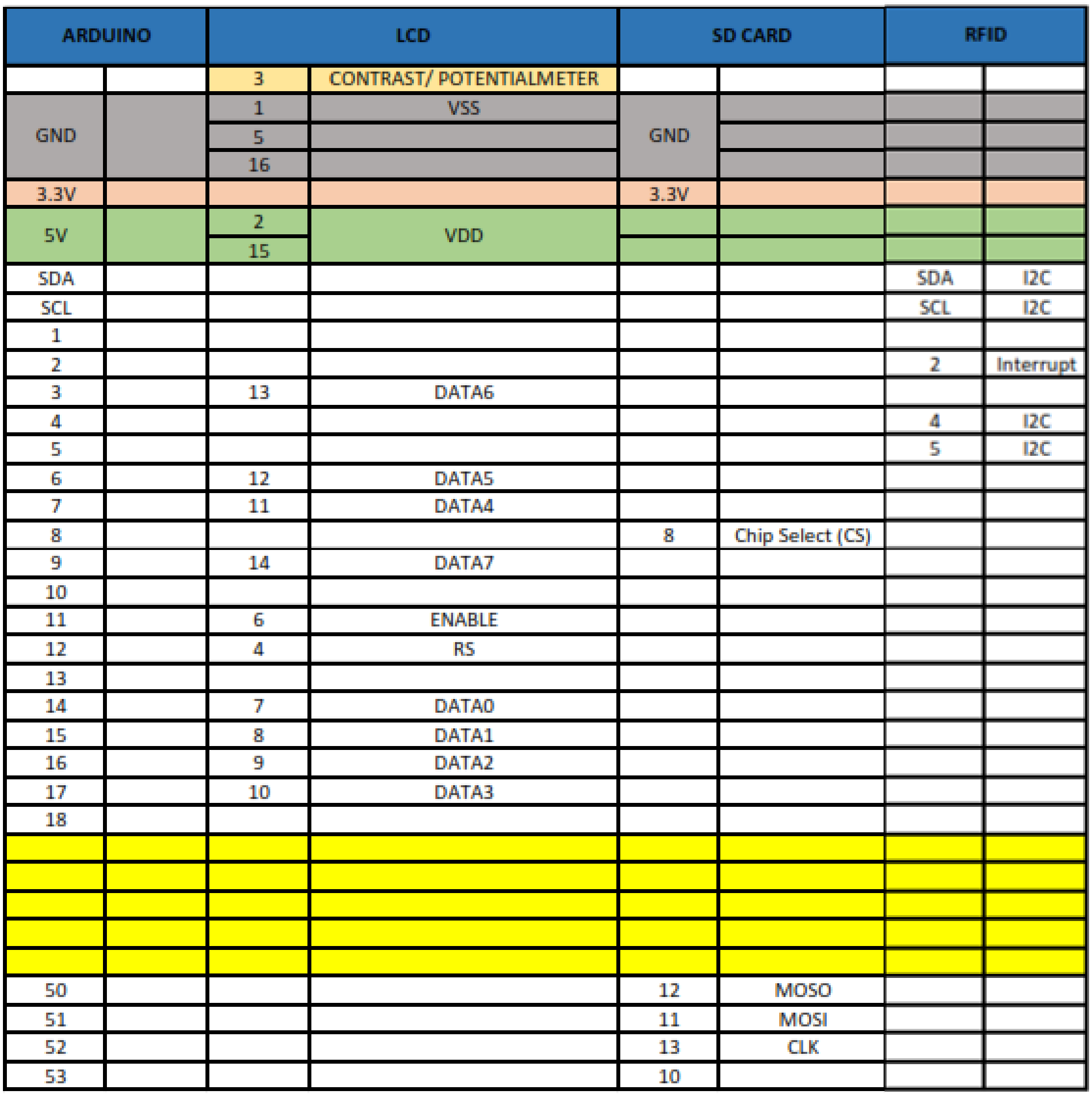


Figure 21: Hardware Installation of Initial Prototype

Table 6: Summary of Module Arrangement for Initial Phase



ARDUINO		LCD		SD CARD		RFID	
		3	CONTRAST/ POTENTIALMETER				
GND		1	VSS	GND			
		5					
		16					
3.3V				3.3V			
5V		2	VDD				
		15					
SDA						SDA	I2C
SCL						SCL	I2C
1							
2						2	Interrupt
3		13	DATA6				
4						4	I2C
5						5	I2C
6		12	DATA5				
7		11	DATA4				
8				8	Chip Select (CS)		
9		14	DATA7				
10							
11		6	ENABLE				
12		4	RS				
13							
14		7	DATA0				
15		8	DATA1				
16		9	DATA2				
17		10	DATA3				
18							
50				12	MOSO		
51				11	MOSI		
52				13	CLK		
53				10			

In every coding/ software construction, the first things need to do is creating and drawing the flow chart of the process. It is very important to ensure the perfection and smoothness of process on designing a coding. This phase project's coding can be divided into two tasks which are scanning card ID on RFID module and comparing card ID with master database inside microSD card (**Appendix B**). For the information, the database used is created in text.csv file which is can be represent in microsoft excell. It can be stored up to 100 to 200 students ID number together with name. **Figure 22** shows the coding process flow chart of initial prototype and **Figure 23** shows the database window saved in microSD card.

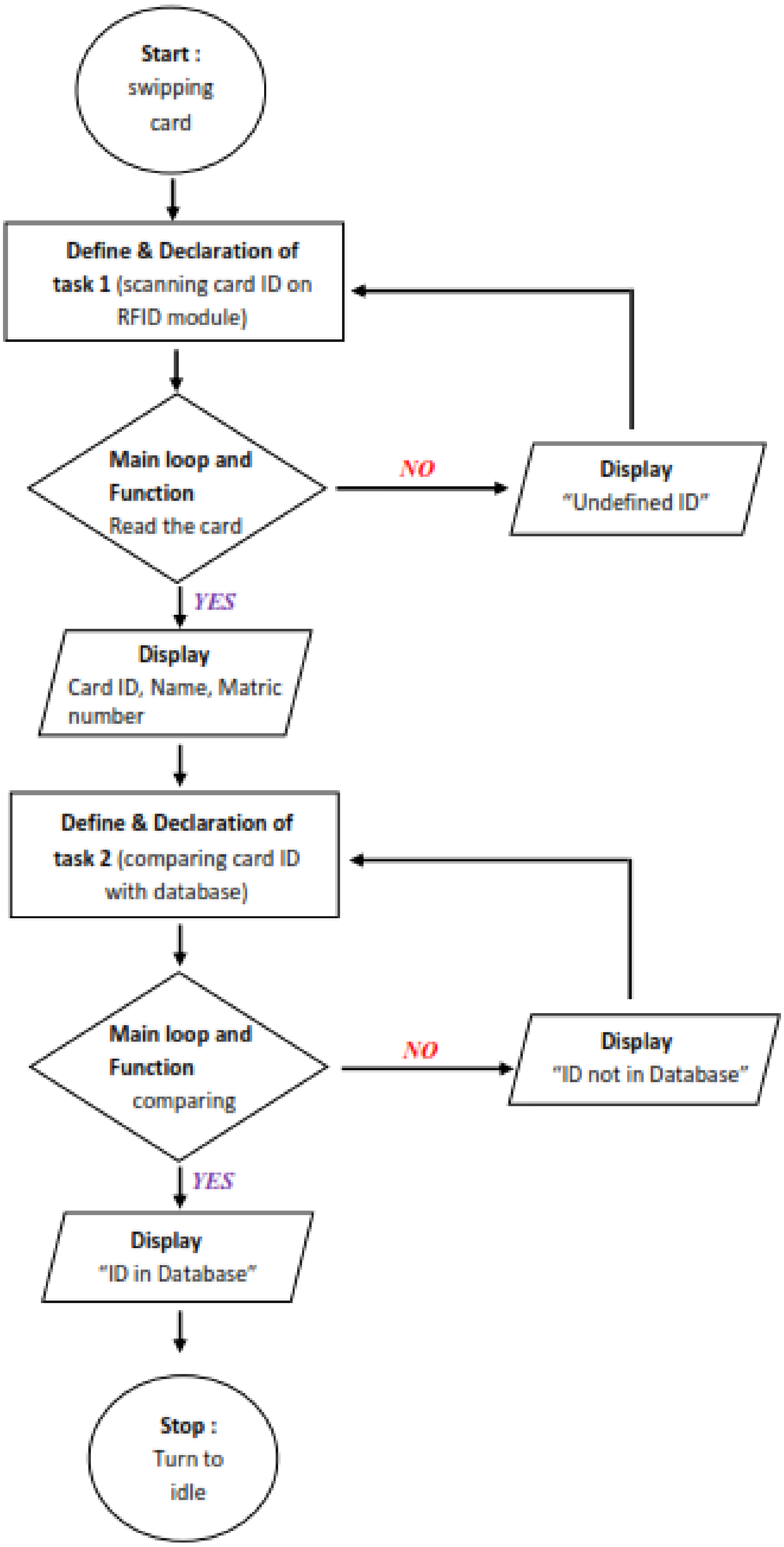
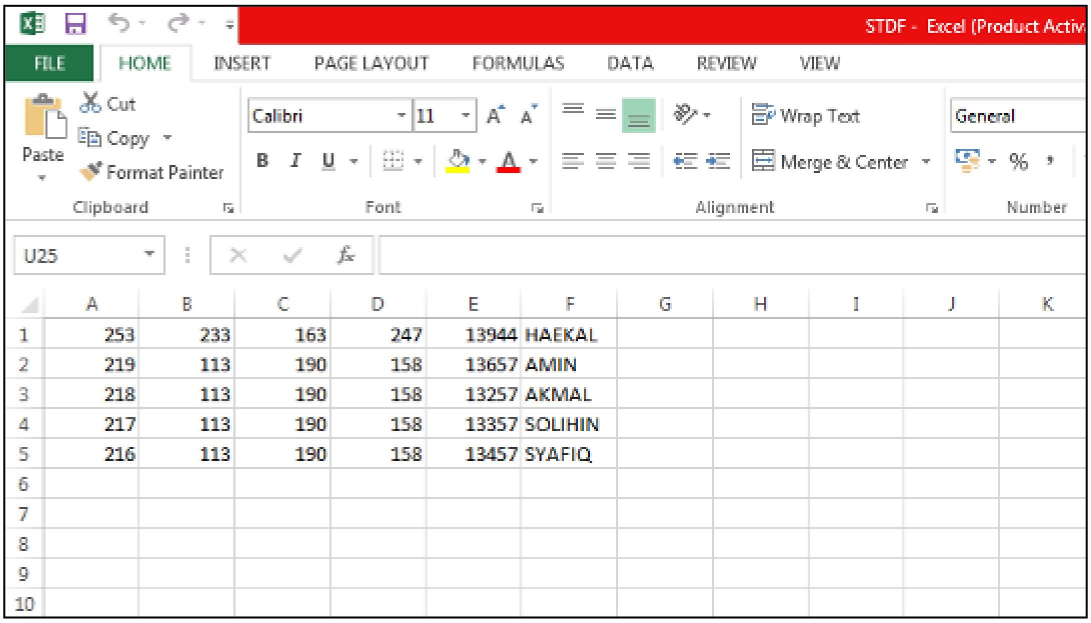


Figure 22: Initial Flow Diagram of the System

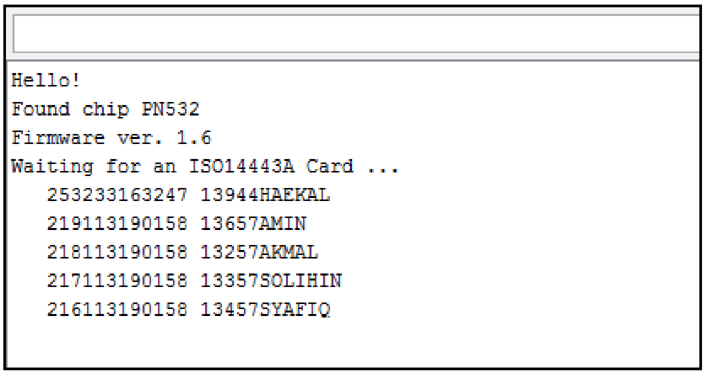


	A	B	C	D	E	F	G	H	I	J	K
1	253	233	163	247	13944	HAEKAL					
2	219	113	190	158	13657	AMIN					
3	218	113	190	158	13257	AKMAL					
4	217	113	190	158	13357	SOLIHIN					
5	216	113	190	158	13457	SYAFIQ					
6											
7											
8											
9											
10											

Figure 23: Student's Database Window (Master Database)

OUTPUT :

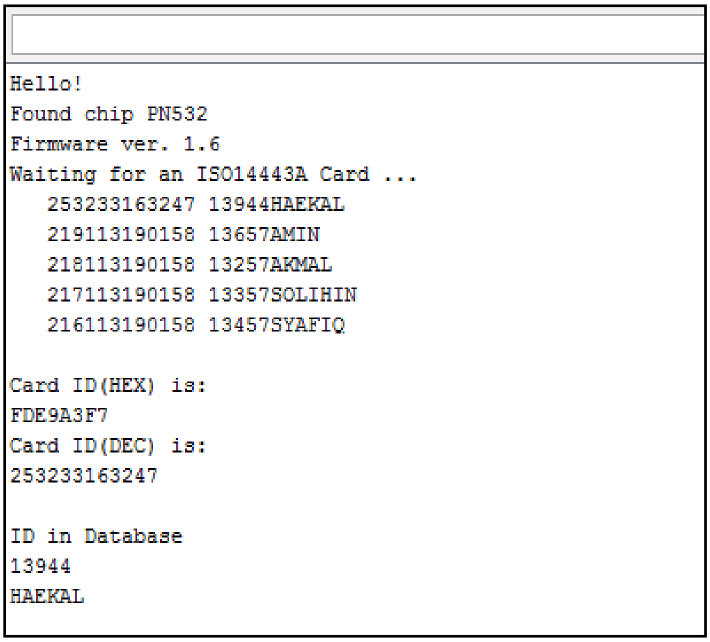
In this phase, the communication between software and hardware is observed in serial monitor with 115200 baud. After the coding (**Appendix B**) are compiled, the serial monitor will list the database including the student's names and their matric numbers which is stored inside the microSD card as in **Figure 24**. In the same time, this serial monitor also shows the type of chip used in RFID module, its version and also type of compitible card.



```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944HAEKAL
   219113190158 13657AMIN
   218113190158 13257AKMAL
   217113190158 13357SOLIHIN
   216113190158 13457SYAFIQ
```

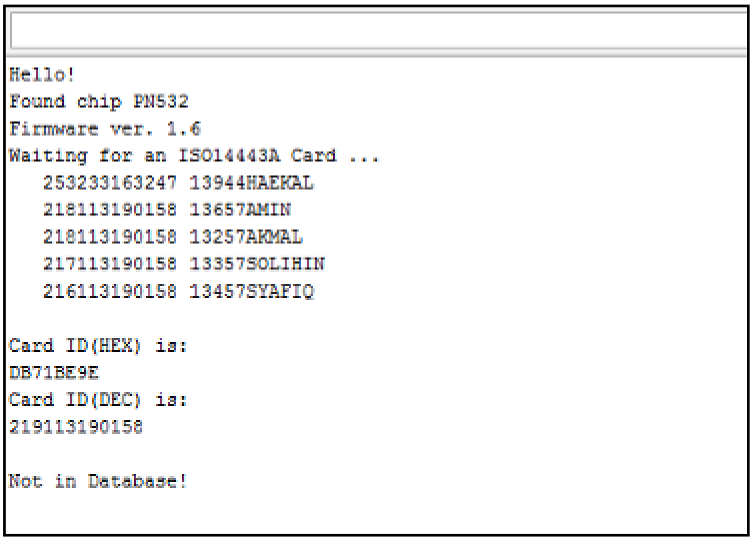
Figure 24: Serial Monitor Display before
swipping milfare card of Initial Phase

When swipping a milfare card, the serial monitor will list down a few additional things which are ID card number in hexadecimal and decimal, name together with matric number of card's owner and scanning condition. If the card is set/ stored in the database, serial monitor will show "ID in Database" as in **Figure 25** but if the card is not set/ stored, it will show "Not in Database" as in **Figure 26**.



```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944HAEKAL
   219113190158 13657AMIN
   218113190158 13257AKMAL
   217113190158 13357SOLIHIN
   216113190158 13457SYAFIQ

Card ID(HEX) is:
FDE9A3F7
Card ID(DEC) is:
253233163247

ID in Database
13944
HAEKAL
```

