

RFID Entrance Security System

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Abstract

This system was developed to improve home or office security using by controlling entrance access using Radio Frequency Identification (RFID) unit and an Arduino microcontroller for authentication and authorization purposes. The entrance access systems had used manual locks and keys from the early days until now. Security breaches are common due to lost or stolen keys, picked locks and duplicate keys. The technology has now evolved to electronic gadgets from PIN pads and intelligent card readers with microcontroller attached to the system. Here, RFID system is introduced as a device that uses radio waves to transfer data signal from the RFID tags to the RFID reader. This system can enable a person to access the entrance without manually unlocking a door. In this system, RFID module reads the card information when the card is touched to the reader and is compared with the data in the database and displays either the authorized or unauthorized entry. RFID could also be considered as a developing technology where it can be implemented for several applications such as security, asset tracking, people tracking, inventory detection and access control applications. Therefore this research is used to secure the system and to identify the authorized and unauthorized persons where the security of any entrance door could be more efficient and systematic

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I. INTRODUCTION

A security system is crucial for our daily life to prevent an unauthorized personal from entering any home premises and building. Owners have been using many different types of locks to keep themselves and their belongings safe at all times. Ever since the year 2016, crime rate in Malaysia has been stated as high in the Overseas Security Advisory Council (OSAC) yearly report. The latest 2018 OSAC report has stated that Malaysia is treated as a high-threat crime location especially in densely-populated urban centers where residential break-ins are common [1]. Also reported in the New Straits Times that an increase of 4.6 per cent between January and April 2016 is due to the increase in property crimes [2]. Thus to prevent all these crimes, different types of security systems have been developed. It varies from hiring a security

guard, using conventional door lock to electronic automatic identification systems [3]. Conventional door lock is mainly a mechanical lock type using different types of keys to secure the entrance of the building. However, nowadays this method is incapable to keep our premises safe as burglars have sophisticated gadgets for them to use during break-ins. To keep abreast with the current lifestyles, many sophisticated entrance locks have been developed and produced especially the automatic access control system. Different automatic types of wireless technology are ZigBee [4], Cellular telephone [5], GPS/GSM/SMS [6], Bluetooth [7], RFID [8] and etc. By deploying RFID wireless technologies to secure and control in the security systems, it could also offer attractive benefits along with the user-friendly interface. RFID could also be linked with other methods for the same purpose of application.

RFID is an emerging technology which is becoming more sophisticated and rapidly growing in the residential area and also among the industries [9].

Therefore, a simple, low cost and smart security system is developed to make sure only authorized personnel is allowed to enter through the locked door. The system is using the RFID technology with Arduino microcontroller to replace the conventional lock system as to develop the entrance security system. This Arduino can be activated by using the programming code list which is short and easy to create. In addition, RFID is a read or write technology where the data is encoded in the tag during the tracking cycle and it can be updated or changed wirelessly.

II. BACKGROUND

RFID technology is rapidly growing for the past few years in different aspects all over the world. The RFID system with different types of applications have been developed, presented and published in proceedings, journal and etc. The related RFID technology publications have been reviewed based on similar research idea in controlling the incoming and outgoing processes.

- Umar Farooq et al. [10] has developed a system which combined the RFID technology and biometrics to accomplish the design of RFID based security and access control system in Punjab University hostels premises. The RFID reader is installed at the entrance of hostel to detect a number where the user image is captured to match with the scanned database. The access is granted when both the card and captured image belong to a registered user or else the alarm is turned on and proceed with an emergency call to the security van through GSM modem to catch the suspicious person.
- Yashi Mishra et al. [11] has developed a secure system that provides information about authorized and unauthorized persons by comparing the data in the program memory when the card is placed on the RFID module where it reads the card

information. Authorized entry relates to door opens and attendance is marked which links to the id code and save in excel sheet format in SD card. The related information is displayed on the LCD such as the name and employee code number with the welcoming audio greetings message. As for the unmatched entry, the gate remains closed and at the same time the security personnel is informed through speakers with separate audio file saying that the entry is unauthorized.

- AmolSapkal et al. [12] have implemented the entrance type of security at the girl's hostel. The tools used in the system are finger print, GPS modem and GSM modem. Password authentication is applied for further finger print. The flow process is that whenever any student is going out from the hostel, the student needs to enter the out time and destination place and bring along the security module. The student needs to press the key on the security module to send one message to the wardens mobile when the student is in danger. At the same time, the message is sent to the parents' mobile number along with the location of that particular student.
- GrewalKaushal et al.[13] has carried out a research on the security access and control system using RFID and Arduino with GSM module for which some drastic changes have been made on its programming with a lot shorter and easier to understand by replacing microcontroller with Arduino. Some of the sensors are used such as passive infrared sensors (PIR).

