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ABSTRACT

Radio Frequency Identification (RFID) technology utilizes the electromagnetic fields for data transfer in order to perform automatic detection and tracking of tags or tags of objects. It can provide ways to design and implement relatively inexpensive systems particularly for security aspects.

In this paper, we have proposed a digital access control system that can be employed to a protected area where none but people with authenticated credentials can enter. In fact, we have implemented the system in the server room of an educational Institute to test its efficiency as well as expenditure.

The implemented system comprises of digital door lock which is unlock able in real time to ensure secured access specifying activation, authentication and validation of users prior to bringing the RFID card close to the reader and entering the password or ID which is assigned. This system will certainly provide an idea about the design and installation of a relatively inexpensive security system which is suitable in the perspective of a developing country like Pakistan.

INTRODUCTION

RFID in congregation with keypad has gained immense popularity for security issues. Identification of individuals is always prioritized in secured places like bus and train stations, national and international airports, commercial complexes, movie theaters, hotels, banks, homes, educational organizations and so on [1]. Undoubtedly, associated expense is an important factor to be considered while promoting security solutions for such locations. In that sense, RFID is a relatively inexpensive technology which is capable of transmitting data without the usage of any guided media. This technology has not been very often used in industry due to lack of standardization among the manufacturing companies earlier.

RFID technologies are efficient [2] and secure compare to other network [3]. With RFID, wireless automatic identification takes a very specific form: the object, location, or individual is marked with a unique identifier code contained with an RFID tag, which is in some way attached to or embedded in the target [3]. RFID is not a single product but a comprehensive system, a typical RFID system include three basic elements: RFID tag (transponder), reader (transceiver) and back-end application system (or database), which demands the support of the computer network. The software is used for management, controlling, transaction, operation and maintaining record of the various users.

In our proposed system, a mess attendance system is administered via RFID reader, a fingerprint module and a keypad that initiates the authentication as well as validation of the user or controls the access in short.

The systems also maintain evidences regarding the access and exit records of each user in the form of a log report against every access. The administrator of the central sub-system can terminate the validity of any user at anytime to avoid unexpected situations. In fact, a three layer of security has been applied. First, the user needs to get permission from the system administrator to access and then comes the combined process of authentication and validation.

The events of access and log report generation take place at real time. The system is more convenient to install and implement as access security solution of a particular arena due to its cost effectiveness with respect to the satisfactory level of protection provided. Another advantage is that the system consumes considerably less space for installation and maintenance purposes.

The prime objective of this paper is to describe how to design, develop, implement and install a comparatively inexpensive security solution with considerable scale of security assurance.

SYSTEM ARCHITECTURE

In the proposed security system, we have controlled a magnetic door lock after processing of the information obtained from RFID cards. The entire system can be splitted into hardware as well as software components.

1. HARDWARE

a. RC522 – RFID Module

The MF RC522 is a highly integrated transmission module for contact-less communication at 13.56 MHz. RC522 supports ISO 14443A/MIFARE mode. The S50 RFID Cards ease up the process helping us to learn and add the 13.56 MHz RF transition to our project.

The module uses SPI to communicate with microcontrollers. The open-hardware community already has a lot of projects exploiting the RC522 – RFID Communication, using Arduino. MFRC522 support MIFARE series of high-speed non-contact communication, two-way data transmission rate up to 424kbit/s. It is Low cost, and ideal for user equipment development. Its operating Current is 13-26mA / DC 3.3V.



b. 4x4 Keypad

Matrix keypad use a combination of four rows and four columns to provide button states to the host device, typically a microcontroller. Underneath each key is a push button, with one end connected to one row, and the other end connected to one column. This 16-button keypad provides a useful human interface component for microcontroller projects. Convenient adhesive backing provides a simple way to mount the keypad in a variety of applications. It has the following specifications:

- Maximum Rating: 24 VDC, 30 mA
- Interface: 8-pin access to 4x4 matrix
- Dimensions: Keypad, 2.7 x 3.0 in (6.9 x 7.6 cm), Cable: 0.78 x 3.5 in (2.0 x 8.8 cm)



c. Fingerprint Module

This is an optical biometric fingerprint reader/sensor (FM2660) module with TTL UART interface for direct connections to a microcontroller UART. The user can store the fingerprint data in the module and can configure it in 1:1 or 1: N mode for identifying the person. This module can directly interface with any 3.3V or 5V microcontrollers, but a suitable level converter/serial adapter is required for interfacing with the serial port of a PC.



Why Fingerprint Sensor (FM2660)?

