International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 02 - Issue 09 || September 2016 || PP. 14-24

Innovative design of RFID based door security system implemented with GUI and student records database system

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ABSTRACT: Door security has been a great concern of worldwide. As the technology is emerging in every second, abundant security systems have been developed and implemented to keep their welfare safe. Door security system is an essential mean of protecting our space from illegal invasion. This is done by preventing unauthorized entrance into buildings through entrance doors. Thus, the main idea in this research is to design a database security system that allows only authorized user to enter the premises depend on the limited time period. This research describes the design of Radio Frequency Identification (RFID) based security and database access control system for use in entrance of Department Door inside the University campus. The system combines RFID technology, keypad and also combine with database management system to accomplish the required task. Such a database management system with a user-friendly graphical interface or graphical user interface (GUI) begets to more secure and more facilitate the user. This research presents one such system that has been developed for the entrance door of the Department. The system facilitates efficient management of secure place, as well as easy edition of user records together with their attribute information; it provides update a user's record. Database used in this system can easily be update by using limited software application. The communication between the entrance points with central office by means of wireless technology. Limitation of user's check in time period is modified by Real Time Clock (RTC). In this door security system, Arduino MEGA is used for the purposes of storing user information, identifying whether authorized person or not, checking limitation time zone and emergency case.

KEYWORDS: Arduino MEGA, Database Management system, GUI, RFID, RTC, Security system

I. INTRODUCTION

Security is one of main concern in today's life. Technologies have been implemented for security purposes. Many solutions are available for all levels of access control from highly restricted areas such as banks, or laboratories to less restricted areas such as classrooms or department. The door security systems are any devices or system designed to prevent unauthorized access through a doorway, such as occurs during a break-in or burglary. There are many types of door security system which are key locks, chains locks, monitoring and alarming system. To replace a tradition door lock system, keyless entry system is most suitable and befit for security. Keyless entry system often uses electronic keypad, RFID, fingerprint, biometric feature, face recognition in place of traditional keys. Although user's character recognitions system are get high security but it also gives high cost, time consume for scanning and complexity due to training producer. Keyless controlled locks prevent unauthorized copying of door lock keys and it gives high security. RFID technology is one of an automation technology that is beneficial in improving current traditional way of door security system. This system is to transform manual management door security system to automatic system with the help of Microsoft Visual studio, Microsoft ACCESS and RFID technology. In this research, RFID and Keypad are used to impact more secure for door security not only to reduce cost effective but also to get simple usage of user. This system is set up with Real Time Clock (RTC), Microsoft Access database system and alarms addition to keep more secure. For data storage spot, Microsoft Access database system create a database that contain Name, Roll Number, Department, Update Time and User's image combining with Arduino Mega microcontroller and Graphical User Interface (GUI). Radio-frequency identification (RFID) based access-control system allows only authorized or responsible persons can enter the permission premises. An RFID system consists of an antenna or coil, a transceiver (with decoder) and a transponder (tag) electronically programmed with unique information. There are many types of RFID systems available in the market. RFID classified based on their frequency ranges and types of tag. Some of the most commonly used RFID kits are low-frequency and high-frequency. The passive tags used in this system are lighter and less expensive than active tags.

II. SYSTEM BLOCK DIAGRAM OF RFID BASED DOOR SECURITY SYSTEM

Overall block diagram of the system is describe as shown in Fig. 1. In this system, Tag serial number and password are used to distinguish people who try to enter is whether authorized person or not. All necessary

information concerned with authorized users is stored in data base system. That can be easy check, update, remove and add of desire records combine with limited user interface application. Real Time Clock (RTC) is used for getting check in time and defining Time Zone for high security. Emergency button is set to open the entrance door without ID card at every condition. Keypad is used to type password. LCD display serve as an output device for displaying information depend on the situation. Relay circuit serve as Motor driver to drive the motor for open or close based on user identification. If unauthorized person try to enter, the alarm system will activate all the time until the authorized user come to check to break-in surrounding and wish to stop the alarm.