Figure 25: Serial Monitor Display after swipping
milfare card of Initial Phase (ID exist)



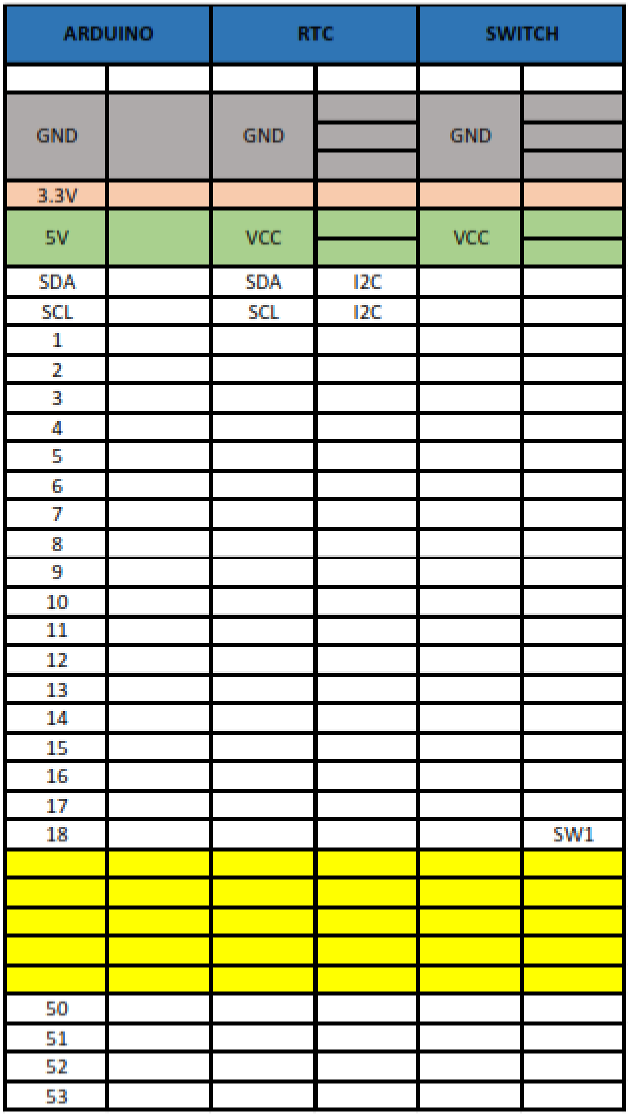
```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944HAEKAL
   218113190158 13657AMIN
   218113190158 13257AKMAL
   217113190158 13357SOLIHIN
   216113190158 13457SYAFIQ

Card ID(HEX) is:
DB71BE9E
Card ID(DEC) is:
219113190158

Not in Database!
```

Figure 26: Serial Monitor Display after swipping
mifare card of Initial Phase (ID not exist)

Final Phase

After finish on initial phase, the development of prototype was proceed to the most crucial part which is updated the database. From that, a few additional features need to add which are Real Time Clock (RTC) to save the attendance date/time, switches to change the state of the system and 2500 mAh power bank as a power source of this device. **Table 7** shows the additional module arrangement inside the prototype.

Table 7: Additional Module Arrangement in Final Phase



ARDUINO		RTC		SWITCH	
GND		GND		GND	
3.3V					
5V		VCC		VCC	
SDA		SDA	I2C		
SCL		SCL	I2C		
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					SW1
50					
51					
52					
53					

For the software part, an additional task needs to be programmed. The updated database will be created in text.csv file and save inside the microSD card. To avoid any mistakes in creating a new coding, a flow diagram will be edited from the initial phase in order to illustrate the flow of the system. **Figure 27** shows the final flow diagram of the system and the final coding are shows in **Appendix C**.

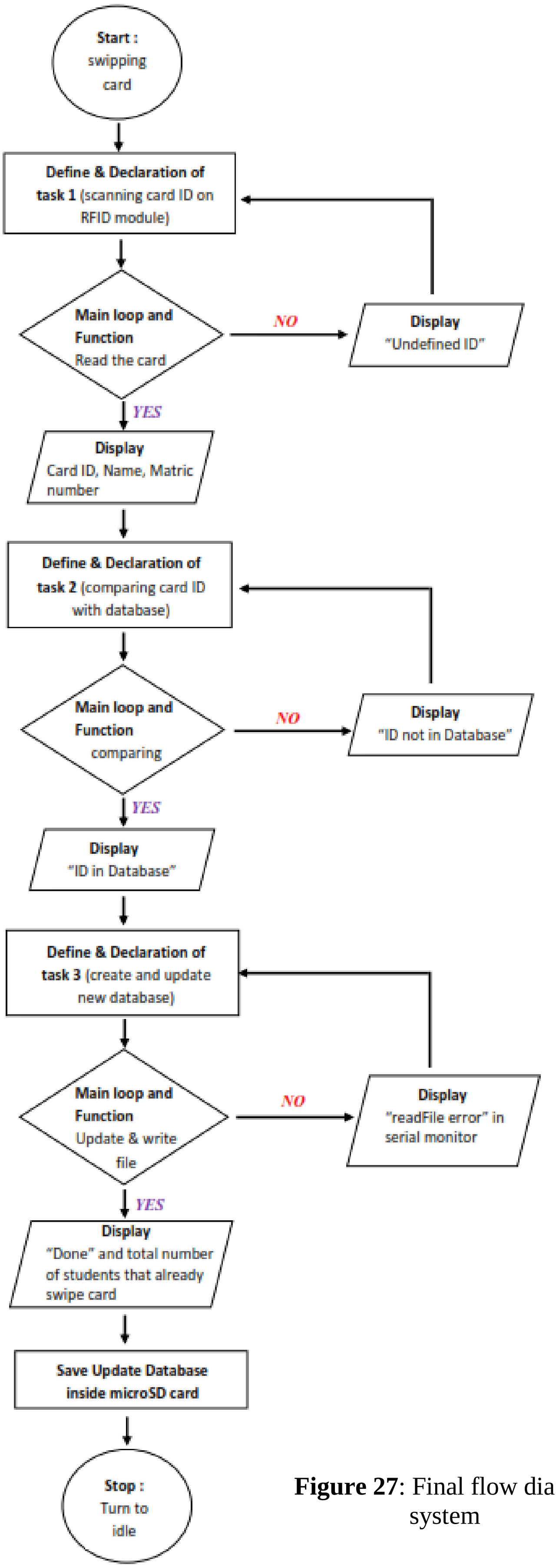
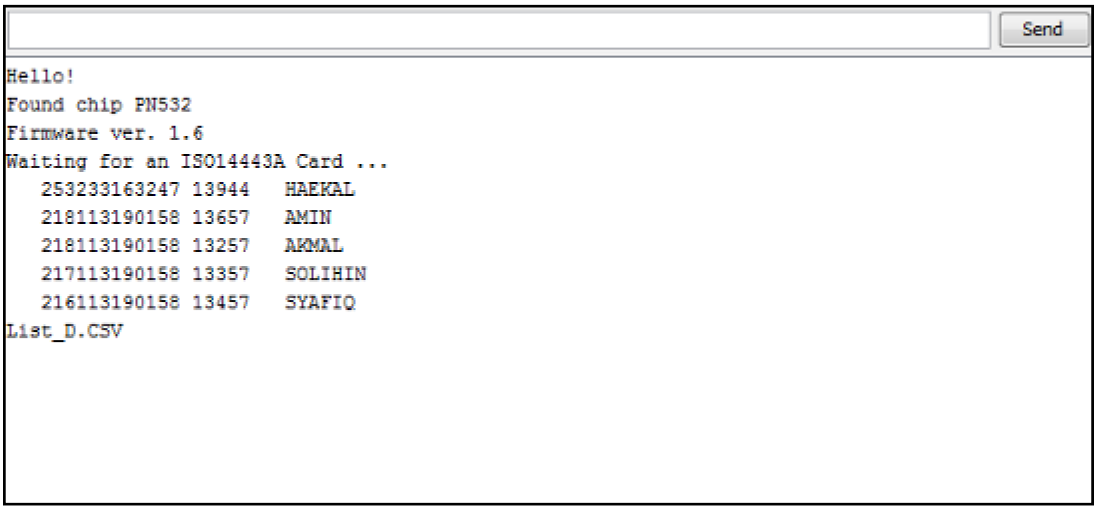

Start : swipping card
Define & Declaration of task 1 (scanning card ID on RFID module)
Main loop and Function Read the card
NO
Display "Undefined ID"
YES
Display Card ID, Name, Matric number
Define & Declaration of task 2 (comparing card ID with database)
Main loop and Function comparing
NO
Display "ID not in Database"
YES
Display "ID in Database"
Define & Declaration of task 3 (create and update new database)
Main loop and Function Update & write file
NO
Display "readFile error" in serial monitor
YES
Display "Done" and total number of students that already swipe card
Save Update Database inside microSD card
Stop : Turn to idle

Figure 27: Final flow diagram of the system

OUTPUT :

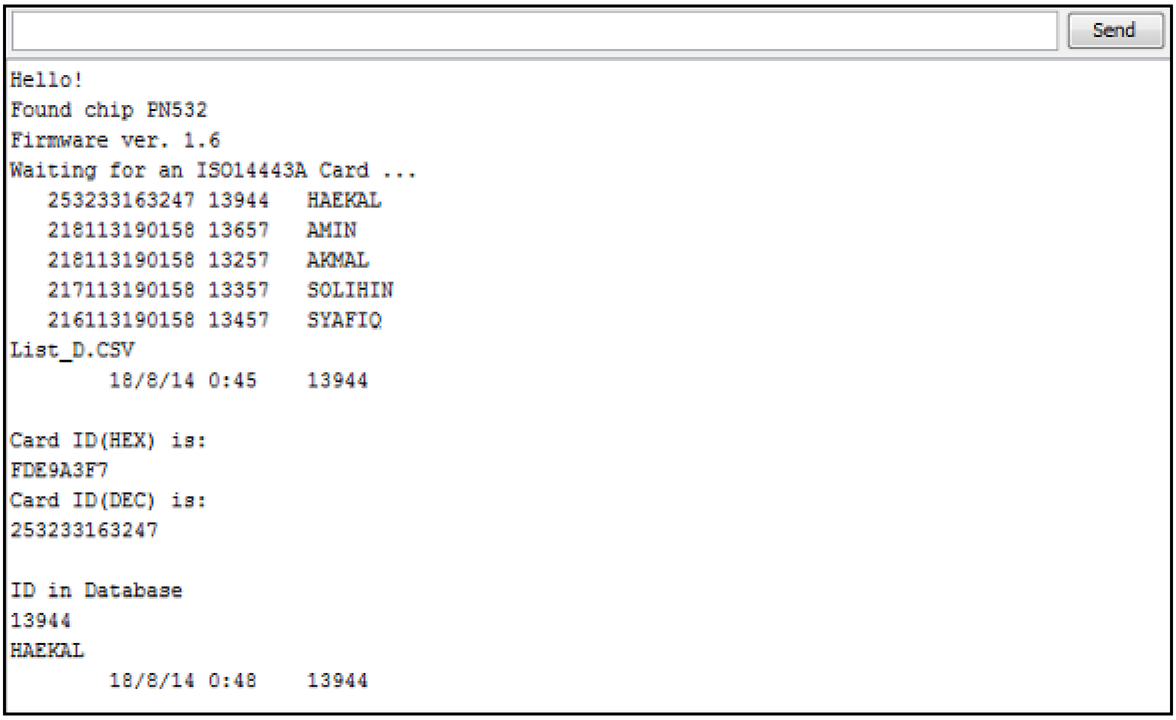
In final phase, the communication between software and hardware is also observed in serial monitor with 115200 baud. After the coding (**Appendix C**) are compiled, the serial monitor will listed the master database including the student's names and their matric numbers which is stored inside the microSD card as in **Figure 28**. In the same time, the LCD will display "Please scan.." to give a message that the system is ready to operate. In this serial monitor also shows the type of chip used in RFID module, its version, type of compitible card and also file name which is "List_D.CSV". The new file can be created by pressing the push button switch at the prototype's body.



```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944   HAEKAL
   218113190158 13657   AMIN
   218113190158 13257   AKMAL
   217113190158 13357   SOLIHIN
   216113190158 13457   SYAFIQ
List_D.CSV
```

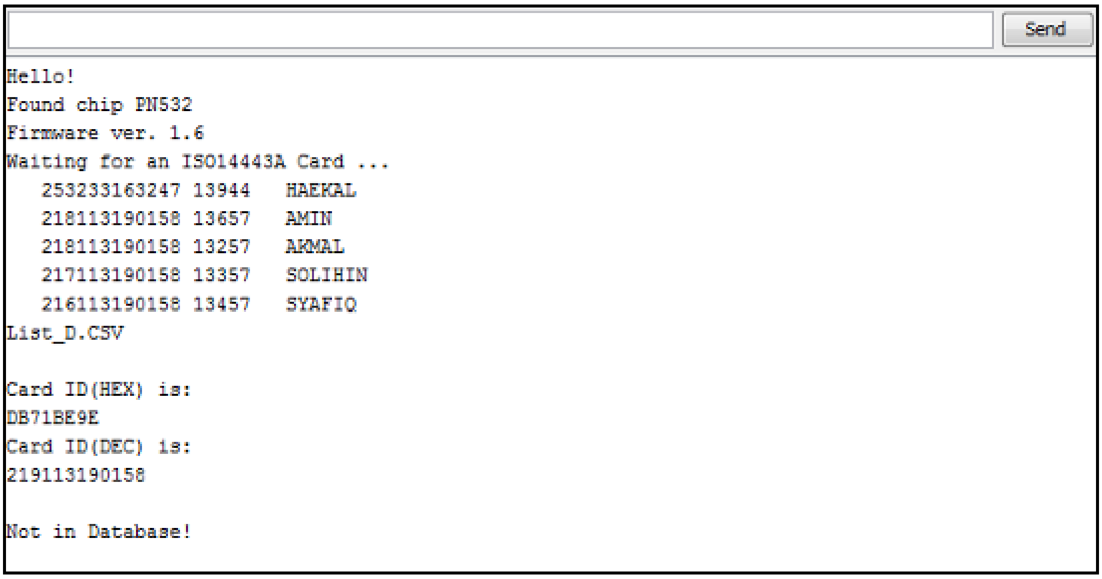
Figure 28: Serial Monitor Display before swipping
mifare card of Final Phase

After swipping a mifare card, the serial monitor will list down a few details which are ID card number in hexadecimal and decimal, name together with matric number of card's owner and scanning condition. If the card is set/ stored in the database, serial monitor will show "ID in Database" as in **Figure 29** but if the card is not set/ stored, it will show "Not in Database" as in **Figure 30**. The card can be swiped and save only for a once and if it is swipped repeatedly, the serial monitor will display "Already Updated Attendance" as in **Figure 31**. Besides, a new feature is added in this prototype which is the time and date record. From that, the file become more easy to keep track.