The techniques are used for security and access controlled systems with different approaches such as by using finger print authentication. This is because the password or an SD card module is used to save different audio files with different names for each individual tag ID. The RFID technology evolution is based from manual to automatic. That is by using Arduino Uno as the microcontroller to control the system where the Arduino IDE software is used to write the source code for the system such as to operate the stepper motor used as an actuator that

enables to open and close the door in real-time. Also, a GSM as an additional method of security as it alerts different security personnel by providing a security message on their mobile phone for any unauthorized access to occur.

III. METHODOLOGY

The implementation of the system is explained in terms of the block diagram and flow chart for overall system development progress.

i. Block Diagram

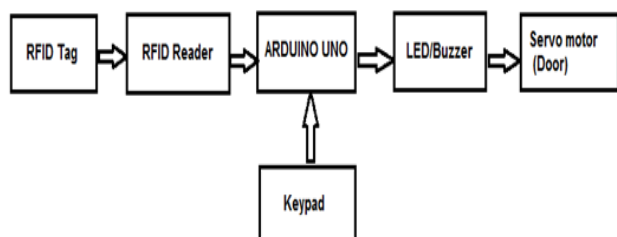


Figure 1: Block diagram of Entrance Security System

The elements of the block diagram in Figure 1 are described as follows:

- **RFID Tag:** The RFID tag or also known as the transponder which holds the data that needs to be transmitted to the reader when the tag is interrogated by the reader. Passive, Active or Semi-Passive types of RFID tags can be used. Here, the passive RFID tag is used. Passive tag does not have an internal power source and the power is supplied by the reader. Since the tag does not depend on an internal power source, the lifespan is unlimited. The tag used in the system is the smallest and cheapest.
- **RFID Reader (MFRC522):** The RFID reader reads the data and send the code with unique ID to Arduino. An RFID reader or known as interrogator is the brain of the RFID system. It is a device that transmits and receives radio waves in order to communicate with RFID tags. A fixed RFID reader is used in this system because it stays in one specific location when encoding and reading the tags

occurred.

- **Arduino:** Arduino is an open-source prototyping platform based on easy-to-use hardware and open-source software. Here, Arduino UNO board is used which is based on ATmega328 microcontroller. The board has 14 digital input/output pins where 6 pins are Pulse Width Modulation (PWM) output pins, six analogue inputs, a USB connection for programming the on-board microcontroller, power jack, an In-Circuit Serial Programming (ICSP) header and a reset button. The Arduino programming language is a simplified version of C/C++. Arduino receives the code from the RFID reader and compares to identify the correct code with the unique identification number which has been written within the syntax of the programming code.

- **Keypad:** Keypad is used to enter the password. The door opens when the correct password is keyed in and vice versa. The matrix 3 (rows) x 4 (columns) keypad consists of number 0 until 9, star (*) and hash (#). The matrix is controlled by the Arduino Uno. The algorithm for the key-press detection is 'scanning rows and columns' where row and column pins are shorted when a key is pressed.

- **Servo motor:** A servo motor or servos are self-contained electric devices that rotate or push parts of a machine with great precision. The servo that is used in this system is SG90 servo motor which is tiny and lightweight with a high output power. It can rotate approximately 180 degrees which 90 degrees in each direction. This servo has metal gears for added strength and durability. The servo motor moves when the correct password is entered by the user to open the door.

- **LED:** A Light-emitting diode (LED) is essentially a p-n junction diode which produces light. LED is inexpensive, robust and have long life. It is used in this system as an indicator to detect authorized or unauthorized user. The green LED indicates an authorized user with correct password. The red LED indicates the authorized user with

wrong password.

- **Buzzer:** A buzzer is an audio signaling device which can be used mechanical, electromechanical, or piezoelectric. Here, the buzzer is used as an alarm to notify that the user is unauthorized. The buzzer produces a buzzing sound to notify either authorized or unauthorized user at the same time with the LED.

All the elements are assembled with reference to their specifications and placed in an appropriate casing box for hardware development shown in Figure 2. The buzzer and LED are placed at the box's lid and wired to the strip board. The input and output of the system are linked, operated and controlled by implementing the Arduino Integrated Development Environment (IDE), Fritzing and Simulation that constitute to the software development part of the system as described in Table 1.