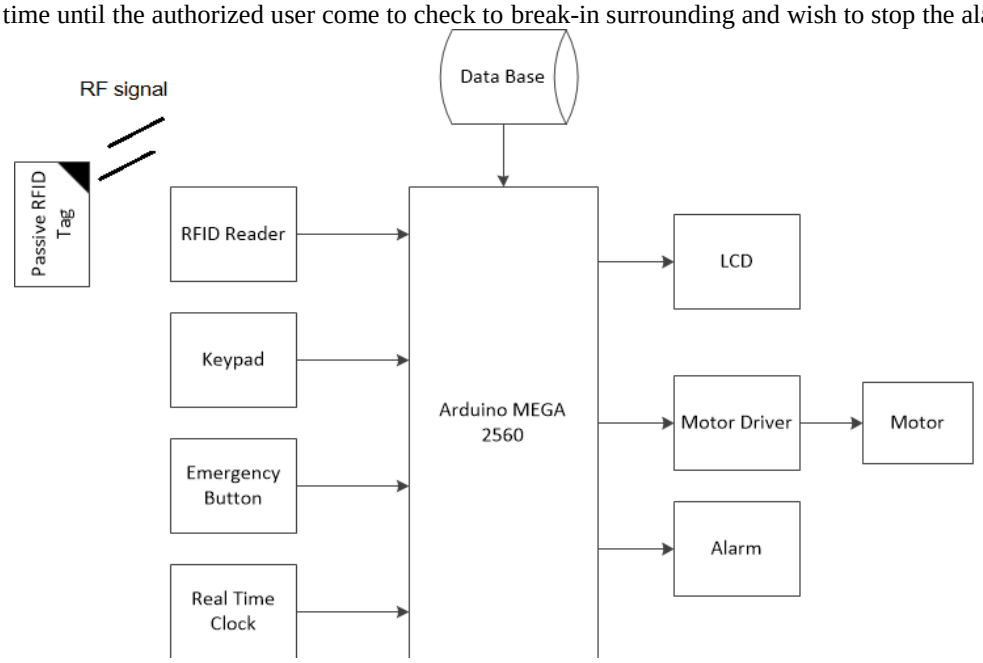


Figure 1. Block diagram of the system

III. HARDWARE COMPONENTS OF DOOR SECURITY SYSTEM

Arduino MEGA microcontroller is used to control the overall door security system. In this system, the following components are mainly used for controlling the RFID based door security system as shown in Table I.

TABLE I

HARDWARE COMPONENT AND OPERATION FOR DOOR SECURITY SYSTEM

No.	Components	Operation
1	Arduino Mega 2560	To control overall system
2	RFID reader	To detect unique Tag serial number
3	RFID Tag	Transmit unique Tag serial to reader
4	Keypad	To type password
5	Real Time Clock (DS1307)	To know user's check in time and limit Time period
6	Microswitch	Decide to check emergency condition
7	Liquid Crystal Display	To Display notification message
8	Buzzer	Use as alarm system
9	Relay	To drive dc motor

3.1 Arduino MEGA 2560 Microcontroller

To control the overall door security system Arduino MEGA microcontroller is used. The Arduino MEGA is a microcontroller board based on the ATmega2560. It has 54 digital input/output, 16 analog inputs, a 16 MHz crystal oscillator, 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 MEGA can be powered via the USB connection or with an external power supply. The Arduino MEGA can be programmed with the Arduino C programming software.

3.2 V1.2 RFID reader and RFID tag

RFID is known as Radio Frequency Identification System. The RFID reader used in this application will operate with 5V DC power supply and have a RS232 serial interface with 9600 baud rate. The operating frequency of the RFID reader is 13.56 MHz with 1.5 cm reading range and 0.1s response time. The primary goal of RFID technology is to automatically identify data that are contained in electromagnetic fields. They are divided into passive and active RFID tags. Most RFID tags are inexpensive and small where it derives its power from the signal produced by the RFID reader. Since the door security system only needs to read tag from short distance, passive RFID tag is choose for this application. It is also give lighter, small in size, less expensive and more lifespan than any other tags. RFID reader transmit radio frequency and tag receive radio frequency to power up the chip and then transmit its own serial number by frequency. This power is sufficiently enough to sends back information on that transponder to the RFID reader to be processed. The tags store and transmit data to readers using radio waves. The readers gather data from the different tags and relay them back to the server for further analysis and processing. The system serves the purposes of identification, monitoring, authentication and alerting through this exchange of data between the tag and the reader.

3.3 Real Time Clock (RTC)

The implementation of RTC will provide useful information to better analyze recorded data such as to know the real time of the system and to control for determining Time Zone. It's also used for storing students' entry time that enters by permission process. In this door security system, there are three limited Time Zone. Limitation of time period in door security system provide with 24hr format.