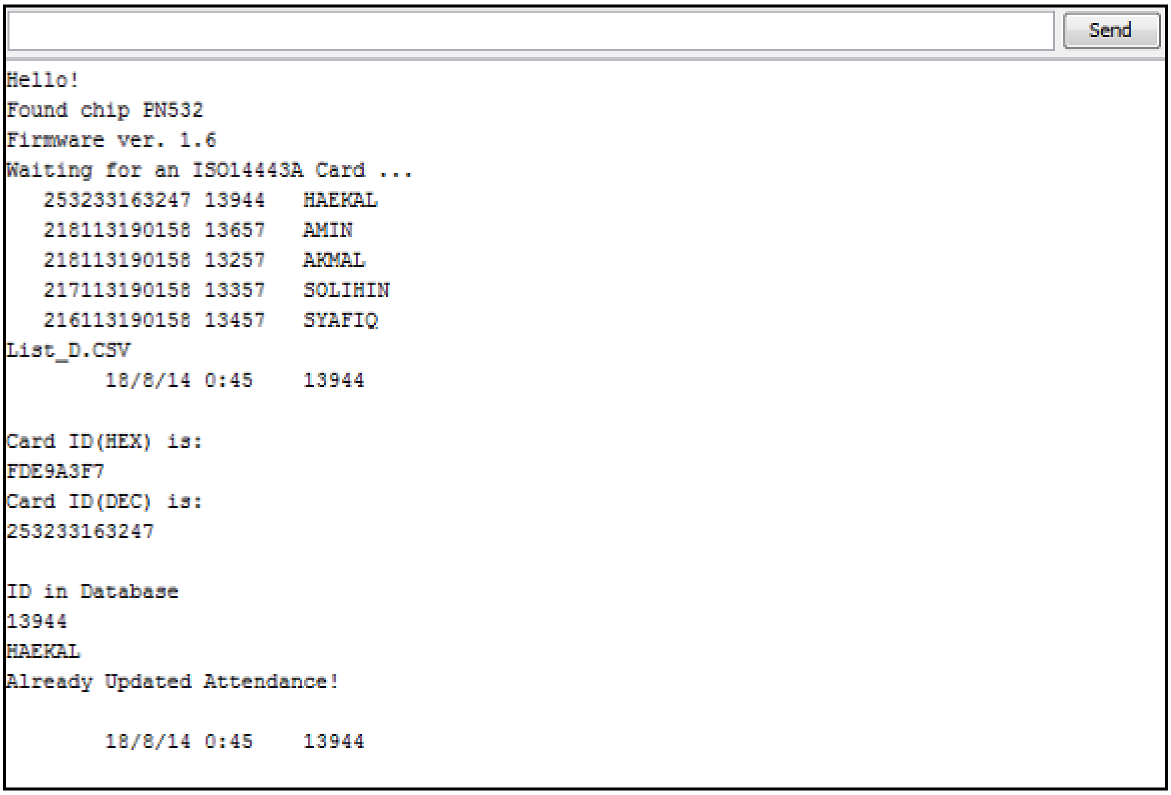
```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944   HAEKAL
   218113190158 13657   AMIN
   218113190158 13257   AKMAL
   217113190158 13357   SOLIHIN
   216113190158 13457   SYAFIQ
List_D.CSV
        18/8/14 0:45    13944

Card ID(HEX) is:
FDE9A3F7
Card ID(DEC) is:
253233163247

ID in Database
13944
HAEKAL
        18/8/14 0:48    13944
```

Figure 29: Serial Monitor Display after swipping milfare card of Final Phase (ID exist)



```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944   HAEKAL
   218113190158 13657   AMIN
   218113190158 13257   AKMAL
   217113190158 13357   SOLIHIN
   216113190158 13457   SYAFIQ
List_D.CSV

Card ID(HEX) is:
DB71BE9E
Card ID(DEC) is:
219113190158

Not in Database!
```

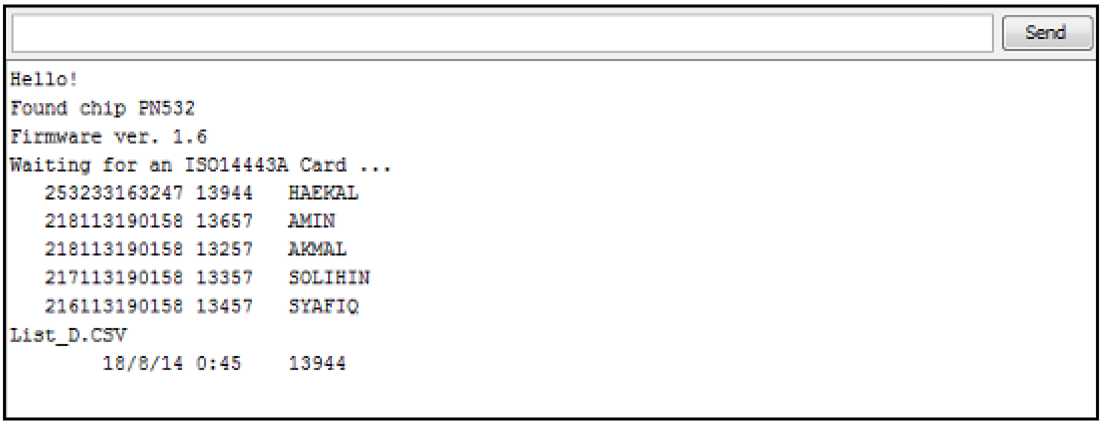
Figure 30: Serial Monitor Display after swipping milfare card of Final Phase (ID not exist)



```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944   HAEKAL
   218113190158 13657   AMIN
   218113190158 13257   AKMAL
   217113190158 13357   SOLIHIN
   216113190158 13457   SYAFIQ
List_D.CSV
        18/8/14 0:45    13944

Card ID(HEX) is:
FDE9A3F7
Card ID(DEC) is:
253233163247

ID in Database
13944
HAEKAL
Already Updated Attendance!

        18/8/14 0:45    13944
```

Figure 31: Serial Monitor Display when swipping mifare card repeatedly

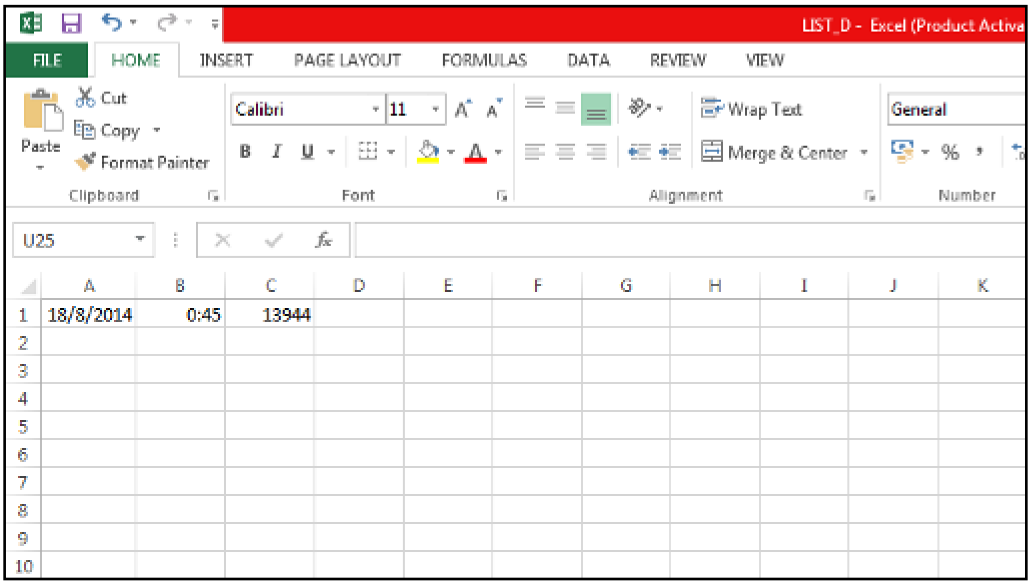
In addition, this prototype is also added with an on/off switch. After record the attendance, it can be stop working by pressing that switch. When turned on the switch back, all the data stored inside microSD card will be displayed as **Figure 32**. This additional feature is a very useful in order to save the power source storage which is the power bank.



```
Hello!
Found chip PN532
Firmware ver. 1.6
Waiting for an ISO14443A Card ...
   253233163247 13944   HAEKAL
   218113190158 13657   AMIN
   218113190158 13257   AKMAL
   217113190158 13357   SOLIHIN
   216113190158 13457   SYAFIQ
List_D.CSV
        18/8/14 0:45    13944
```

Figure 32: Serial Monitor Display after On/Off switch turn on

The last part of this system is creating and updating a new database. When pressing a push button, the new file of database will be created. This prototype can be create new file up to 200 files. There are three details will be updated which are date, time and id number. Figure below shows the database that already update.



	A	B	C	D	E	F	G	H	I	J	K
1	18/8/2014	0:45	13944								
2											
3											
4											
5											
6											
7											
8											
9											
10											

Figure 33: The Updated Database

4.3 Final Prototype Representation

Portable RFID student attendance system prototype has 7.8 inch length, 4.7 inch width and 2.9 inch depth dimention. It has a few features which are On/Off button, Change File Button, LCD Display and USB cable as in **Figure 34**. Its design is simple so that easy to handle and bring everywhere. In assembling process, all the connection and position of components are arranged according to the schematic diagram prepared in designing process. The schematic diagram is designed online at digikey.com. **Figure 35** shows the schematic diagram of the system.

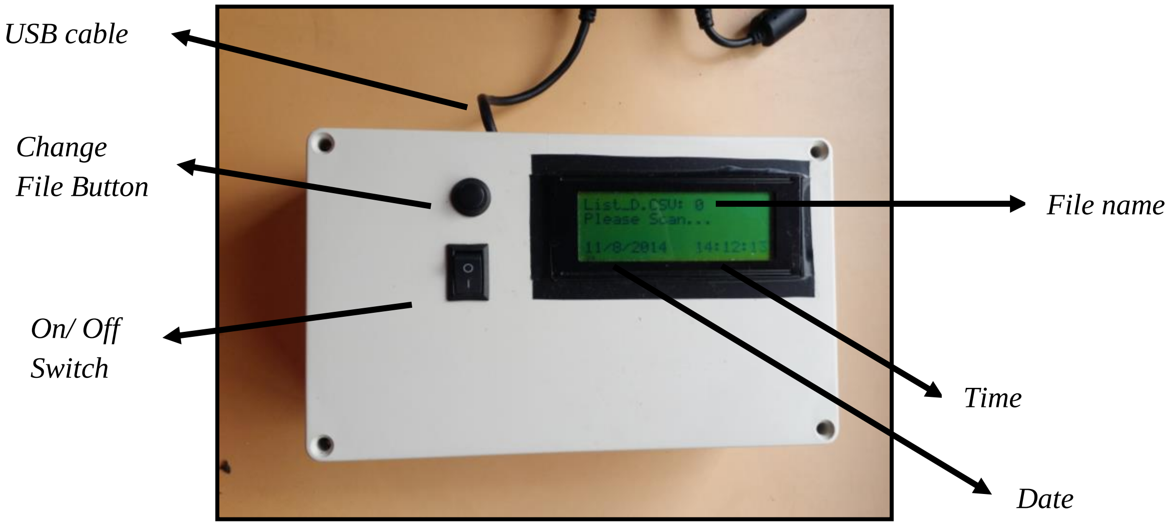


Figure 34: Prototype Features

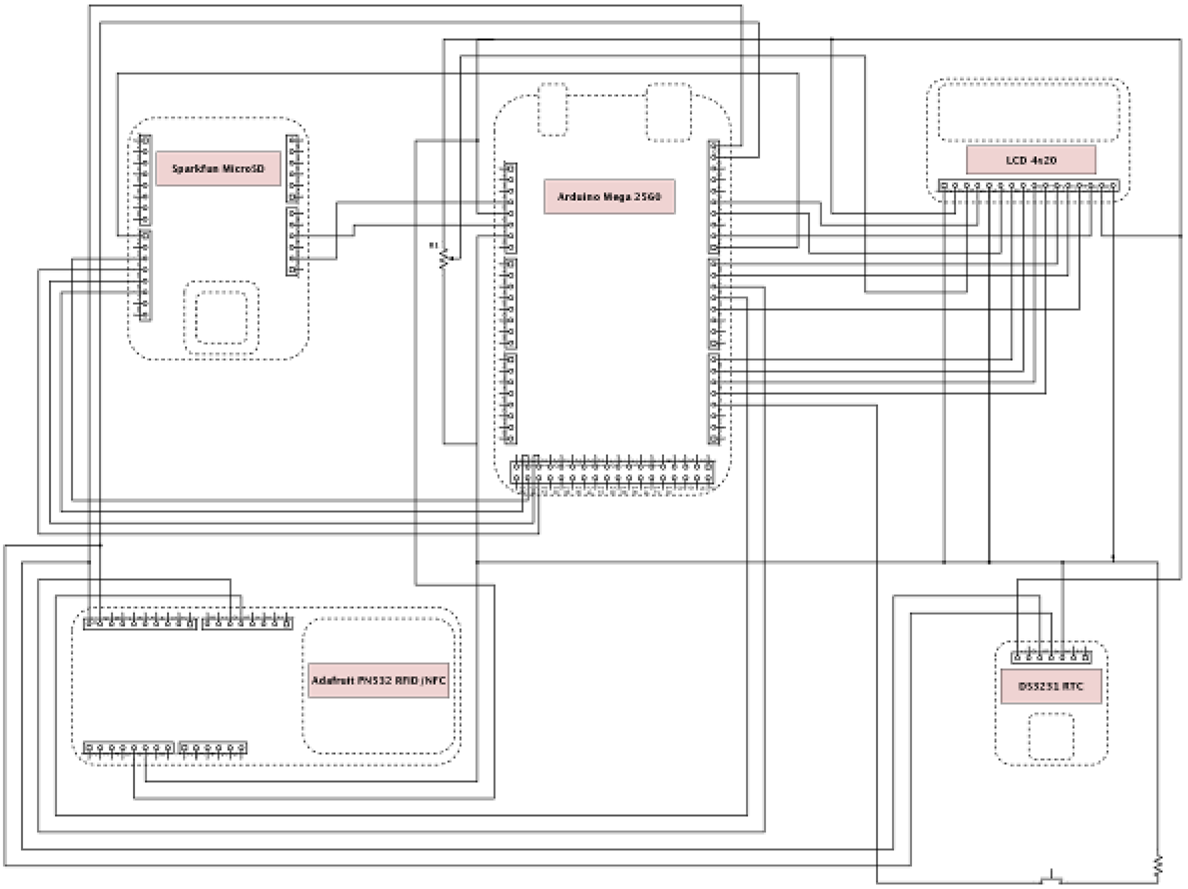


Figure 35: Schematic Diagram of the prototype

The output can be observed throughout the LCD. When a card that are registered inside the database was swipe, the LCD will display “Done”, matric number and name as in **Figure 36**. For the information, the card can be swipe once only for each file. If it is swiped repeteadly, the LCD will display “Already Save” as in **Figure 37**. Besides, if the unregistered card is swipe inside the database, LCD will display “Not in Database” as in **Figure 38**. On prototype’s body was fabricated with two switches which are used to change the file and the other one is to change the on/off condition. This prototype can be last for 1 days and after that, the power bank need to charge back.

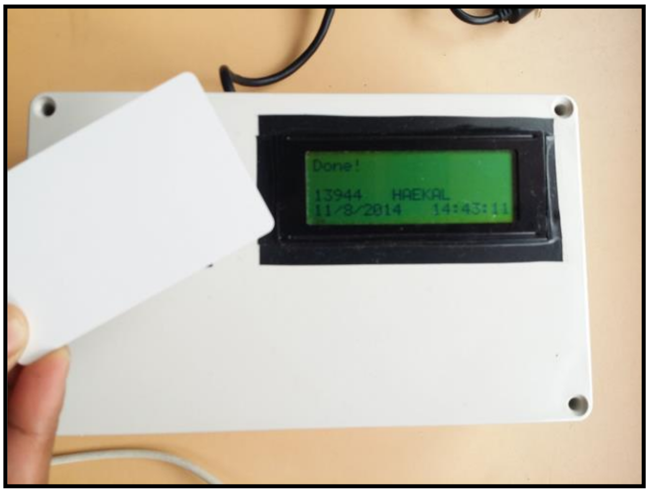


Figure 36: Swipping Registered Card

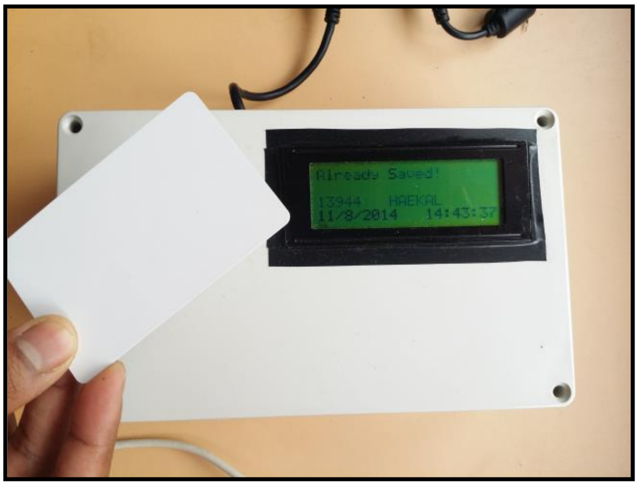


Figure 37: Swipping Registered Card Repeteadly

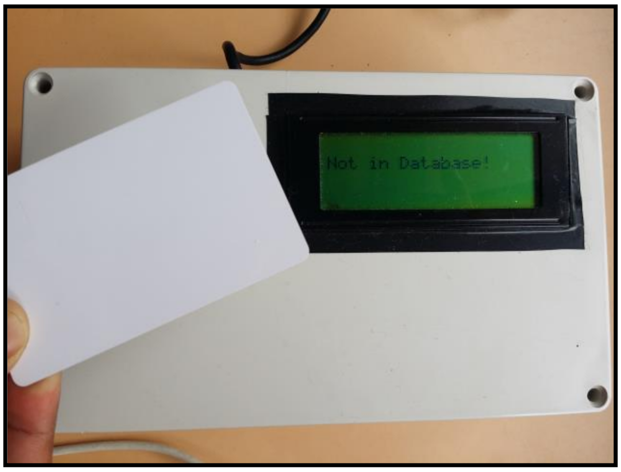


Figure 38: Swipping Unregisterd Card

4.4 Problem Encountered

While developing this project, there are a lot of challenges and problems were faced. Most of them had caused some delay in a project frametime. Luckily, at the end of semester, they were solved succesfully. Some of the problems were caused by lack of understanding in certain area but these mistakes bring new experience and knowledge. One of the problem is configuring the communication between hardware and software part. Actually, creating a coding in IDE needs a good skill in C programming software due to its similarity in script and for the beginner, it will takes a lot of time to master in that area. From that, the most challenging part is creating a task coding for updating a new file and database. Basically, the estimated time to complete that coding is just two week, but due to the understanding problem, it takes about four week to complete. As a measure to overcome that problem, the hardware istallation part had to be done faster than the planning. Moreover, the suitable components need to be used also one of the problem in this project. There are several components took sometimes to purchase such as Arduino Mega 2560 and Adafruit PN532 RFID/NFC module. Thus, the good solution is studied about the components first while waiting the purchasing product arrived.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

The Student Attendance System Using RFID is developed with the purpose to automate and improve the current processes and procedured of manual attendance recording. In developing the system, the student had to prepare 3 major scopes of functions which include the Arduino microcontroller, RFID module and microSD Card module. The system is developed using Arduino Integrated Development Environment (IDE) software as its main platform. IDE is used because of its open source and a very easy to program user interface. Overall, the objectives of this project are achieved. A portable RFID reader with data storage for the purpose of recording students attendance where enable the communication between ATmega 2560 and a computer via serial port Universal Asynchronous Receiver/Transmitter (UART) is managed to build. From that, this device can be propose to be implemented in UTP in order to improve management system especially in recording student's attendance.