As we know that the Fingerprint Sensor FM2660 is so expensive in price but still this is part of our project. The reason is the memory, speed and power consumption. FM2660 has required less power as compared to other sensor and it can be operated directly from the Arduino mega 2560. FM2660 has of 2 Kilo bytes which can store the record of 256 person because each fingerprint size is 8 bits. Another plus point of using FM2660 is we can expand the memory up to 8 kilo bytes through programming so it can be able to store 1024 person records. The library we are using in this project for FM2660 is actually the library of FM2666 because we did not find the actual library for FM2660.

d. Arduino Mega 2560

Arduino is an open-source physical computing platform based on a simple i/o board and a development environment that implements the Processing/Wiring language. Arduino can be used to develop stand-alone interactive objects or can be connected to software on your computer (e.g. Flash, Processing, Max MSP). The open-source IDE can be downloaded for free (currently for Mac OS X, Windows, and Linux).



The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), 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. Never fear for accidental electrical discharge, either since the Mega also includes a plastic base plate to protect it!

The Mega 2560 R3 also adds SDA and SCL pins next to the AREF. In addition, there are two new pins placed near the RESET pin. One is the IOREF that allow the shields to adapt to the voltage provided from the board. The other is a not connected and is reserved for future purposes. The Mega 2560 R3 works with all existing shields but can adapt to new shields which use these additional pins.

Why Arduino Mega 2560?

In this project we are using Arduino Mega 2560 because of the specification such as lot numbers of data pins and a powerful processor of clock speed 16MHz. Arduino Mega has an in built in EEPROM memory of 4 Mega bytes which help us to store the data of RFID and fingerprint modules locally in this project.

2. SOFTWARE

a. Language

We are using C/C++ as programming language in this project.

b. Arduino IDE

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.



c. Firebase Database

Store and sync data with our NoSQL cloud database. Data is synced across all clients in realtime, and remains available when your app goes offline.

The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in realtime to every connected client. When you build cross-platform apps with our iOS, Android, and JavaScript SDKs, all of your clients share one Realtime Database instance and automatically receive updates with the newest data.

[iOS setup](#) [Android setup](#)

[Web setup](#) [REST API](#)

[C++ setup](#) [Unity setup](#)

[Admin setup](#)

**3. ALGORITHM**

- Start
- Add these Libraries
 - a) EEPROM
 - b) MFRC22
 - c) LiquidCrystal_I2C
 - d) Keypad
 - e) Servo
 - f) SPI
 - g) Wire
- Void Setup Function
- Initialize Arduino pins for LEDs, Servo, Buzzer & tactile switch
- Initialize boolean variables match, programMode, replaceMaster & successRead
- Initialize arrays as storeCard, readCard, masterCard, storePass, password & masterPass
- Void Loop Function
- Conditional statements
 - a) Master Tag
 - i. Enter Pass
 - ii. If master tag scanned, then Exit
 - iii. If known tag scanned, then Remove from EEPROM
 - iv. If unknown tag scanned, then Enter New Pass & ADD to EEPROM
 - b) Other Tag

- i. If known tag scanned, then Enter Pass & Scan fingerprint then Grant Access
 - ii. If unknown tag scanned, then Deny Access
- c) Wipe Button
 - Go To Void Loop Function