Condition I for the time from 06:00 to 17:59

In this condition, door will open if authorized card is enter or Emergency cases.

Condition II for the time from 18:00 to 23:59

In this situation, door will open if detected card and password enter is correct or Emergency cases.

Condition III for the time from 24:00 to 05:59

For this time, the door can open only for the person who wants to enter will have to use master key or emergency case.

A real time clock module is single package that contains mainly a 32.768 kHz crystal and a real time clock IC. Along with the design, this will provide more detailed information of the data such as the date and time of the recorded data. The real time clock IC includes the oscillation circuitry, clock, calendar, alarms and can contain additional features. RTC counts seconds, minutes, hours, day, month, and year with leap-year compensation valid up to 2100. The DS1307 Real-Time Clock is a low-power, full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially via a 2-wire, bi-directional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is occurring over a limited time period such as a time from 18:00 to 23:59 is control by password. 4x4 Keypad which is used to get password type by a user for checking and identifying whether it is an authorized person or not who try to enter. For emergency condition, user can enter permission area without present ID card with automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply.

3.4 4x4 Keypad

In this system, authorization process private password. In this door security system, 4 digits are used as a keyword.

3.5 Buzzer in alarm system

These alarm system will turn on if an illegal person tries to enter with unauthorized ID or password. This activation will be continued until the authorized user stop the alarm.

3.6 Emergency switch

If the user faces with an emergency condition that means the user forgot or loss ID card or over a limitation of Time period, user can enter by private password. That password will be accepted to check when the user push micro switch button on the system.

3.7 16x2 line LCD(Liquid Crystal Display)

16x 2 lines LCD is used for display information depend of the identification result. System produce message on LCD such as request to user for showing ID card or enter Key or Try again depend on identification situation. If detected ID card is matched with an authorized person, controller uses student information file from database and display students name on LCD. If the detected ID card is not authorized, LCD will display alert notification message depend on the detection result.

IV. DATABASE SECURITY SYSTEM CONTROL WITH GUI

4.1 Microsoft Access Database System

A database is a structured collection of records or data that is stored in a computer system. Accessibility and storage of large amount of data is important for a designing a database system. Programming techniques may include features such as data abstraction, encapsulation, measuring, modularity, and inheritance. A database system needs be managed with a Graphical User Interface (GUI), which is also called a Human-Computer Interface, that is, a way for humans to interact with computers. A series of elements conforming to a visual language have evolved to represent information stored in computers. Such a database management system with a user-friendly graphical interface this makes it easier for people with few computer skills to work with and use computer software. The GUI employs windows, icons and menus which can be manipulated by use of a mouse and often to a limited extent by use of a keyboard as well. Thus, a GUI uses a combination of technologies and devices to provide a platform for the tasks of collection and producing information.

4.2 Microsoft Visual Studio

Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows super families of operating systems, as well as web sites, web applications and web services. Visual Studio used Microsoft software development platforms such as Windows API, Windows Forms applications, Windows Presentation Foundation and Windows Store. This IDE can connect with database by using query language. The Visual Basic programming language is used to write the program. There are three primary steps involved in building a Visual Basic application:

1. Draw the user interface
2. Assign properties to controls
3. Write code for event procedure.

GUI used in this system, it is much easier for a new user to update a file from Microsoft Access Database without remember and type practically mysterious commands to accomplish the task. The aesthetics of the interface was developed with user interface design tools and coded by programming. The programming languages and Application software employed were Visual Basic (vb.net) for the development of graphical user interface Applications.

The GUI is developed by using Visual Studio and the .NET Framework version 3.5 Express Edition. It is used to display and perform the function that is triggered when the signals (Tag serial number) are received from the RFID via USD-RS232 cable. The reflected signal from RFID is sent to the computer through microcontroller that enables the communication between the hardware and the software. That calls the record of user from database. As shown in Fig.2, the description of the student record are ID, Name, Roll no, Department, Update Time and Photo are set in student information form. Browse key button perform to choose picture from open dialog box as user desire. When the user press Update key button, the system will save new update record of user to the database. For the beginning of the program, port name and baud rate must be declared. Baud rate 9600 is used in this system.