There are several recommendations to be made regarding this project. Recommendation are not meant to be used to change this project wholly, but to allow improvements in certain espects and to put some factor into consideration. One of the recommendations for future plan is to develop the design of the prototype become smaller and lighter so that the prototype can be commercialized. On the other hand, the system is recommended to improvise in the uploading the data directly to the personal computer. A thorough research is needed to be made in order to make it succesful.

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[1] Aysha Qaiser and Shoab A Khan, “Automation of Time and Attendance Using RFID System” IEE-ICET 2nd International Conference on Imaging Technology, 2006

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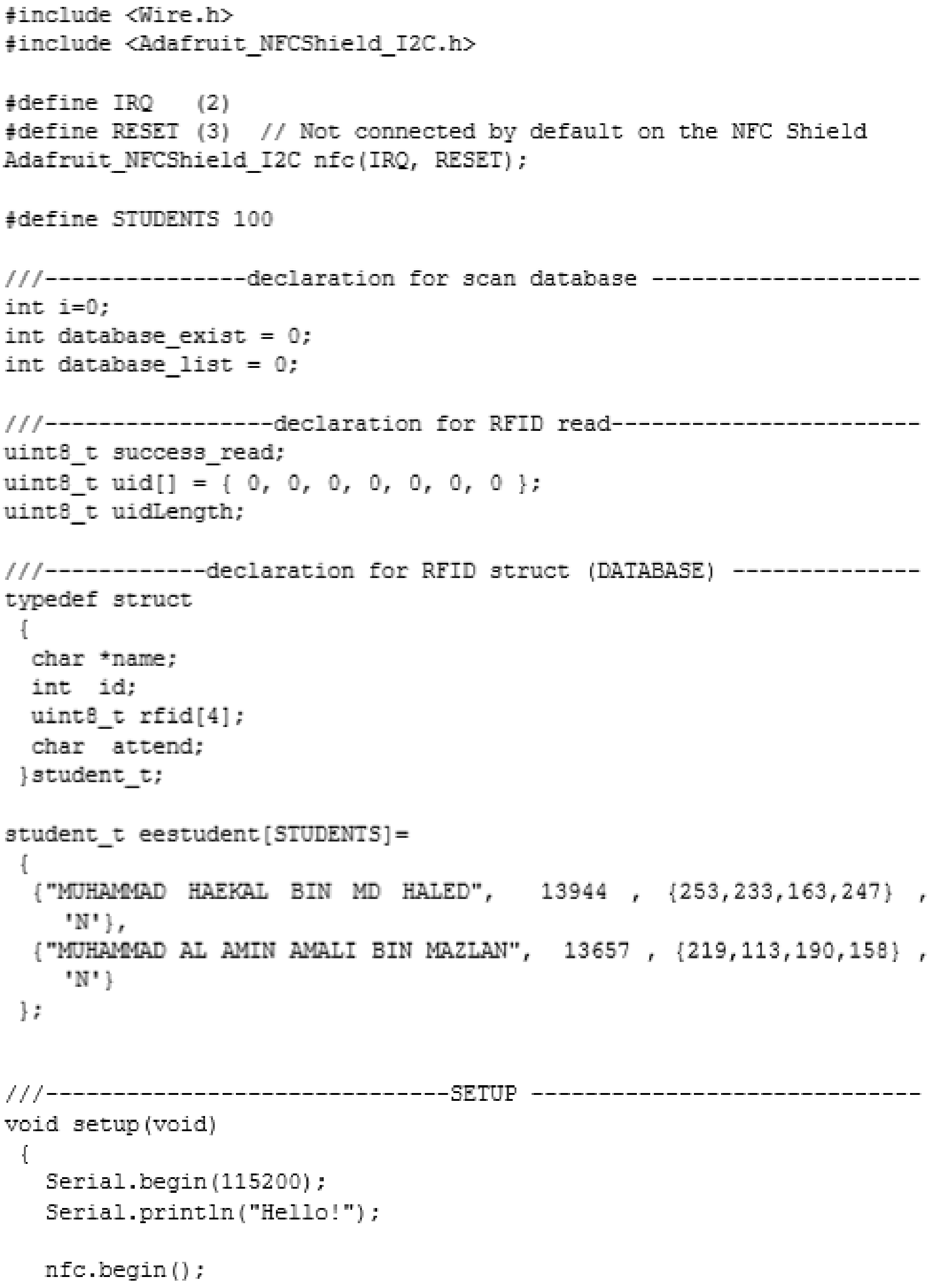
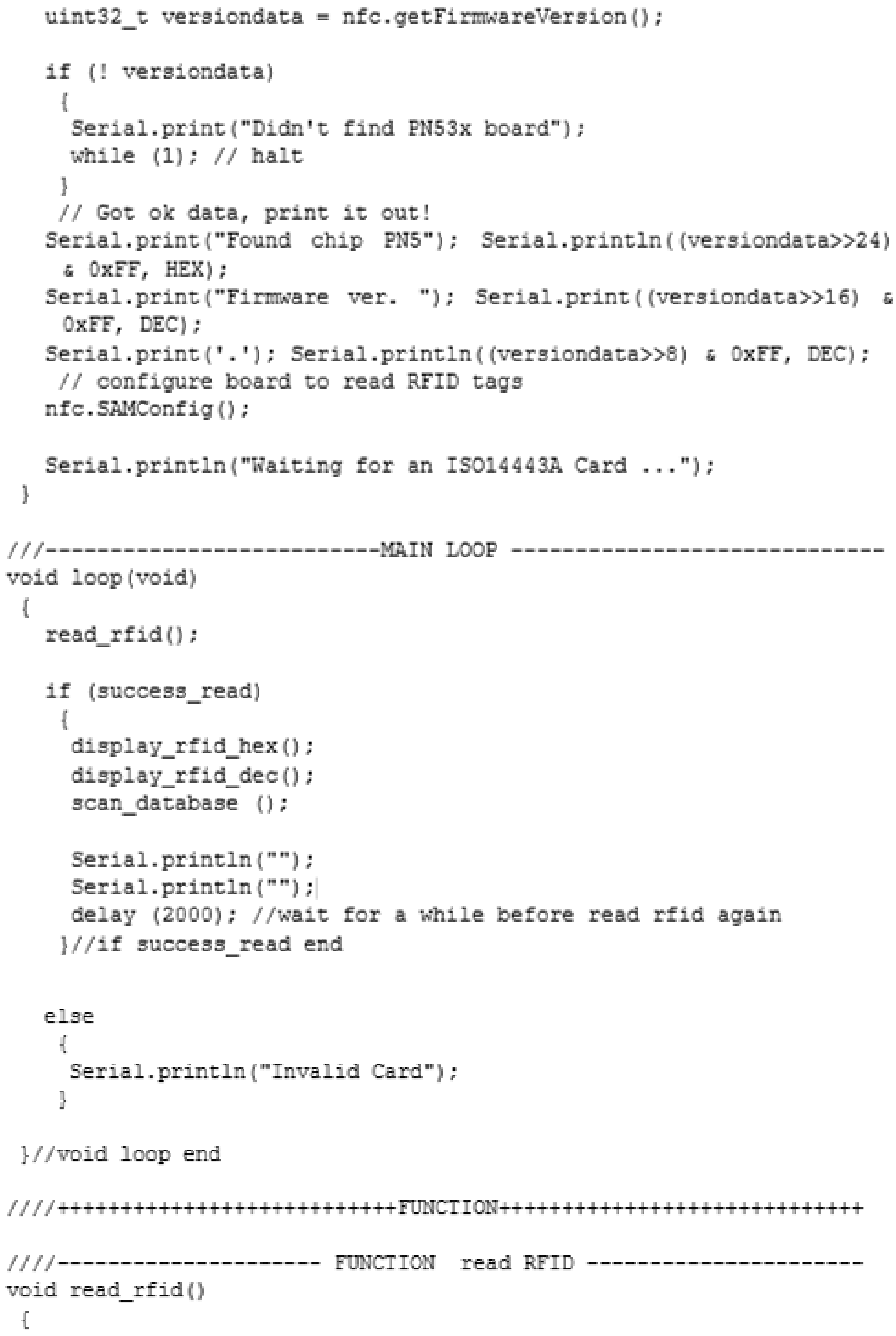
APPENDICES

Appendix A

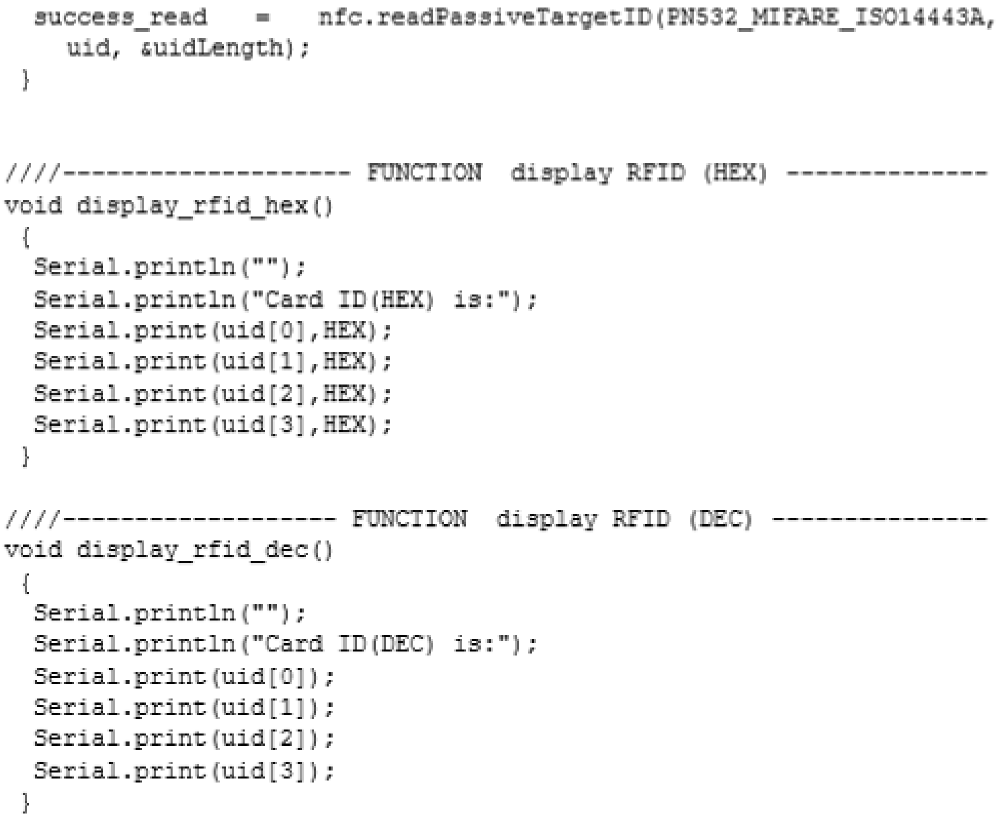
RFID MODULE TEST CODING



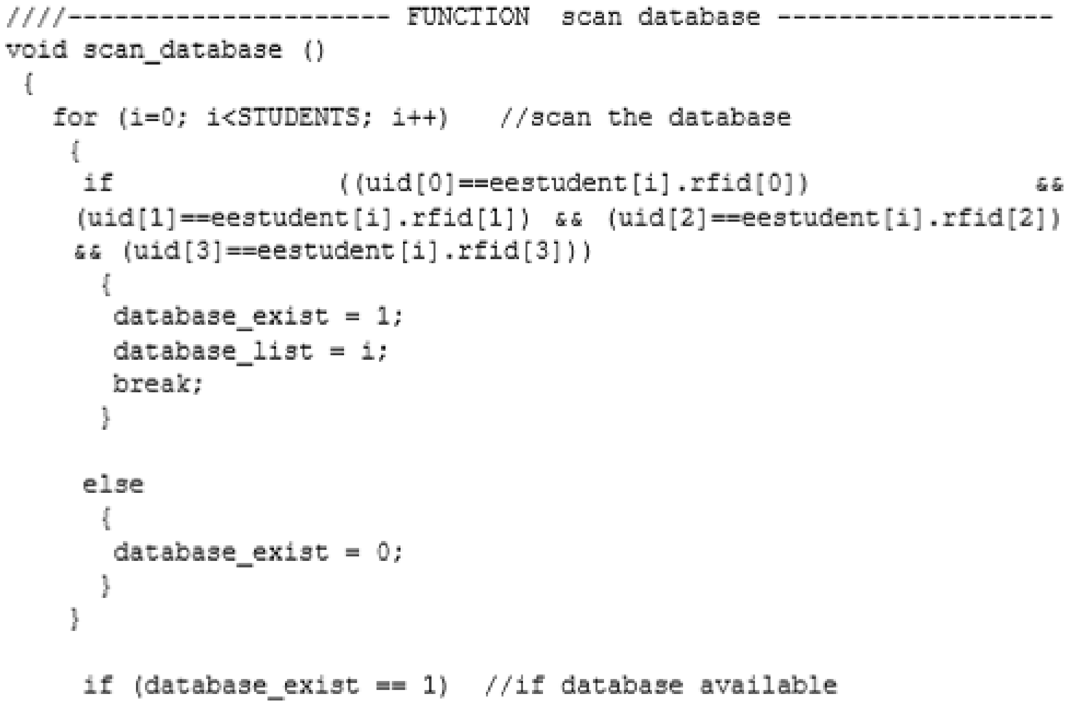
```
#include <Wire.h>
#include <Adafruit_NFCShield_I2C.h>

#define IRQ   (2)
#define RESET (3)  // Not connected by default on the NFC Shield
Adafruit_NFCShield_I2C nfc(IRQ, RESET);

#define STUDENTS 100

///---------------declaration for scan database --------------------
int i=0;
int database_exist = 0;
int database_list = 0;

///-----------------declaration for RFID read-----------------------
uint8_t success_read;
uint8_t uid[] = { 0, 0, 0, 0, 0, 0, 0 };
uint8_t uidLength;

///------------declaration for RFID struct (DATABASE) -------------
typedef struct
 {
  char *name;
  int  id;
  uint8_t rfid[4];
  char  attend;
 }student_t;

student_t eestudent[STUDENTS]=
 {
  {"MUHAMMAD  HAEKAL  BIN  MD  HALED",   13944  ,  {253,233,163,247}  ,
    'N'},
  {"MUHAMMAD AL AMIN AMALI BIN MAZLAN",  13657 , {219,113,190,158} ,
    'N'}
 };


///------------------------------SETUP ----------------------------
void setup(void)
 {
   Serial.begin(115200);
   Serial.println("Hello!");

   nfc.begin();
```