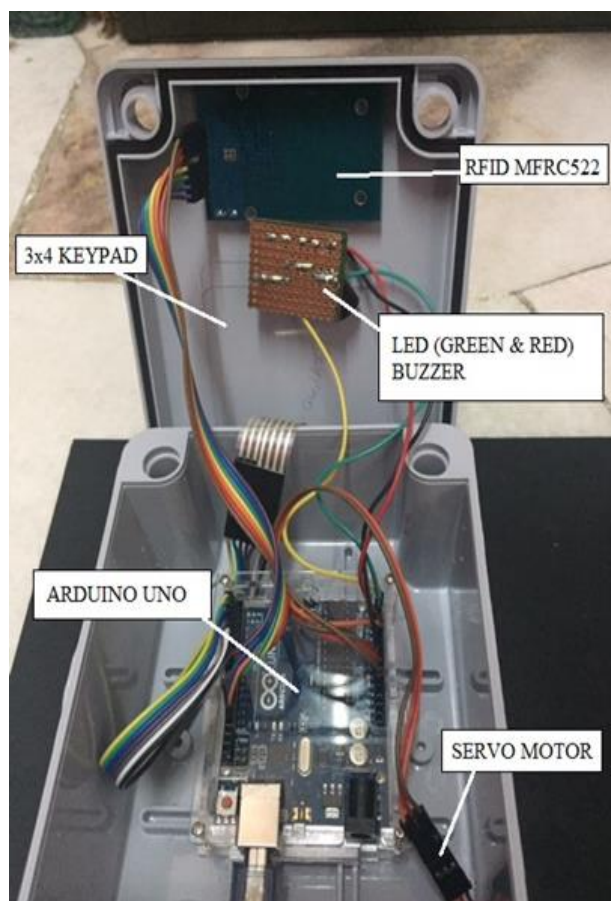


Figure 2: Hardware Development

Table 1: Software development descriptions of the system

NO.	ELEMENT	DESCRIPTION
1	Arduino Integrated Development Environment (IDE)	Arduino IDE contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and series of menus. It is connected to the Arduino and Genuino hardware to upload the programming codes and communicate between them.
2	Fritzing	Fritzing is an open-source hardware initiative that makes electronics accessible as a creative material. The software is created in the spirit of processing the programming language and the Arduino microcontroller that allows to document the Arduino-based prototype and create a PCB layout.
3	Simulation	• Interface Arduino Uno with Keypad. The simulation of Arduino Uno with keypad is done by using Fritzing application software. The pin configurations are based on 3x4 keypad datasheet. The output is shown on the serial monitor to prove that the simulation coding and configuration are both correct as shown in Figure 3. • Interface Arduino Uno with RFID MFRC522. The simulation of Arduino Uno with RFID MFRC522 is done by using Fritzing application software. The pin configurations are based on RFID MFRC522 datasheet. The output shows on serial monitor has proved that the simulation coding and configuration are both correct as shown in Figure 4.

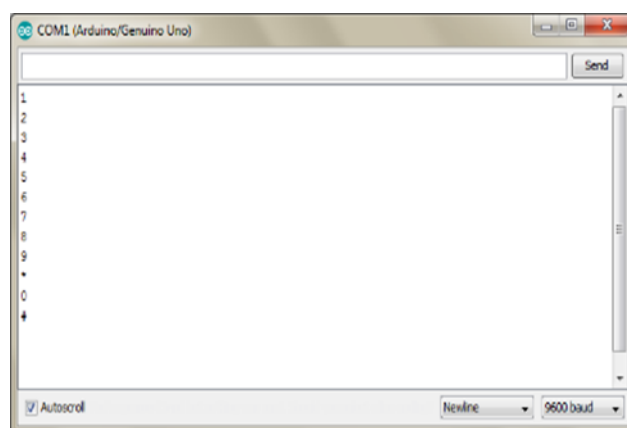


Figure 3: The output of keypad on serial monitor

ii. Flow Chart

The operation of the system is described in the flowchart shown in Figure 5. The card is tagged by the user to the RFID reader. The RFID reader decrypts the code to retrieve any unique ID from the card. The unique ID that is obtained from the card is compared with the stored data in the database. If the data user does not match with all the stored data in the database, the user is not allowed to key in at the keypad to pass through the entrance. Or else if the user data is recorded in the database, the user is able to key in the password at the keypad. Then, again the password is compared with the stored data in the database. If the user data is the same as the stored data in the database, the green LED lights up which indicates the "ON" status for authorized user and the door is opened.