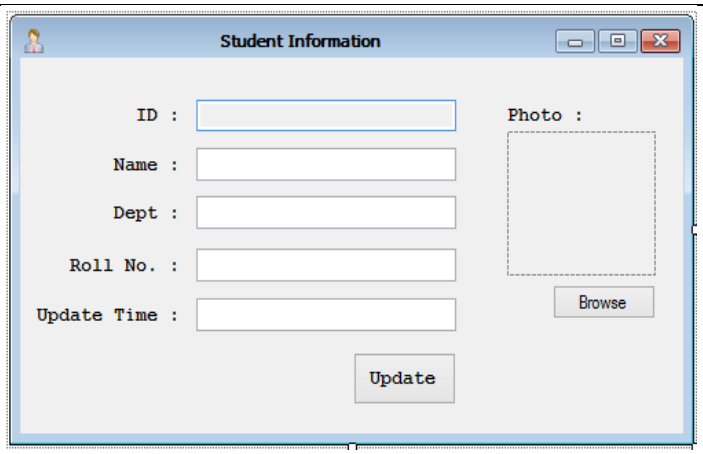


Figure 2. GUI for display and update record of students.

4.3 Flow Chart of Microsoft Access Database System

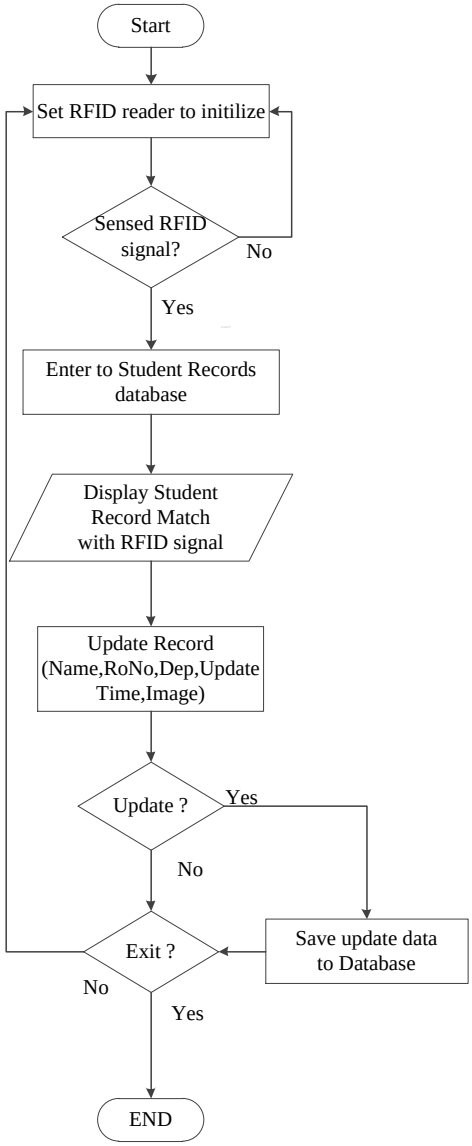


Figure 3. Flow chart of Microsoft Access Database

The system is activated when the tag is read by RFID reader while it is being located within the effective range. When the system is start, the Component Object Module (COM) will be initialized.COM7 is initialized in this system. If the system get signal form RFID reader, GUI display student record form the database system match with the signal receive form RFID reader. User can update student information in respective text box then click update button to save record. User update time will record automatically match with real time clock. Photo can be change by click browse button to choose desire image. Then the system checks for exit and go to end. The flow chart of the database system is show in Fig.3.

V. OPERATION OF THE SYSTEM

RFID Tag serves as a key and student ID card which is read by a reader. This system is interfaced with a database system through a computer or some electronic circuits. In this system, When the RFID reader installed at the entrance of department that detects a number of ID card, the system captures the user's Tag serial number and scans the database for a match. The system include door locking system which open automatically when the user put their student ID card in contact with RFID reader during school time and the user information matched with the information already stored in database. If the user's identification is verified, the door is unlocked and all the information such as user ID, date and time are stored in central office otherwise the system turns on the alarm and generate notification message on LCD to show valid ID card. For getting higher security, real time clock module is used to control time zone. Depend on the defined Time Zone the system will serve for asking only ID card or password or both. The system can also control the door entrance when the user wishes to open the door without ID card and no limitation time period. This type of situation is called as emergency case on this system. In this door security system, Arduino MEGA is the main controller interfacing with other devices by receiving the data from RFID module and transmits serial data with the baud rate 9600bps. Pin assignment of door security was shown in Table II.