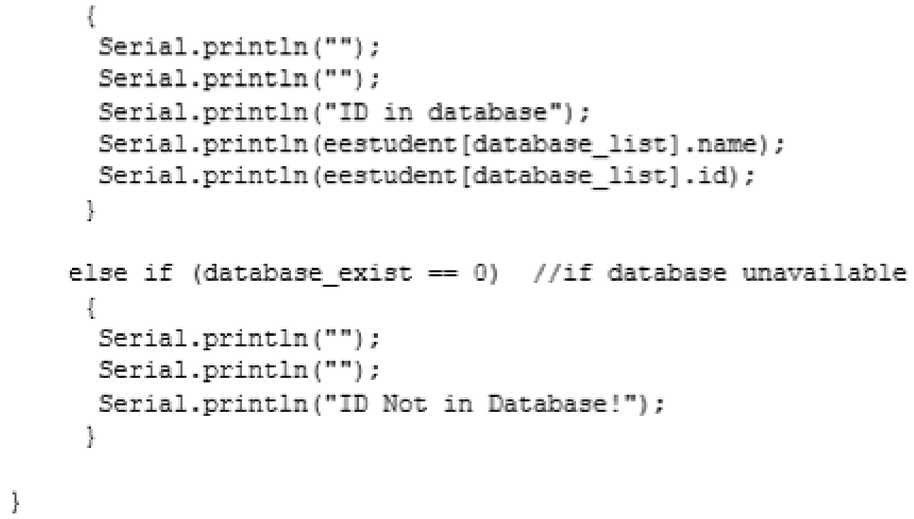
```
   uint32_t versiondata = nfc.getFirmwareVersion();

   if (! versiondata)
    {
     Serial.print("Didn't find PN53x board");
     while (1); // halt
    }
    // Got ok data, print it out!
   Serial.print("Found chip PN5"); Serial.println((versiondata>>24)
    & 0xFF, HEX);
   Serial.print("Firmware ver. "); Serial.print((versiondata>>16) &
    0xFF, DEC);
   Serial.print('.'); Serial.println((versiondata>>8) & 0xFF, DEC);
    // configure board to read RFID tags
   nfc.SAMConfig();

   Serial.println("Waiting for an ISO14443A Card ...");
 }

///--------------------------MAIN LOOP -----------------------------
void loop(void)
 {
   read_rfid();

   if (success_read)
    {
     display_rfid_hex();
     display_rfid_dec();
     scan_database ();

     Serial.println("");
     Serial.println("");
     delay (2000); //wait for a while before read rfid again
    }//if success_read end


   else
    {
     Serial.println("Invalid Card");
    }

 }//void loop end

////+++++++++++++++++++++++++++FUNCTION+++++++++++++++++++++++++++++

////--------------------- FUNCTION  read RFID ----------------------
void read_rfid()
 {
```



```
  success_read   =   nfc.readPassiveTargetID(PN532_MIFARE_ISO14443A,
    uid, &uidLength);
 }


////-------------------- FUNCTION  display RFID (HEX) --------------
void display_rfid_hex()
 {
  Serial.println("");
  Serial.println("Card ID(HEX) is:");
  Serial.print(uid[0],HEX);
  Serial.print(uid[1],HEX);
  Serial.print(uid[2],HEX);
  Serial.print(uid[3],HEX);
 }

////------------------- FUNCTION  display RFID (DEC) ---------------
void display_rfid_dec()
 {
  Serial.println("");
  Serial.println("Card ID(DEC) is:");
  Serial.print(uid[0]);
  Serial.print(uid[1]);
  Serial.print(uid[2]);
  Serial.print(uid[3]);
 }
```



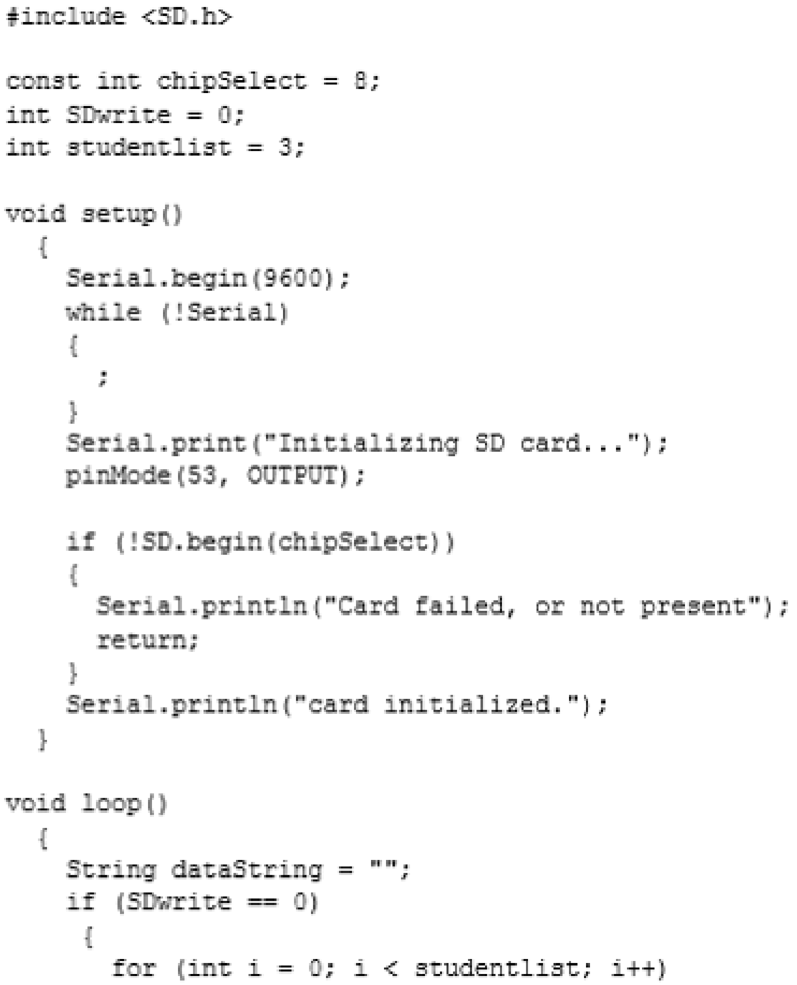
```
////--------------------- FUNCTION  scan database ------------------
void scan_database ()
 {
   for (i=0; i<STUDENTS; i++)   //scan the database
    {
     if               ((uid[0]==eestudent[i].rfid[0])               &&
     (uid[1]==eestudent[i].rfid[1]) && (uid[2]==eestudent[i].rfid[2])
     && (uid[3]==eestudent[i].rfid[3]))
       {
        database_exist = 1;
        database_list = i;
        break;
       }

     else
       {
        database_exist = 0;
       }
    }

     if (database_exist == 1)  //if database available
```



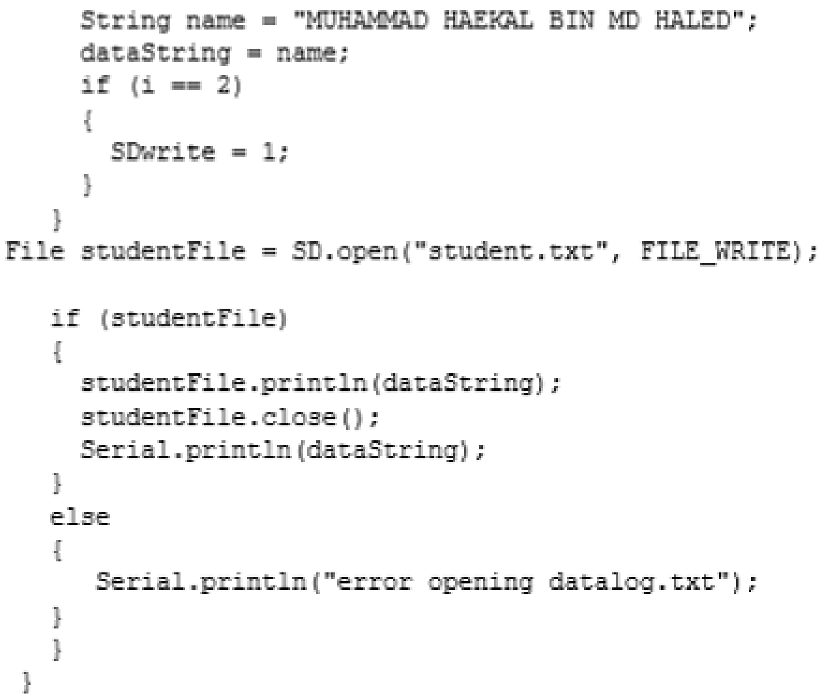
```
     {
      Serial.println("");
      Serial.println("");
      Serial.println("ID in database");
      Serial.println(eestudent[database_list].name);
      Serial.println(eestudent[database_list].id);
     }

    else if (database_exist == 0)  //if database unavailable
     {
      Serial.println("");
      Serial.println("");
      Serial.println("ID Not in Database!");
     }

}
```

MICRO SD CARD MODULE TEST CODING

a)write database

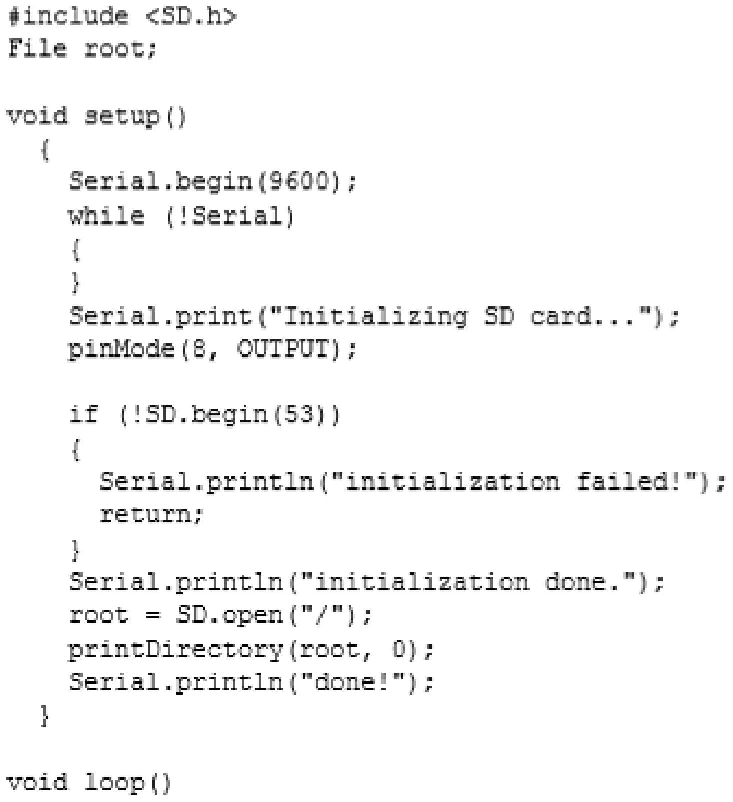


```
#include <SD.h>

const int chipSelect = 8;
int SDwrite = 0;
int studentlist = 3;

void setup()
  {
    Serial.begin(9600);
    while (!Serial)
    {
      ;
    }
    Serial.print("Initializing SD card...");
    pinMode(53, OUTPUT);

    if (!SD.begin(chipSelect))
    {
      Serial.println("Card failed, or not present");
      return;
    }
    Serial.println("card initialized.");
  }

void loop()
  {
    String dataString = "";
    if (SDwrite == 0)
     {
       for (int i = 0; i < studentlist; i++)
```

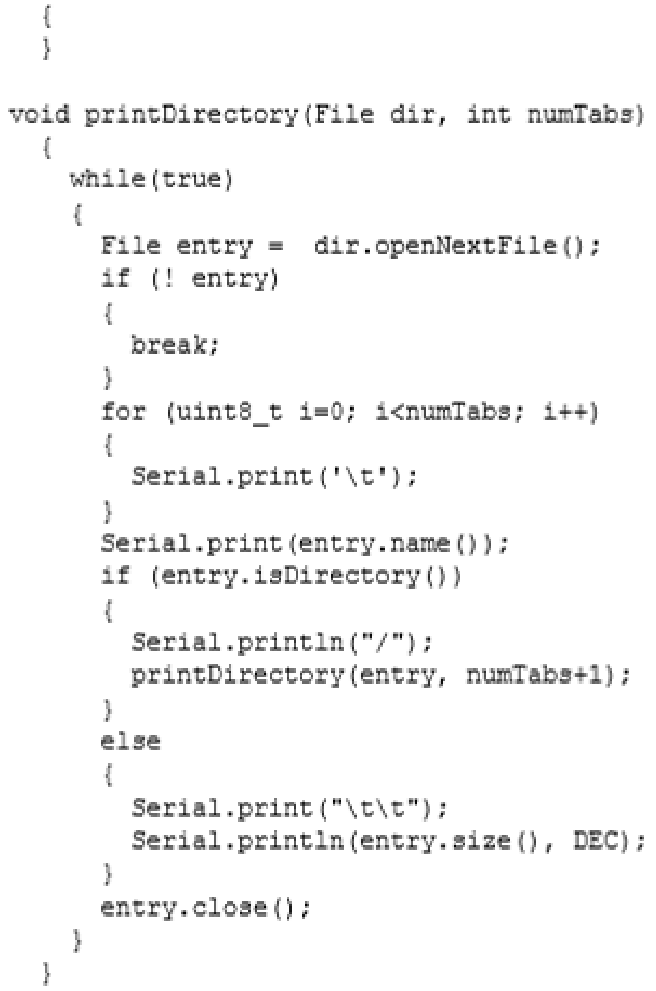


```
      String name = "MUHAMMAD HAEKAL BIN MD HALED";
      dataString = name;
      if (i == 2)
      {
        SDwrite = 1;
      }
    }
File studentFile = SD.open("student.txt", FILE_WRITE);

    if (studentFile)
    {
      studentFile.println(dataString);
      studentFile.close();
      Serial.println(dataString);
    }
    else
    {
       Serial.println("error opening datalog.txt");
    }
    }
  }
```

b)list file

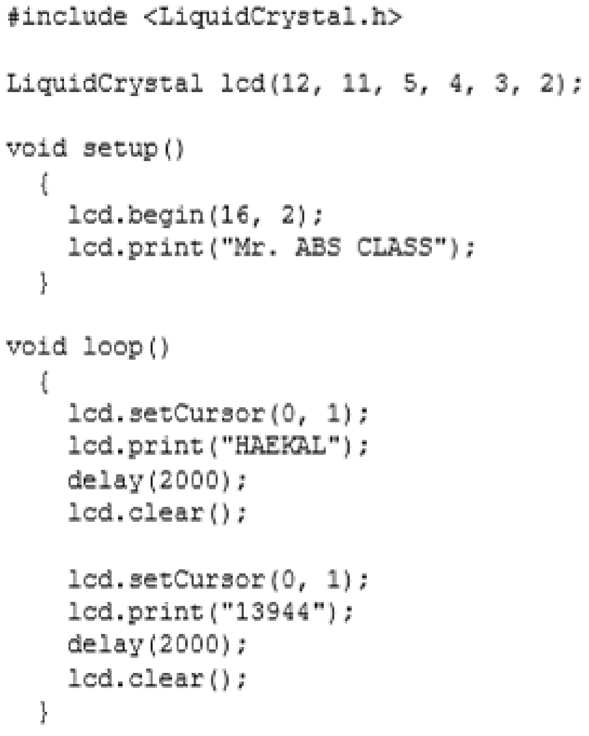


```
#include <SD.h>
File root;

void setup()
  {
    Serial.begin(9600);
    while (!Serial)
    {
    }
    Serial.print("Initializing SD card...");
    pinMode(8, OUTPUT);

    if (!SD.begin(53))
    {
      Serial.println("initialization failed!");
      return;
    }
    Serial.println("initialization done.");
    root = SD.open("/");
    printDirectory(root, 0);
    Serial.println("done!");
  }

void loop()
```



```
  {
  }

void printDirectory(File dir, int numTabs)
  {
    while(true)
    {
      File entry =  dir.openNextFile();
      if (! entry)
      {
        break;
      }
      for (uint8_t i=0; i<numTabs; i++)
      {
        Serial.print('\t');
      }
      Serial.print(entry.name());
      if (entry.isDirectory())
      {
        Serial.println("/");
        printDirectory(entry, numTabs+1);
      }
      else
      {
        Serial.print("\t\t");
        Serial.println(entry.size(), DEC);
      }
      entry.close();
    }
  }
```