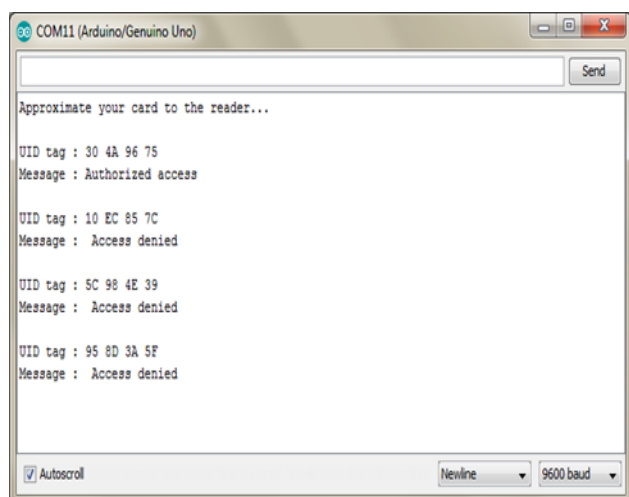


Figure 4: The output of MFRC522 on serial monitor

If the user data is recorded in the database and wrongly keyed in the password, the red LED lights up which indicates "OFF" status and the buzzer produces an alarming sound. This is to highlight an unauthorized user and the door is closed. Whereas if the user data is not registered in the database the LED does not light up which indicates unauthorized user and the door is closed.

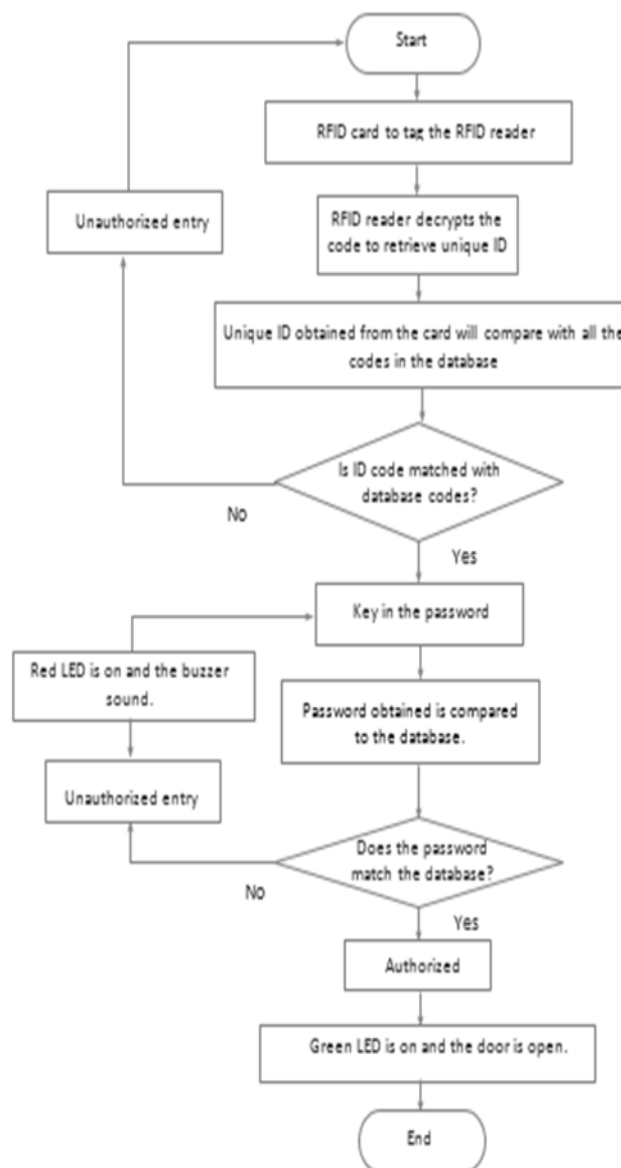


Figure 5: Flow chart of Entrance Security System

IV. RESULTS AND ANALYSIS

The overall system has been assembled and prototyped as shown in Figure 6. The output of the system is linked with the software programming and the sampled window and the output layout is shown in Figure 7 where the coding of RFID MFRC522 is combined with the keypad. Any ultimate adjustments in the operation to obtain the output can be done by manipulating the coding of the software programming coding list. The sample of the output for the combined coding on serial monitor is shown in Figure 8.