TABLE III

PIN ASSIGNMENT FOR DOOR SECURITY SYSTEM

Pin No.	**Pin Assignment**	**Connect Process**
10 and 11	TX and RX	For detecting Tag serial number
20 and 21	SCK and SDA	For detecting real time clock
14,15,16,17, 18,19,22,23	R4,R3,R2,R1, C4,C3,C2,C1	For getting password
3	Button Pin	For detecting micro switch
5,6,7,8,9,12	D7,D6,D5,D4,E,RS	For display notification
USB interface	Com 7	Connection with user PC

5.1. Hardware and Circuit Testing

This door security system has been tested at a model of department entrance. The circuitry is integrated with the model of door security system. The hardware is divided into three modules which are the input modules, identification module and output module. The input module consists of RFID Tag serial number sensing, emergency button sensing, real time clock detecting, and database system. The identification module comprises a RFID and a keypad. The output modules contain a series of responding components which correspond to the input obtained from the input modules such as door open or close, notification message on LCD, and a buzzer. Fig. 4 show the overall circuit diagram of door security system.

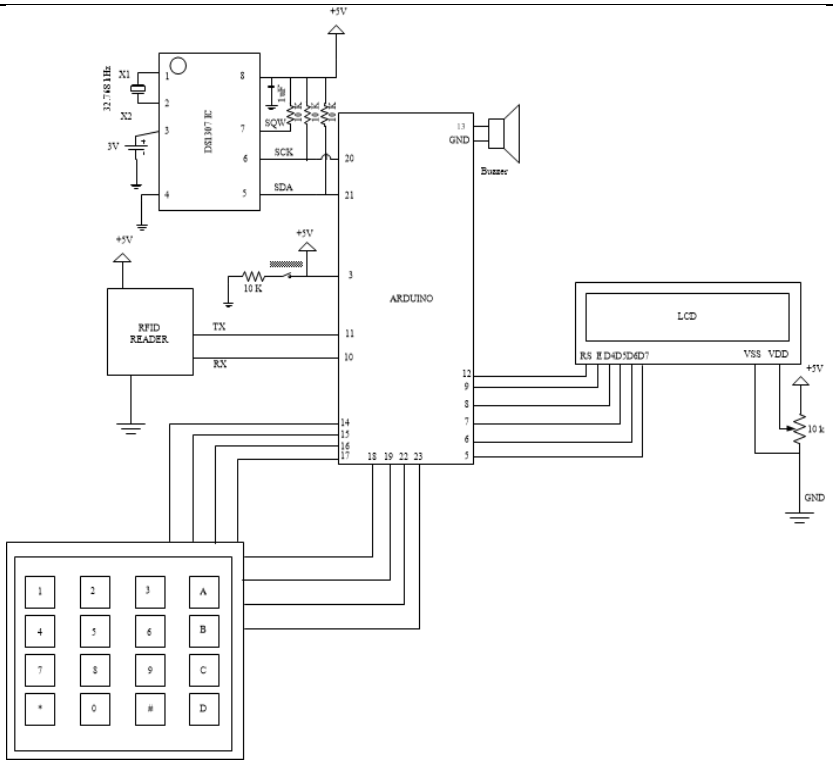


Figure 4. Over all circuit diagram

VI. SOFTWARE IMPLEMENTATION OF THE DOOR SECURITY SYSTEM

Arduino C programming is used in this door security system. To complete this system, the choosing of software for database and type of RFID are very important. The Microsoft ACCESS is used for database and Microsoft Visual Studio is used for GUI design. The Arduino C and VB.net programming language are used to implement the system.

Baud rate is set as 9600 in this system. Microcontroller is connecting with serial communication to PC. When the signals are received from the RFID to controller, GUI perform display record of students from database. Browse key button perform to choose picture from open dialog box as user desire. Update key button serve the system to save new update record of user to the database.

There are three types of software processing. The first type is for storing students' information and tag serial number with respect to their ID card in database. The second is for limiting of time defined by user and the last one is for identification and classification authorized users. For the first activation, RFID reader waits RFID Tag or ID card for detection or reading unique serial number. After receiving tag serial number transmit with radio frequency by RFID reader, the Arduino MEGA microcontroller check the detected Tag serial number is authorized or not.