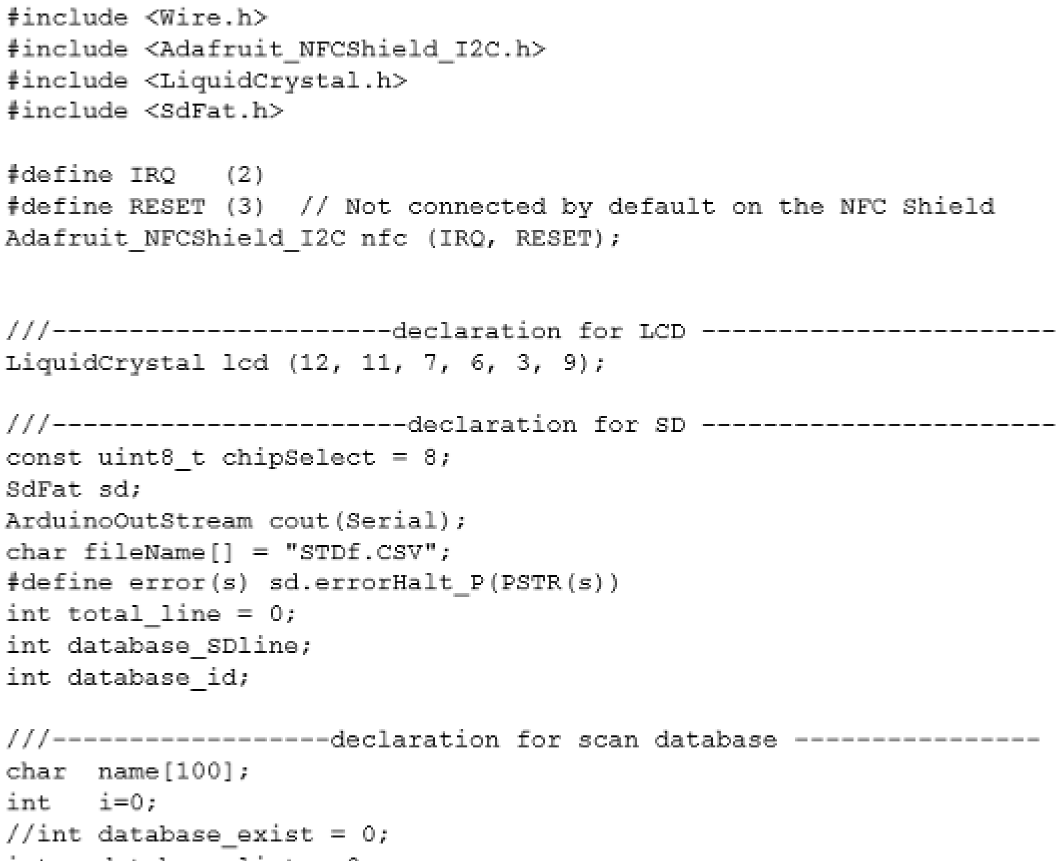
2x6 LCD TEST CODING



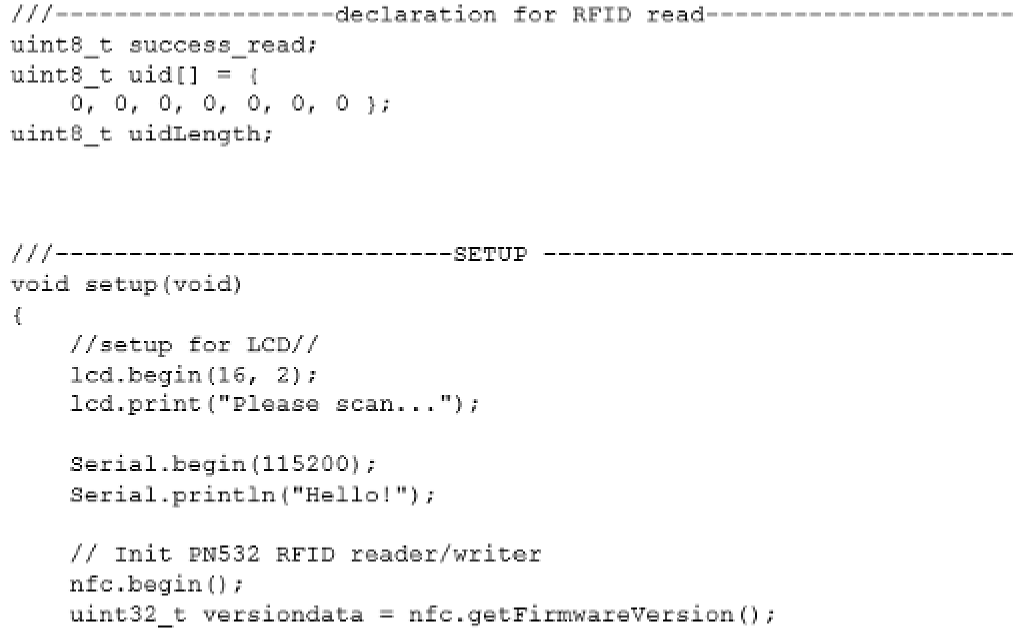
```
#include <LiquidCrystal.h>

LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

void setup()
  {
    lcd.begin(16, 2);
    lcd.print("Mr. ABS CLASS");
  }

void loop()
  {
    lcd.setCursor(0, 1);
    lcd.print("HAEKAL");
    delay(2000);
    lcd.clear();

    lcd.setCursor(0, 1);
    lcd.print("13944");
    delay(2000);
    lcd.clear();
  }
```

Appendix B

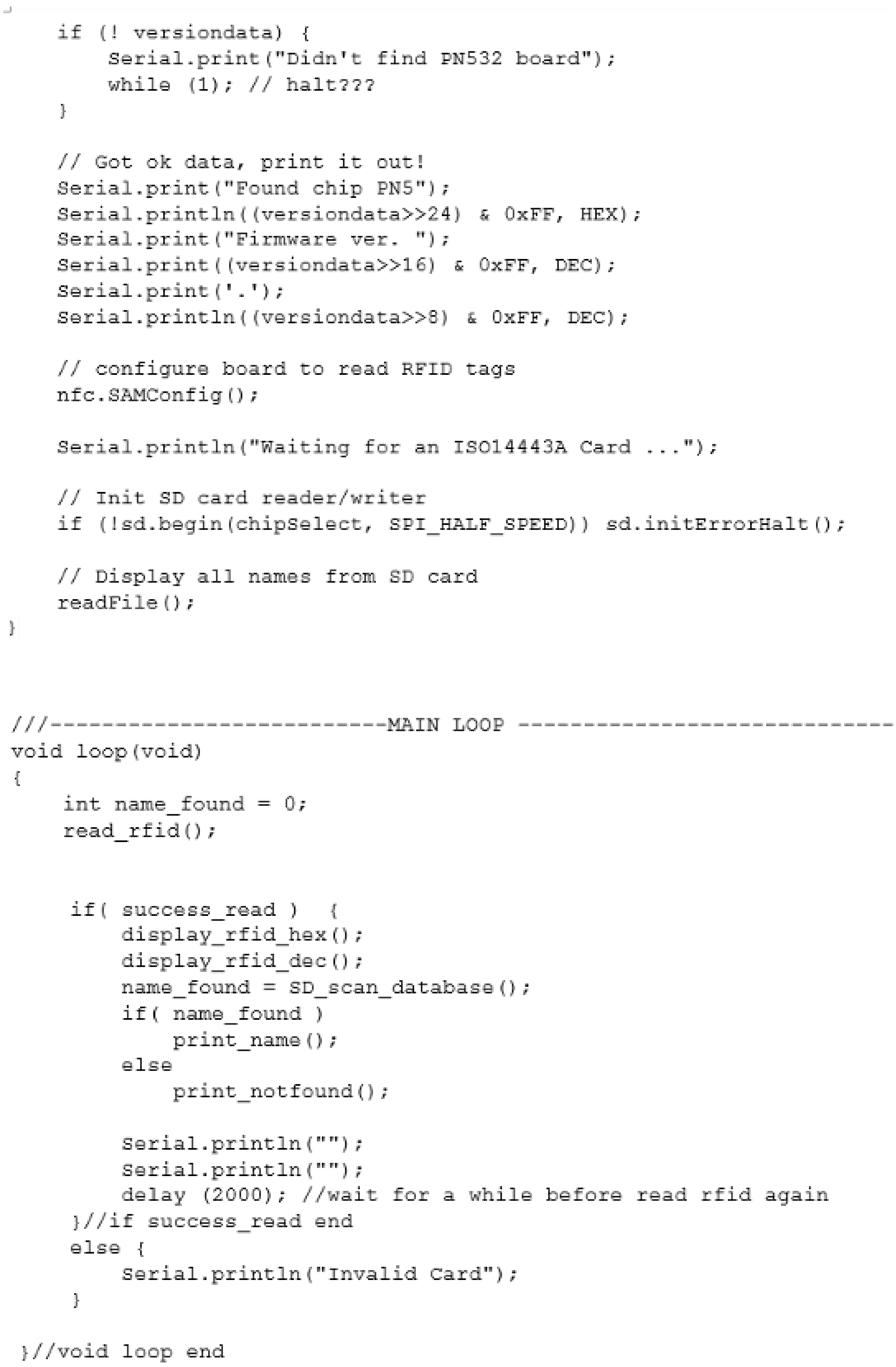
INITIAL PHASE PROTOTYPE CODING



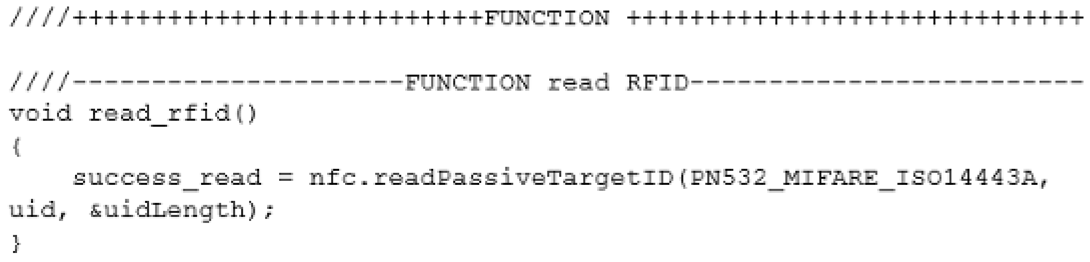
```
#include <Wire.h>
#include <Adafruit_NFCShield_I2C.h>
#include <LiquidCrystal.h>
#include <SdFat.h>

#define IRQ   (2)
#define RESET (3)  // Not connected by default on the NFC Shield
Adafruit_NFCShield_I2C nfc (IRQ, RESET);


///----------------------declaration for LCD -----------------------
LiquidCrystal lcd (12, 11, 7, 6, 3, 9);

///-----------------------declaration for SD -----------------------
const uint8_t chipSelect = 8;
SdFat sd;
ArduinoOutStream cout(Serial);
char fileName[] = "STDf.CSV";
#define error(s) sd.errorHalt_P(PSTR(s))
int total_line = 0;
int database_SDline;
int database_id;

///------------------declaration for scan database ----------------
char  name[100];
int   i=0;
//int database_exist = 0;
```



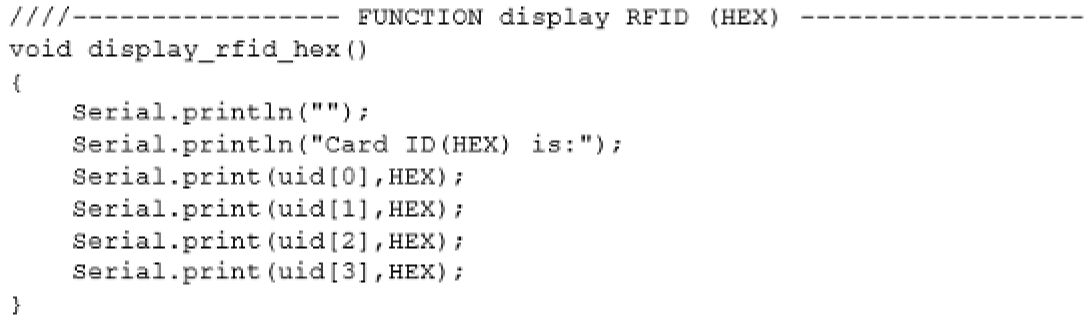
```
///------------------declaration for RFID read--------------------
uint8_t success_read;
uint8_t uid[] = {
    0, 0, 0, 0, 0, 0, 0 };
uint8_t uidLength;



///--------------------------SETUP -------------------------------
void setup(void)
{
    //setup for LCD//
    lcd.begin(16, 2);
    lcd.print("Please scan...");

    Serial.begin(115200);
    Serial.println("Hello!");

    // Init PN532 RFID reader/writer
    nfc.begin();
    uint32_t versiondata = nfc.getFirmwareVersion();
```



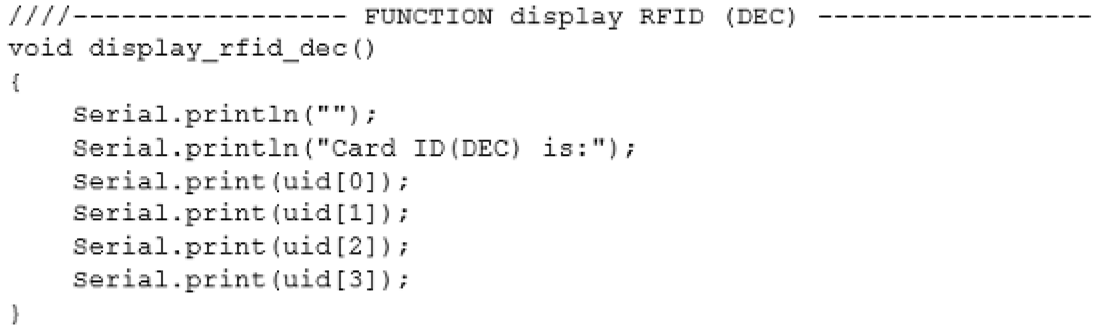
```
    if (! versiondata) {
        Serial.print("Didn't find PN532 board");
        while (1); // halt???
    }

    // Got ok data, print it out!
    Serial.print("Found chip PN5");
    Serial.println((versiondata>>24) & 0xFF, HEX);
    Serial.print("Firmware ver. ");
    Serial.print((versiondata>>16) & 0xFF, DEC);
    Serial.print('.');
    Serial.println((versiondata>>8) & 0xFF, DEC);

    // configure board to read RFID tags
    nfc.SAMConfig();

    Serial.println("Waiting for an ISO14443A Card ...");

    // Init SD card reader/writer
    if (!sd.begin(chipSelect, SPI_HALF_SPEED)) sd.initErrorHalt();

    // Display all names from SD card
    readFile();
}


///--------------------------MAIN LOOP -----------------------------
void loop(void)
{
    int name_found = 0;
    read_rfid();


     if( success_read )  {
         display_rfid_hex();
         display_rfid_dec();
         name_found = SD_scan_database();
         if( name_found )
             print_name();
         else
             print_notfound();

         Serial.println("");
         Serial.println("");
         delay (2000); //wait for a while before read rfid again
     }//if success_read end
     else {
         Serial.println("Invalid Card");
     }

 }//void loop end
```



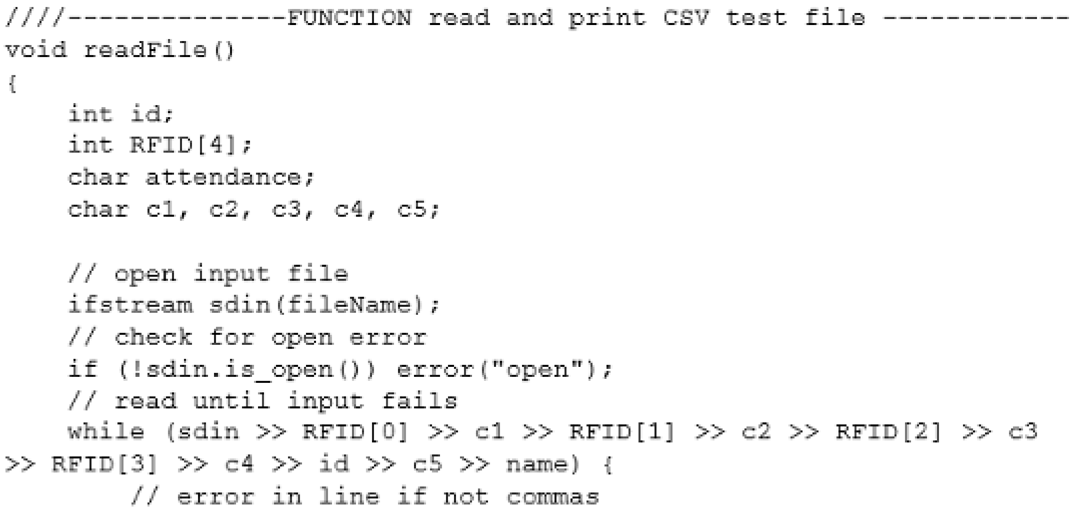
```
////++++++++++++++++++++++++++FUNCTION +++++++++++++++++++++++++++++

////---------------------FUNCTION read RFID-------------------------
void read_rfid()
{
    success_read = nfc.readPassiveTargetID(PN532_MIFARE_ISO14443A,
uid, &uidLength);
}
```



```
////----------------- FUNCTION display RFID (HEX) ------------------
void display_rfid_hex()
{
    Serial.println("");
    Serial.println("Card ID(HEX) is:");
    Serial.print(uid[0],HEX);
    Serial.print(uid[1],HEX);
    Serial.print(uid[2],HEX);
    Serial.print(uid[3],HEX);
}
```