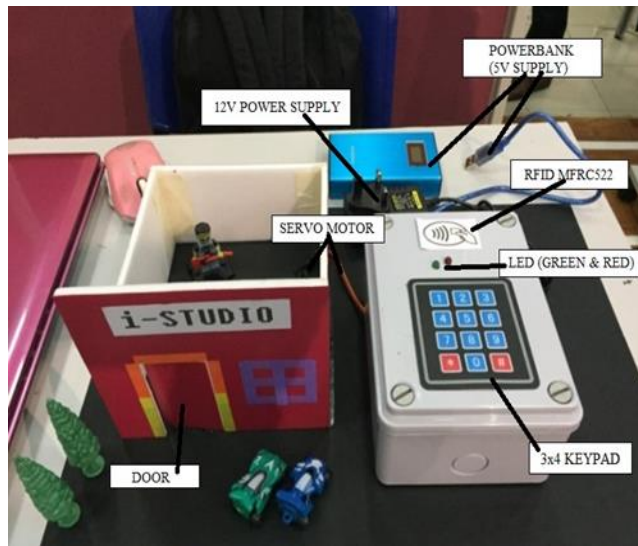


Figure 6: The prototype design of Entrance Security System

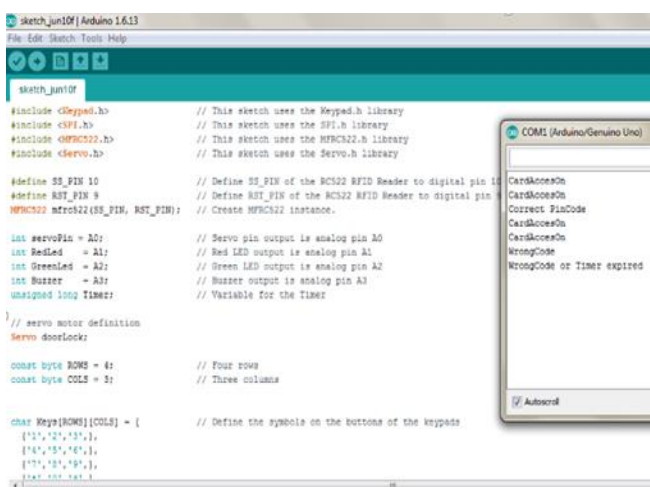


Figure 7: The coding of RFID MFRC522 combined with keypad

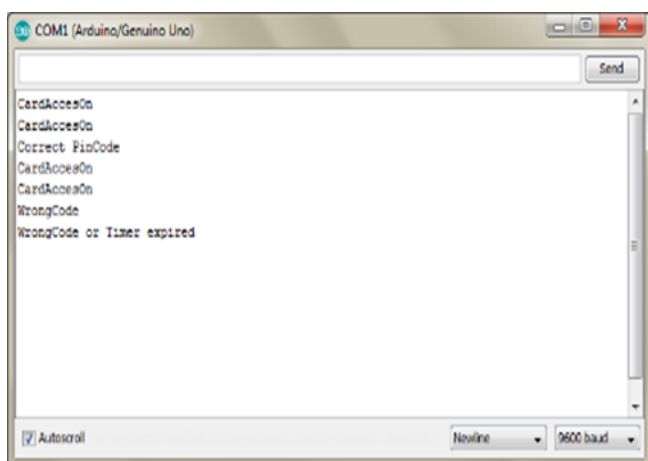


Figure 8: The output of the combined coding on serial monitor

Table 2 also shows the detail data information obtained from the output of the system. The data output relates with three different types of indicators which linked with three different types of users using the system respectively and at different time. Each indicator relates to different user condition for either the door is opened or closed.

Table 2: The outcomes of Entrance Security System

INDICATOR	USER	DOOR ACCESS
Green	Authorized with correct password	Opened
Red	Authorized with incorrect password	Closed
None	Unauthorized	Closed

When the GREEN LED is turned “ON”, it indicates that the user card is authorized where when the user touches the card to the card reader and enters the correct password, the door access is granted. Meanwhile, when the RED LED is turned “ON”, it indicates that the card is authorized and the user has entered an incorrect password after the card is touched to the reader. Since the password is incorrectly entered, the door access is denied. Here, the unauthorized entry means no activation occurred because the data of the unauthorized card is not recorded in the system even though the card is touched to the reader.

The simulation of keypad and RFID MFRC522 are successfully carried out where both of the programming code lists are combined for the system to operate accordingly. After both code lists are combined, they are uploaded into the Arduino Uno through Arduino IDE software. Then, the data output is displayed on the serial monitor after the card is touched to the reader and then, the password is entered at the keypad.

V. CONCLSION

The whole system has been successfully developed and prototyped for an electronic access at the entrance based on user identification. The system is

designed as a simple contribution to the RFID technology which is carried out based on the research objectives. The adoption of RFID technology with Arduino, implemented in the entrance security application is feasible and provides more secure access as an automatic technology which minimizes the risk of tag cloning. It provides access only to authorized person and recognises the identity of the user as soon as the tag is placed within the activation range of the card reader. The system can be used for entrance security for offices, hospitals, laboratories, hostels and many more premises.

VI. ACKNOWLEDGMENT

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