6.1. System Flow Chart

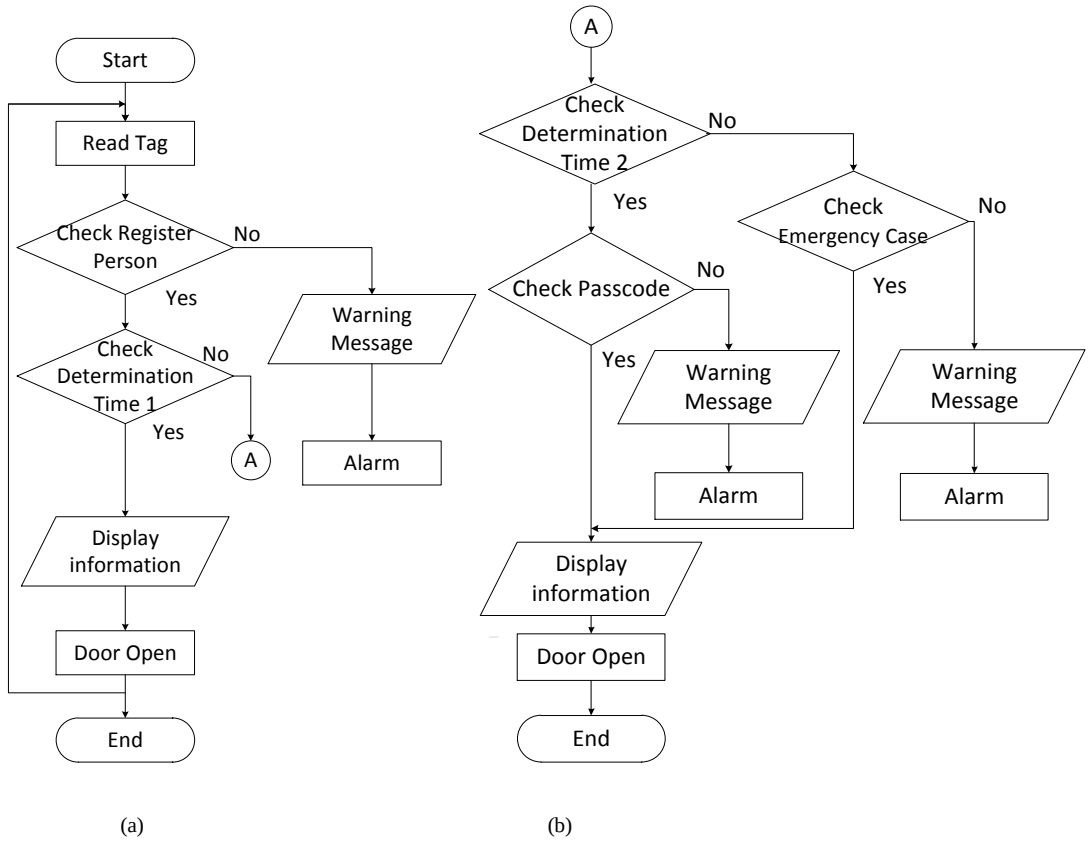
For detailing explanation of the overall system is shown in Fig,.5 (a) and (b). The door security system will activate when student ID card or RFID tag is reached in detection area. That detection area will make detection approximately less than a few millimeters from RFID reader. In this system, master key and master password are set for Emergency case i.e. a time when the door has to open where there were no authorized ID card or over a user's limitation time period. The operation of the system describes as follows:

When RFID tag reach in detection area, system will read tag serial number and send it to Arduino Mega controller for identifying process. After that, if the identification of Tag serial number is correct then the system will check user's predefined Time Zone match with real time clock. Otherwise, the system display warning message on LCD and activate the alarm system.

If the result of checking time is in condition I, the system will display user information on LCD and activate the motor to open the door. Otherwise, check for the time in condition II. The system commands to user to type password when checking time is in condition II. And then check this password by Arduino MEGA controller whether it is correct or not. If the checking password is correct, the system will display user

information on LCD and activate the motor driver to open the door. If the system is not in condition II then the system check for emergency case.

If the checking time is not include in condition I and II, the system will only check for emergency case. The door will open when the emergency password type by user is correct. Otherwise, the system display warning message and the alarm system will activate Alarm system activation will be stop when the authorized user stop with authorized password. After that, the system serves again for detecting ID card.