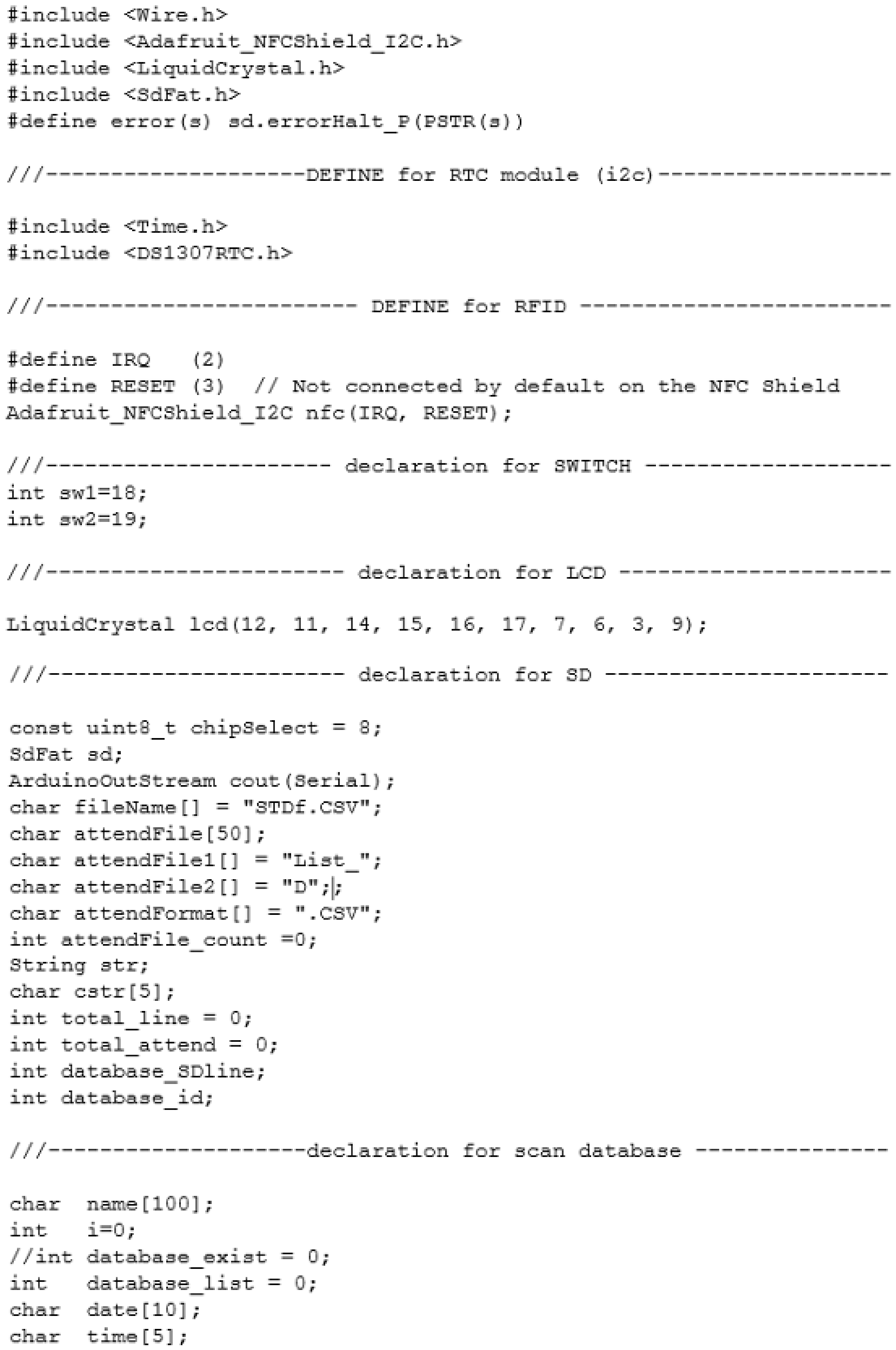
```
////----------------- FUNCTION display RFID (DEC) -----------------
void display_rfid_dec()
{
    Serial.println("");
    Serial.println("Card ID(DEC) is:");
    Serial.print(uid[0]);
    Serial.print(uid[1]);
    Serial.print(uid[2]);
    Serial.print(uid[3]);
}
```



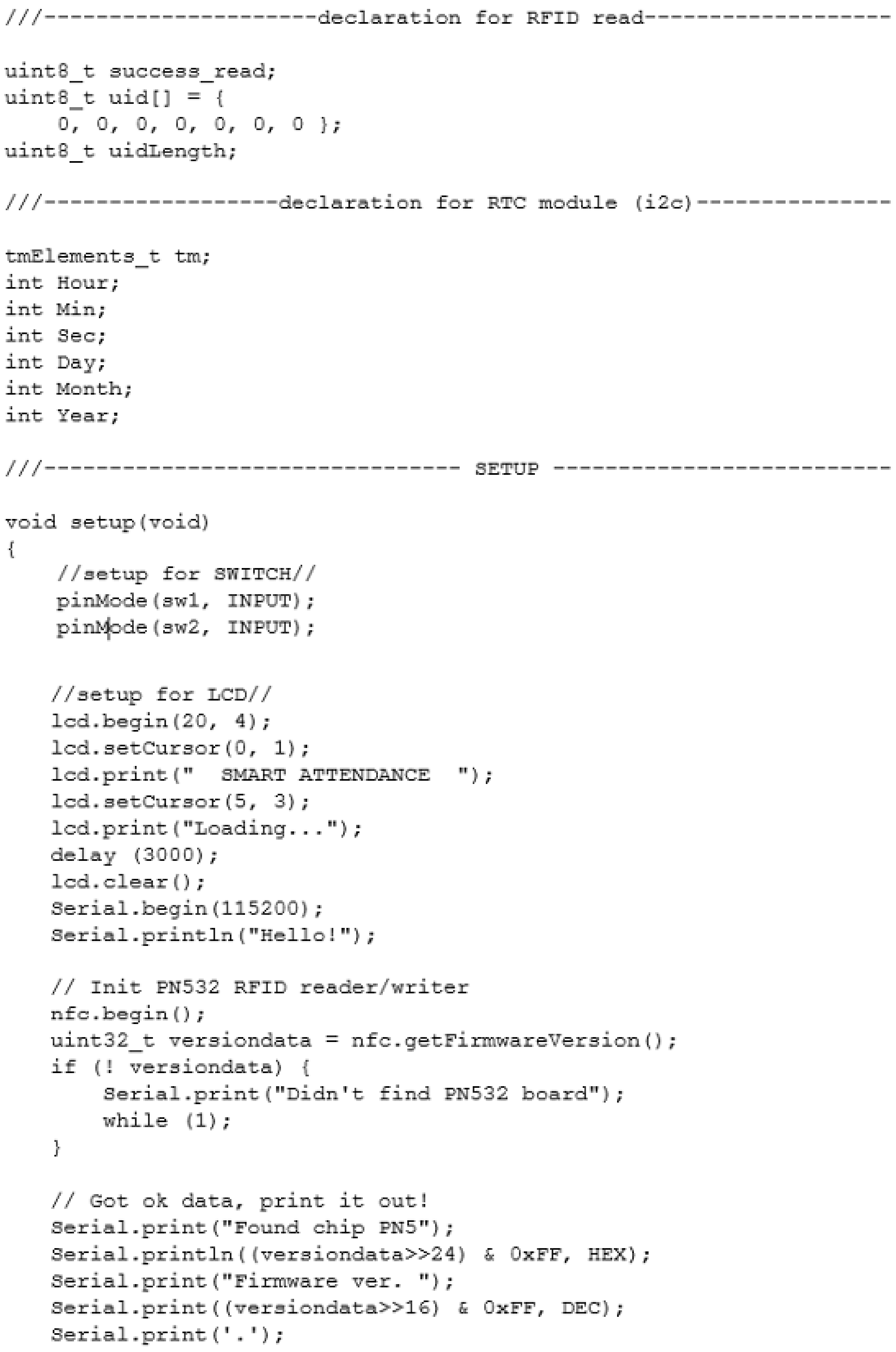
```
////--------------FUNCTION read and print CSV test file ------------
void readFile()
{
    int id;
    int RFID[4];
    char attendance;
    char c1, c2, c3, c4, c5;

    // open input file
    ifstream sdin(fileName);
    // check for open error
    if (!sdin.is_open()) error("open");
    // read until input fails
    while (sdin >> RFID[0] >> c1 >> RFID[1] >> c2 >> RFID[2] >> c3
>> RFID[3] >> c4 >> id >> c5 >> name) {
        // error in line if not commas
        if (c1 != ',' || c2 != ',' || c3 != ',' || c4 != ',' || c5
!= ',' ) error("comma");
        // print in six character wide columns
        cout << setw(6) << RFID[0] << RFID[1] << RFID[2] << RFID[3]
<< setw(6) << id << name << endl;
        total_line = total_line + 1;
    }
    // Error in an input line if file is not at EOF.
    if (!sdin.eof()) error("readFile");
}


////--------------------FUNCTION write test file--------------------
void writeFile()
{
    //ofstream sdout(fileName, ios::out | ios::app);
    // create or open and truncate output file
    ofstream sdout(fileName);
    // write file from string stored in flash
    sdout << pstr(
        "253,233,163,247,13944,Y\n"
        "219,113,190,158,13657,Y\n"
        "218,113,190,158,13257,Y\n"
        "217,113,190,158,13357,Y\n"
        "216,113,190,158,13457,Y\n"
        ) << flush;
    // check for any errors
    if (!sdout) error("writeFile");
    sdout.close();
}


 ////------------------ FUNCTION SD scan database ------------------

 int SD_scan_database()
 {
     int database_exist = 0;
     total_line = 0;
     int id;
     int RFID[4];
     char attendance[7];
     char c1, c2, c3, c4, c5;
     int count = 0;

    // open input file
    ifstream sdin(fileName);
    // check for open error
    if (!sdin.is_open()) error("open");
    // read until input fails
    while (sdin >> RFID[0] >> c1 >> RFID[1] >> c2 >> RFID[2] >> c3
>> RFID[3] >> c4 >> id >> c5 >> name) {
        // error in line if not commas
        if (c1 != ',' || c2 != ',' || c3 != ',' || c4 != ',' || c5
!= ',') error("comma");

        if ( uid[0]==RFID[0] && uid[1]==RFID[1] && uid[2]==RFID[2]
&& uid[3]==RFID[3] ) {
            database_exist = 1;
            database_list = i;
            database_id = id;
            database_SDline = total_line;
            total_line = count;
            return database_exist;
        }
        count = count + 1;
    }

    return database_exist;

    // Error in an input line if file is not at EOF.
    if (!sdin.eof()) error("readFile");

}

////-------------Print name----------------------------------------

void print_name()
{
    Serial.println("");
    Serial.println("");
    Serial.println("ID in Database");
    Serial.println(database_id);
    Serial.println(name);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(database_id);
    lcd.setCursor(0, 1);
    lcd.print(name);

}

////-------------Print not found-----------------------------------

void print_notfound()
{
    Serial.println("");
    Serial.println("");
    Serial.println("Not in Database!");
    lcd.clear();
    lcd.setCursor(0, 1);
    lcd.print("Not in Database!");
}
```

Appendix C

FINAL PHASE PROTOTYPE CODING

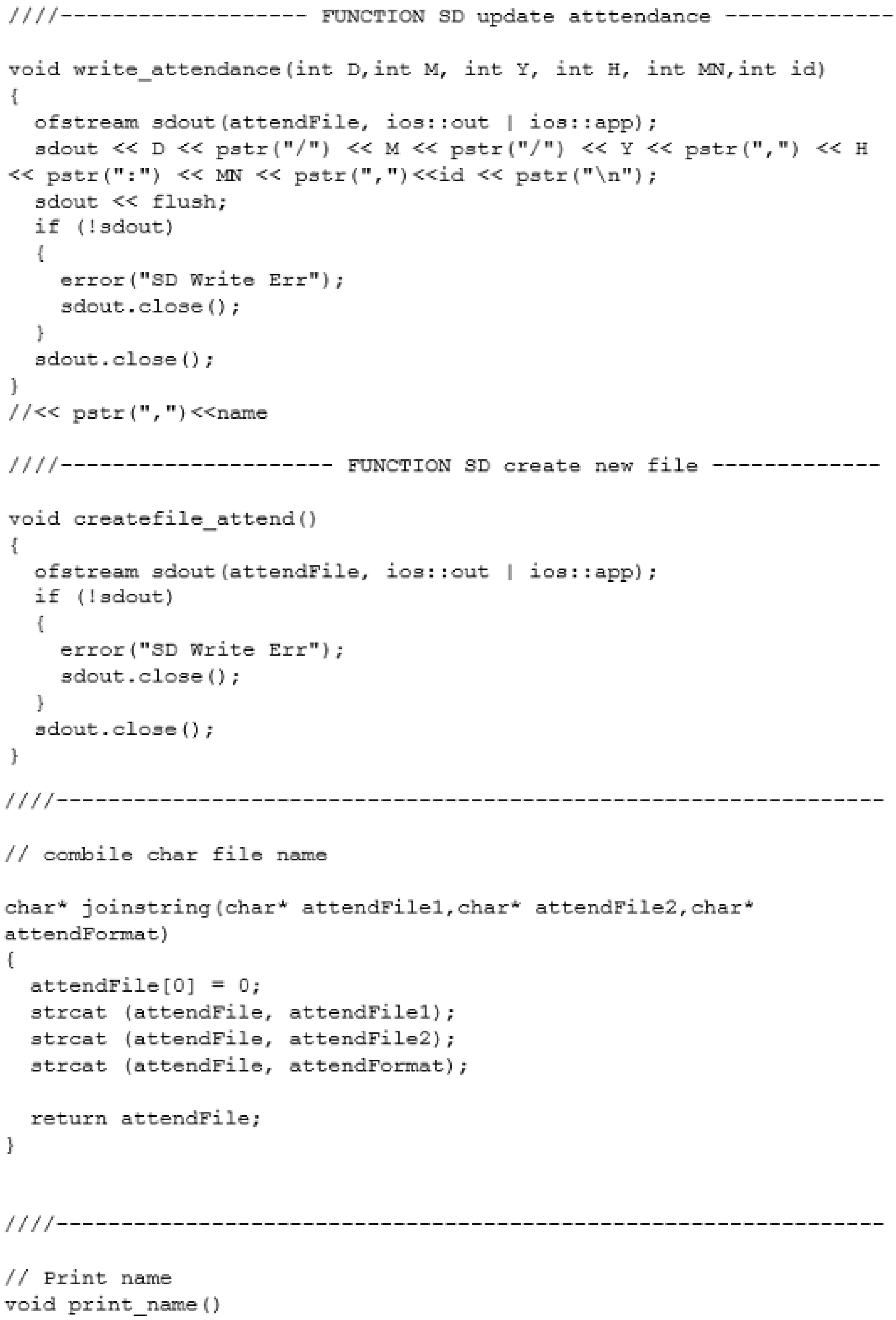


```
#include <Wire.h>
#include <Adafruit_NFCShield_I2C.h>
#include <LiquidCrystal.h>
#include <SdFat.h>
#define error(s) sd.errorHalt_P(PSTR(s))

///--------------------DEFINE for RTC module (i2c)-----------------

#include <Time.h>
#include <DS1307RTC.h>

///------------------------ DEFINE for RFID -----------------------

#define IRQ   (2)
#define RESET (3)  // Not connected by default on the NFC Shield
Adafruit_NFCShield_I2C nfc(IRQ, RESET);

///---------------------- declaration for SWITCH ------------------
int sw1=18;
int sw2=19;

///----------------------- declaration for LCD --------------------

LiquidCrystal lcd(12, 11, 14, 15, 16, 17, 7, 6, 3, 9);

///----------------------- declaration for SD ---------------------

const uint8_t chipSelect = 8;
SdFat sd;
ArduinoOutStream cout(Serial);
char fileName[] = "STDf.CSV";
char attendFile[50];
char attendFile1[] = "List_";
char attendFile2[] = "D";|;
char attendFormat[] = ".CSV";
int attendFile_count =0;
String str;
char cstr[5];
int total_line = 0;
int total_attend = 0;
int database_SDline;
int database_id;

///--------------------declaration for scan database --------------

char  name[100];
int   i=0;
//int database_exist = 0;
int   database_list = 0;
char  date[10];
char  time[5];
```