SYSTEM WORKING MECHANISM

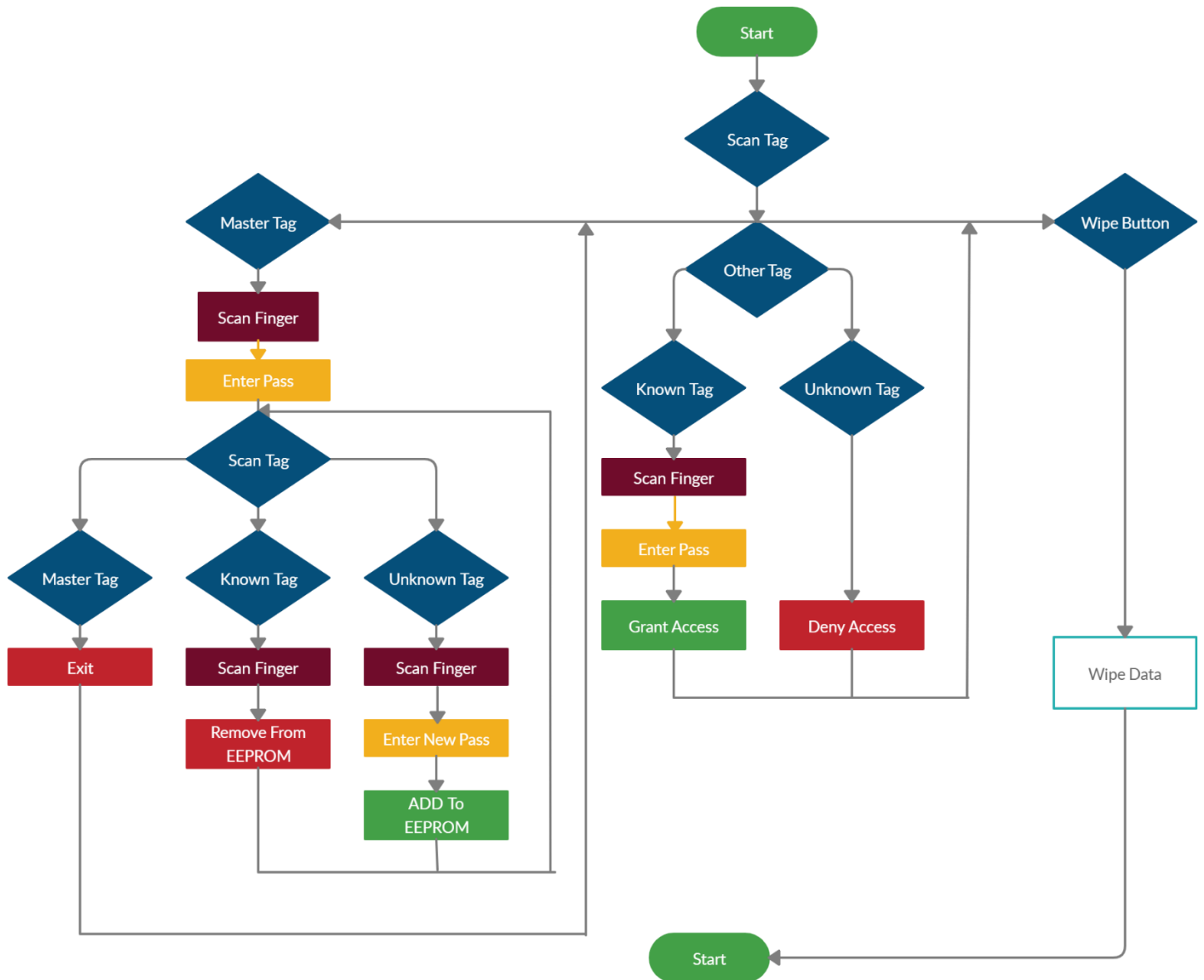
Power requirements for the RFID reader module is +3.3v and fingerprint module is 5v. The system is initiated upon providing the power supply. An LCD display has been used to inform the user visually about the next state to be initiated by the system. A beep sound from buzzer ensures that RFID reader has read the information stored in the RFID card prior to bringing the card in readability range.

LCD also assists a user for providing accurate password that is eventually subjected to transmission to the system. In case of matching of transmitted information along with the valid user credentials, then after it the user have access to the system or in case of our project the door will open.

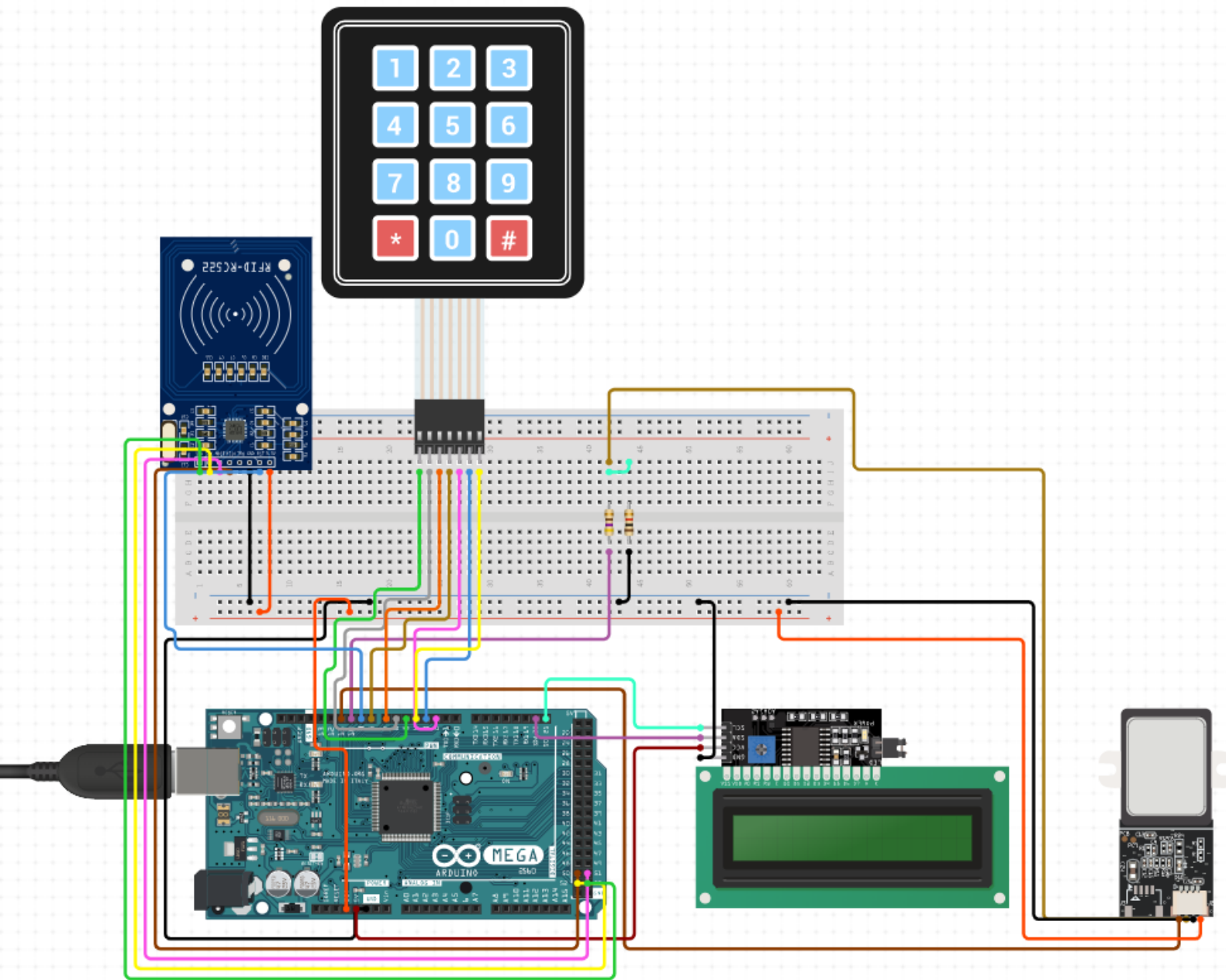
The door remains open for a pre-specified time and then the door closing event initiates. In case of information mismatch, the door remains closed to prevent unauthorized access. That's how security is preserved.