(a) (b)

Figure 5. (a) and (b) Flow chart of the system

VII. RESULTS AND ANALYSIS

In this system, the identification of authorized user is controlled by RFID tag serial number and password. For this system, Arduino MEGA can be performed as a controller to control overall operating system. In testing, the identification of user can be vary depend on limited Time Zone and emergency condition.

7.1 Storing Students Information in Microsoft Access Database

In Fig.6 Students' information such as name, roll number and departments, update time and user's image are stored as a sample record in data base for displaying authorized user record in Microsoft Access Database System and recall this information to display in LCD.

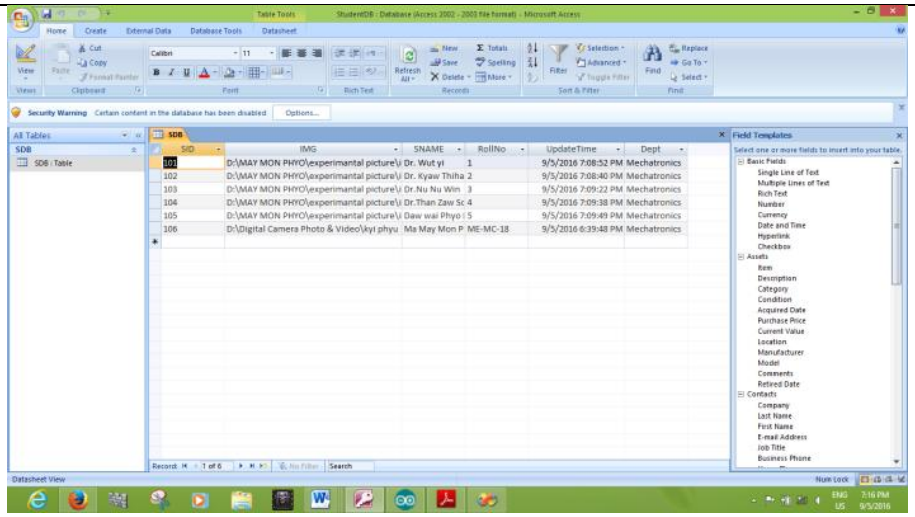


Figure 6. Student information store in Microsoft Access Database System

In this system, Graphical User Interface for displaying student information was constructing by Vb.Net frame. The GUI design and the result are shown in Fig 7. In this student information form, there are two types of button first one is Browse that is used to choose desire user image from file and second is Update that is to save student record edit by user.

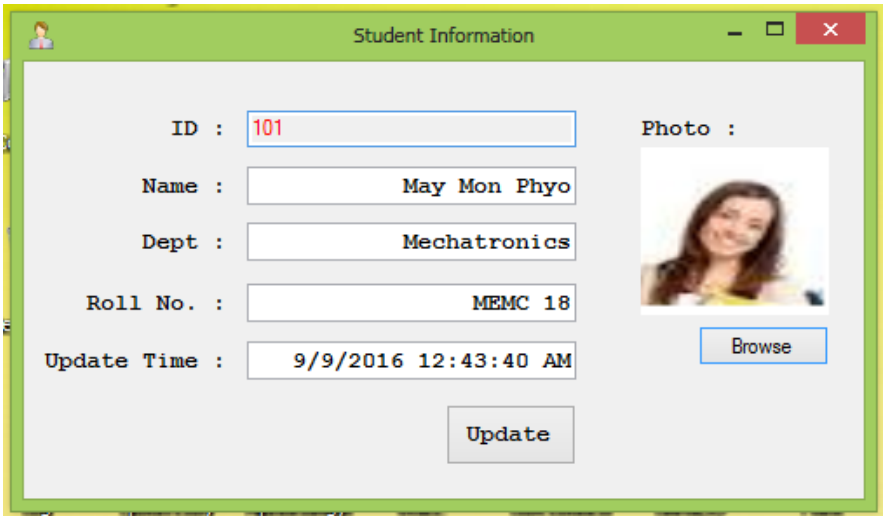


Figure 7. Sample record of user

7.2 Identification of authorized user

Student ID card or Tag is detected by RFID reader when it is reached in detection area where approximately apart 1.5 cm from RFID reader. If the tag detection process is accomplished in conditions of both authorized and in school time, LCD will display a message of "User Name" and "Door Open!". Password will be check when detection time is over school time as the predefined condition II for the time from 18:00 to 23:59. The system command to the user to enter password can be seen in LCD. LCD will display "Invalid Card" and ask for the user to show authorized card when the detected student ID card or Tag is an incorrect ID. For emergency case, there is a keyword to control the door entrance. Emergency keyword can be typed by keypad. The system will permit for asking emergency keyword when the user pushes the micros switch on the system. Fig. 8 which is described the testing of overall system components.