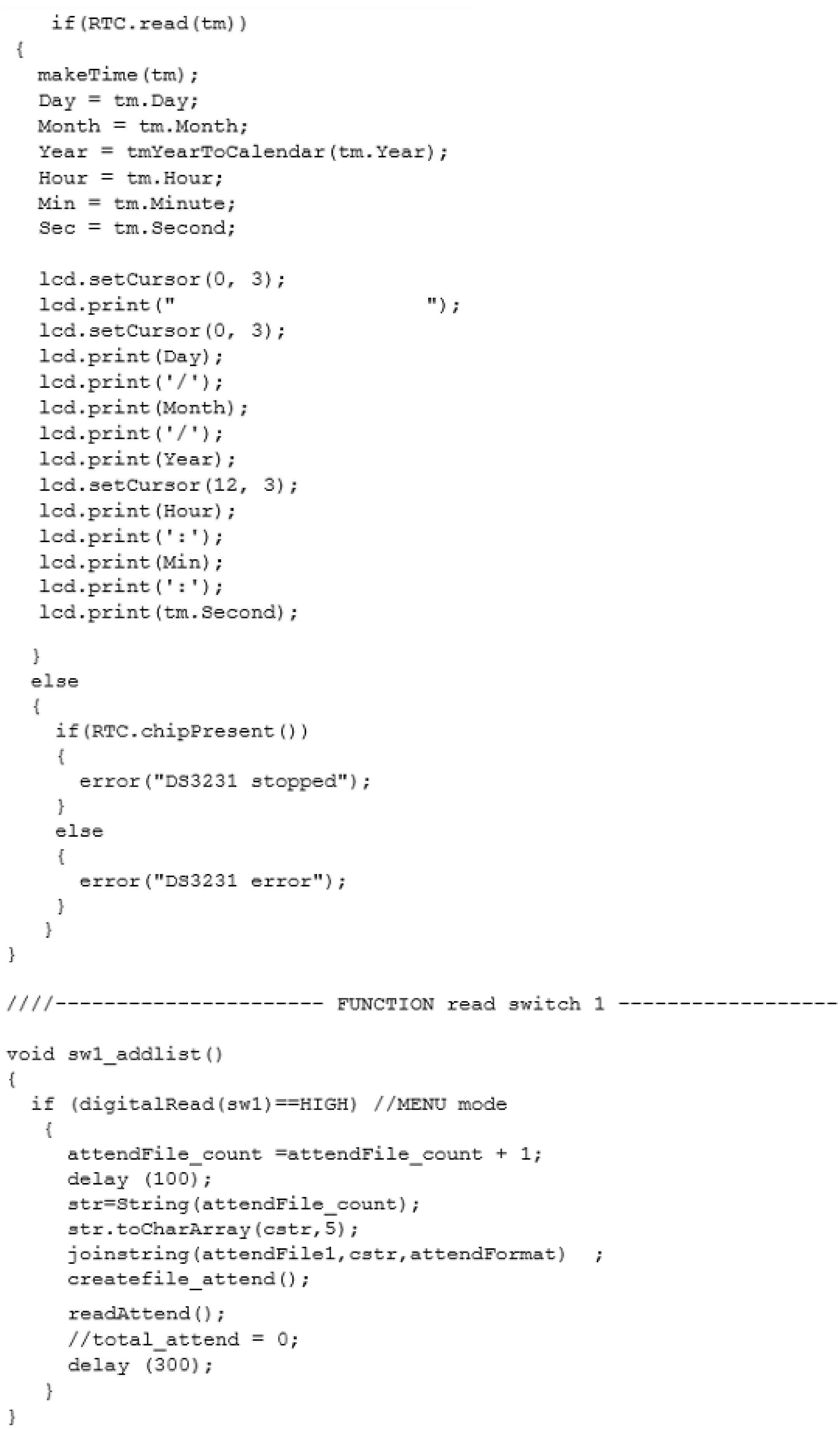
```
///---------------------declaration for RFID read-------------------

uint8_t success_read;
uint8_t uid[] = {
    0, 0, 0, 0, 0, 0, 0 };
uint8_t uidLength;

///------------------declaration for RTC module (i2c)---------------

tmElements_t tm;
int Hour;
int Min;
int Sec;
int Day;
int Month;
int Year;

///-------------------------------- SETUP --------------------------

void setup(void)
{
    //setup for SWITCH//
    pinMode(sw1, INPUT);
    pinMode(sw2, INPUT);


    //setup for LCD//
    lcd.begin(20, 4);
    lcd.setCursor(0, 1);
    lcd.print("  SMART ATTENDANCE  ");
    lcd.setCursor(5, 3);
    lcd.print("Loading...");
    delay (3000);
    lcd.clear();
    Serial.begin(115200);
    Serial.println("Hello!");

    // Init PN532 RFID reader/writer
    nfc.begin();
    uint32_t versiondata = nfc.getFirmwareVersion();
    if (! versiondata) {
        Serial.print("Didn't find PN532 board");
        while (1);
    }

    // Got ok data, print it out!
    Serial.print("Found chip PN5");
    Serial.println((versiondata>>24) & 0xFF, HEX);
    Serial.print("Firmware ver. ");
    Serial.print((versiondata>>16) & 0xFF, DEC);
    Serial.print('.');
    // configure board to read RFID tags
    nfc.SAMConfig();
    Serial.println("Waiting for an ISO14443A Card ...");

    // Init SD card reader/writer
    if (!sd.begin(chipSelect, SPI_HALF_SPEED)) sd.initErrorHalt();

    // Display all names from SD card
    readFile();
    joinstring(attendFile1,attendFile2,attendFormat)  ;
    Serial.println(attendFile);
    createfile_attend();
    readAttend();

}

///-------------------------- MAIN LOOP ----------------------------

void loop(void)
{
   sw1_addlist();
   menu_scanmode();

}//void loop end


////+++++++++++++++++++++++++++ FUNCTION ++++++++++++++++++++++++++++

////----------------------- FUNCTION  read RFID --------------------

void menu_scanmode()
{
   lcd.clear();
   int name_found = 0;
   int attend_found = 0;
   lcd.setCursor(0, 0);
   lcd.print(attendFile);
   lcd.print(": ");
   lcd.print(total_attend);
   lcd.setCursor(0, 1);
   lcd.print("Please Scan...");
   readtime_display_LCD();
   read_rfid();

    if( success_read )
    {
      display_rfid_hex();
      display_rfid_dec();
name_found = SD_scan_database();
if( name_found )
 {
   print_name();
   attend_found = SD_scan_attendwrite();
     if( attend_found  )
      {
       Serial.println("Already Updated Attendance!\n");
       lcd.setCursor(0, 0);
       lcd.print("Already Saved!");
       readAttend();
      }
     else
      {
       readtime();
       write_attendance(Day,Month,Year,Hour,Min,database_id);
       lcd.setCursor(0, 0);
       lcd.print("                ");
       lcd.setCursor(0, 0);
       lcd.print("Done!");
       readAttend();
      }
  }
 else
    print_notfound();
      Serial.println("");
      Serial.println("");
      delay (2000); //wait for a while before read rfid again
    }//if success_read end
    else {
        //Serial.println("Invalid Card");
    }
}

////---------------------- FUNCTION  read RFID ---------------------

void read_rfid()
{
    success_read = nfc.readPassiveTargetID(PN532_MIFARE_ISO14443A,
uid, &uidLength);
}

////------------------- FUNCTION  display RFID (HEX) ---------------

void display_rfid_hex()
{
    Serial.println("");
    Serial.println("Card ID(HEX) is:");
    Serial.print(uid[0],HEX);
    Serial.print(uid[1],HEX);
    Serial.print(uid[2],HEX);
    Serial.print(uid[3],HEX);
}

////------------------- FUNCTION  display RFID (DEC) --------------

void display_rfid_dec()
{
    Serial.println("");
    Serial.println("Card ID(DEC) is:");
    Serial.print(uid[0]);
    Serial.print(uid[1]);
    Serial.print(uid[2]);
    Serial.print(uid[3]);
}

////----------------FUNCTION read and print CSV test file ---------

void readFile()
{
    int id;
    int RFID[4];
    char c1, c2, c3, c4, c5;

    // open input file
    ifstream sdin(fileName);
    // check for open error
    if (!sdin.is_open()) error("open");
    // read until input fails

    while (sdin >> RFID[0] >> c1 >> RFID[1] >> c2 >> RFID[2] >> c3
>> RFID[3] >> c4 >> id >> c5 >> name) {
        // error in line if not commas
        if (c1 != ',' || c2 != ',' || c3 != ',' || c4 != ',' || c5
!= ',' ) error("comma");
        // print in six character wide columns
        cout << setw(6) << RFID[0] << RFID[1] << RFID[2] << RFID[3]
<<  "\t" << id << "\t" << name << endl;
        total_line = total_line + 1;

    }
    // Error in an input line if file is not at EOF.
    if (!sdin.eof()) error("readFile");
}

void readAttend()
{
    int id;
    int D,M,Y ;
    int H,Min;
    char c1, c2;
    char s1, s2;
    char d1;
    total_attend = 0;

    // open input file
    ifstream sdin(attendFile);
    // check for open error
    if (!sdin.is_open())
    {
      error("open");
    }
    // read until input fails
    while (sdin >> D >> s1 >> M >> s2 >> Y >> c1 >> H >> d1 >>Min >>
c2 >> id ) {
        // error in line if not commas
        if (c1 != ',' || c2 != ','  ) error("comma");
        // print in six character wide columns
        cout << "\t" << D << "/" << M << "/" << Y << "\t" << H <<
":" << Min << "\t" << id  << endl;
        total_attend = total_attend + 1;
    }

    if (!sdin.eof()) error("readFile");
}


////-------------------- FUNCTION SD scan database ----------------

int SD_scan_database()
{
  `
     int database_exist = 0;
     total_line = 0;
     int id;
     int RFID[4];
     char c1, c2, c3, c4, c5;
     int count = 0;

     ifstream sdin(fileName);
     // check for open error
     if (!sdin.is_open()) error("open");
     // read until input fails
     while (sdin >> RFID[0] >> c1 >> RFID[1] >> c2 >> RFID[2] >> c3
 >> RFID[3] >> c4 >> id >> c5 >> name) {
         // error in line if not commas
         if (c1 != ',' || c2 != ',' || c3 != ',' || c4 != ',' || c5
 != ',') error("comma");
         if ( uid[0]==RFID[0] && uid[1]==RFID[1] && uid[2]==RFID[2]
 && uid[3]==RFID[3] ) {
             database_exist = 1;
             database_list = i;
             database_id = id;
```

```
            database_SDline = total_line;
            total_line = count;
            return database_exist;
        }
        count = count + 1;
    }
    return database_exist;

    // Error in an input line if file is not at EOF.
    if (!sdin.eof()) error("readFile");
}

////--------------------- FUNCTION  SD scan attend -----------------

int SD_scan_attendwrite()
{
    int attend_exist = 0;
    int id;
    int D,M,Y ;
    int H,Min;
    char c1, c2;
    char s1, s2;
    char d1;

    // open input file
    ifstream sdin(attendFile);
    // check for open error
    if (!sdin.is_open()) error("open");
    // read until input fails
    while (sdin >> D >> s1 >> M >> s2 >> Y >> c1 >> H >> d1 >>Min >>
c2 >> id) {
        // error in line if not commas
        if (c1 != ',' || c2 != ',') error("comma");

        if ( database_id==id )
        {
            attend_exist = 1;
            return attend_exist;
        }
    }
    return attend_exist;

    // Error in an input line if file is not at EOF.
    if (!sdin.eof()) error("readFile");

}
```



```
////------------------- FUNCTION SD update atttendance -------------

void write_attendance(int D,int M, int Y, int H, int MN,int id)
{
  ofstream sdout(attendFile, ios::out | ios::app);
  sdout << D << pstr("/") << M << pstr("/") << Y << pstr(",") << H
<< pstr(":") << MN << pstr(",")<<id << pstr("\n");
  sdout << flush;
  if (!sdout)
  {
    error("SD Write Err");
    sdout.close();
  }
  sdout.close();
}
//<< pstr(",")<<name

////--------------------- FUNCTION SD create new file -------------

void createfile_attend()
{
  ofstream sdout(attendFile, ios::out | ios::app);
  if (!sdout)
  {
    error("SD Write Err");
    sdout.close();
  }
  sdout.close();
}

////------------------------------------------------------------------

// combile char file name

char* joinstring(char* attendFile1,char* attendFile2,char*
attendFormat)
{
  attendFile[0] = 0;
  strcat (attendFile, attendFile1);
  strcat (attendFile, attendFile2);
  strcat (attendFile, attendFormat);

  return attendFile;
}


////------------------------------------------------------------------

// Print name
void print_name()
```

```
{
    Serial.println("");
    Serial.println("");
    Serial.println("ID in Database");
    Serial.println(database_id);
    Serial.println(name);

    lcd.setCursor(0, 1);
    lcd.print("                    ");
    lcd.setCursor(0, 2);
    lcd.print("                    ");
    lcd.setCursor(0, 2);
    lcd.print(database_id);
    lcd.setCursor(8, 2);
    lcd.print(name);
}

////----------------------------------------------------------------

// Print not found
void print_notfound()
{
    Serial.println("");
    Serial.println("");
    Serial.println("Not in Database!");
    lcd.clear();
    lcd.setCursor(0, 1);
    lcd.print("Not in Database!");
}

/// -------------------------- FUNCTION RTC ------------------------

int readtime()
{
     if(RTC.read(tm))
  {
    makeTime(tm);
    Day = tm.Day;
    Month = tm.Month;
    Year = tmYearToY2k(tm.Year);
    Hour = tm.Hour;
    Min = tm.Minute;

  }
  else
  {
    if(RTC.chipPresent())
    {
      error("DS3231 stopped");
    }
    else
    {
      error("DS3231 error");
    }
   }
   return Day, Month, Year, Hour, Min;
}


/// ---------------------- FUNCTION RTC display Serial -------------

void readtime_display()
{
     if(RTC.read(tm))
  {
    makeTime(tm);
    Day = tm.Day;
    Month = tm.Month;
    Year = tmYearToY2k(tm.Year);
    Hour = tm.Hour;
    Min = tm.Minute;


    Serial.print("\n");
    Serial.print(Day);
    Serial.print("/");
    Serial.print(Month);
    Serial.print("/");
    Serial.print(Year);
    Serial.print("\n");
    Serial.print(Hour);
    Serial.print(":");
    Serial.print(Min);
    Serial.print("\n");

  }
  else
  {
    if(RTC.chipPresent())
    {
      error("DS3231 stopped");
    }
    else
    {
      error("DS3231 error");
    }
   }
}

/// ---------------------- FUNCTION Display Time LCD ---------------

void readtime_display_LCD()
{
```



```
    if(RTC.read(tm))
 {
  makeTime(tm);
  Day = tm.Day;
  Month = tm.Month;
  Year = tmYearToCalendar(tm.Year);
  Hour = tm.Hour;
  Min = tm.Minute;
  Sec = tm.Second;

  lcd.setCursor(0, 3);
  lcd.print("                    ");
  lcd.setCursor(0, 3);
  lcd.print(Day);
  lcd.print('/');
  lcd.print(Month);
  lcd.print('/');
  lcd.print(Year);
  lcd.setCursor(12, 3);
  lcd.print(Hour);
  lcd.print(':');
  lcd.print(Min);
  lcd.print(':');
  lcd.print(tm.Second);

  }
  else
  {
    if(RTC.chipPresent())
    {
      error("DS3231 stopped");
    }
    else
    {
      error("DS3231 error");
    }
   }
}

////---------------------- FUNCTION read switch 1 ------------------

void sw1_addlist()
{
  if (digitalRead(sw1)==HIGH) //MENU mode
   {
     attendFile_count =attendFile_count + 1;
     delay (100);
     str=String(attendFile_count);
     str.toCharArray(cstr,5);
     joinstring(attendFile1,cstr,attendFormat)  ;
     createfile_attend();

     readAttend();
     //total_attend = 0;
     delay (300);
   }
}
```