Required information regarding authorized users credentials has been stored in the central sub-system. It is to be noted that the central sub-system software that maintains and tracks the user information has been designed entirely by us for the intranet of the institute. If an authorized user comes to the access point and punches the card issued against his credentials then transmission of accurate information invokes authentication and validation process to be executed successfully. At the same time, a log report is recorded in the database against the user to store check-in as well as check out status with time.

1. FLOW CHART



2. CIRCUIT DIAGRAM



3. PROCEDURE & CONNECTION

The RFID reader communicates with the Arduino through the SPI protocol and different Arduino boards have different SPI pins. I have described the connections of RFID Reader with different Arduino boards in the below table.

MFRC522 RFID Reader	Arduino Uno
RST/Reset	9
SDA	10
MOSI	11/ICSP-4
MISO	12/ICSP-1
SCK	13/ICSP-3
GND	GND
3.3V	3.3V

To test if the RFID reader is working properly or not, upload the “dumpinfo” from the examples in the Arduino and see if it is showing the information of the tags on the serial monitor or not.

The I2C LCD communicates with the Arduino through the I2C protocol. Different Arduino boards have different I2C pins. The I2C pins on Arduino Uno and Arduino Nano are A4, A5. The below table describes the connections of different Arduino's with I2C LCD.

I2C LCD	Arduino Uno
SCL	A5/ SCL
SDA	A4/ SDA
GND	GND
VCC	5V

Next we are going to connect the keypad with Arduino. The 4X4 keypad has 8 connections but we don't require the last column of keypad. We only require numbers for the password. So we won't use the last pin of keypad which is for fourth column. Connections for keypad with Arduino are given in below table. You can also use 4X3 keypad instead of 4X4 keypad.

4X4 Keypad	Arduino
1st Pin	A0
2nd Pin	A1
3rd Pin	A2
4th Pin	A3
5th Pin	D2
6th Pin	D1
7th Pin	D0

The below table describes the connections of Arduino with other components.

Arduino	LED's	Servo	Buzzer
5V		Positive Wire (Red)	
D8		Signal Wire (Yellow)	
D7	Green LED		
D6	Blue LED		
D5	Red LED		

D4

+

D3

GND

Negative
leads
through
220 ohm
resistorGND
Wire
(Brown)

-

In the end, connect the power source to the Arduino. I have used three 18650 cells. We can give 6 to 12V to the Arduino through the barrel jack.

OBSERVATIONS AND DISCUSSION

Our implemented system can be applied effectively in universities to record and maintain students' attendance in a particular class room. Similarly, it can also be used in office rooms to keep track on arrival time of employees at workplace. Not only classrooms or office-rooms, even though the system can also be adapted to any secured zone that only allows authorized access. Central database keeps record of every entry thus capable to generate the frequency of access for each and every user. This system helps to reduce the technical human error plus manual paperwork related to such controlled accesses.

CONCLUSION

- The solution we are providing security system in order to avoid access of intruders.
- We utilize RFID technology to provide solution for secure access of a space while keeping record of the user.
- For a safe system, access is granted to admin only to add/remove members.

REFERNENCES

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