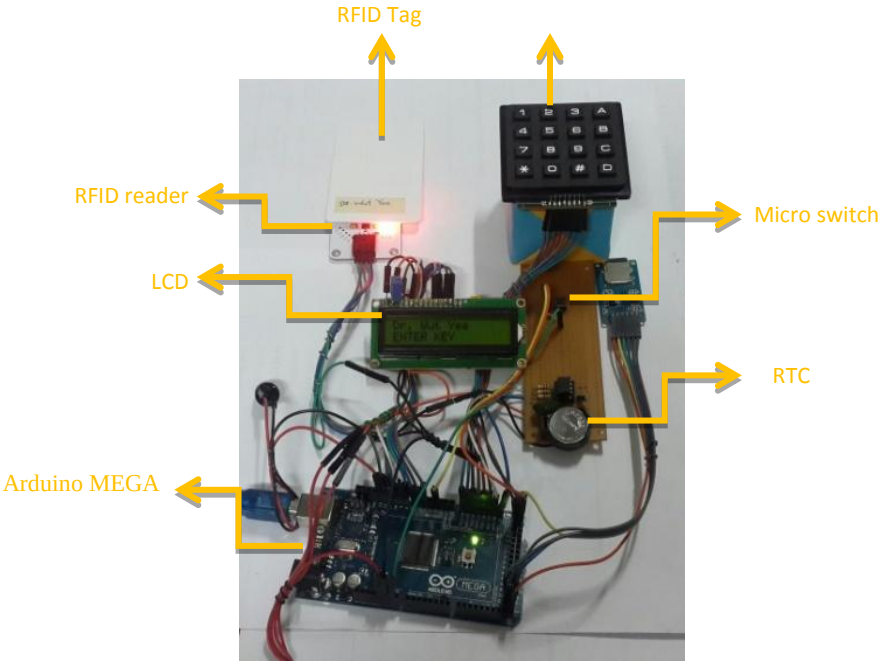


Figure 8. Over all component testing

VIII. CONCLUSIONS

In this research, the integration of Door Security System control with RFID (Radio Frequency Identification) and limited Time Zone technology to enhance the security level in the selected area have been developed. First, RFID technology is used to develop identification and classification of user ID. Then, by adding the second layer of authentication with Time Zone to the system enhanced the security level. Finally, based on the application scenario proposed, this research is to improve the door security of sensitive locations while they are not at working places or homes. The application will also improve management procedure combine with Microsoft Access Database system. Checking student's information and monitoring student's entry with manual operation have time consuming and low security. So, this door security system can solve above problems and it will give more accuracy. And easy to distinguish whether student or not who want to enter. And also enhance the security and safety in selected zone.

In this study, we have implemented a digital security system contains door lock system using passive RFID and Microsoft Access Database system interface with GUI.. A centralized system is being deployed for controlling and transaction operations. Database system control with Graphical User Interface makes it easier to check and update record of user's information. The door locking system functions in real time as when the user put the tag in contact with the reader, the door open and the check-in information is stored in central server along with basic information of the user. This paper utilizes RFID technology to provide solution for secure access of a space while keeping record of the user. The system has a great suitable and easy used to increase security in addition to old door lock used specially if there is no one in that place where the security door found.

The main objective of this research is to design and implement a security system with Student ID card which can deploy in secured zone where only authentic person can be entered. To use in specific area for safety, secure and store record of Students list to the database. So, high security will get around the University Campus. Student ID card it also serve as a key to open entry door so students can easy to carry and easy to distinguish students or not. This door security system will also give low cost, high security and easy to update user information.

ACKNOWLEDGMENT

The author is very thankful to Dr.Myint Thein, Rector of Mandalay Technological University, for his encouragement, invaluable permission and his kind support in carrying out this paper work.

The author is deeply grateful to Dr.Wut Yi Win, Associate Professor and Head, Department of Mechatronic Engineering, Mandalay Technological University for supplying all necessary things.

The author especially appreciates and thanks all her teachers for paper support, and guidance during theoretical study and paper preparation durations.

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