Journal of the Nigerian Association of Mathematical Physics
Volume27, (*July, 2014*), pp 541 – 548

Implementation of an RFID Based Security System

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Abstract

The project aims at providing more protection of lives, properties and information, having only authorized personnel to access locations that are secured, thus making it possible to know exactly when access was granted that resulted in a security breach. This project describes a working prototype of a RFID (Radio Frequency Identification)- based security system which includes an ID-12 RFID scanner and tags for scanning and identification, a motor to control the door for the project and for demonstration purpose, 16x2 LCD to display the security identification details, 4x4 keypad to input the codes for extra measure of security. Arduino Uno development board hosting Atmega328p microcontroller was used for this project and other electronic components to regulate the performance of afore mentioned components. This project took advantage of the current advancements in electronics especially in the area of microcontroller technology. The RFID Based Security System allowed a personnel to check for security by scanning first for valid tags, and if found, a password was requested for which was inputted using the keypad and the stepper motor drives the door open if a valid password is entered.

Keywords: Polling, Frequency Shift Keying (ASK), Manchester code, RFID.

1.0 Introduction

Over the years, more emphasis has been placed on the security of lives and property. A major factor for integrity check for any organization is the type of security measures that it has in place. Security of information and databases is becoming of utmost importance. The expression "Radio-Frequency Identification" refers to two dimensions of the technology: (i) a technical aspect: radio-frequency and (ii) a particular function enabled by the technology: identify objects, animals or people carrying or embedding a tag[1]. A combination of microelectronics and another technology known as Radio Frequency Identification (RFID) in the provision of security would be the main focus of this project. 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 a computer for its full operation [2]. The software running on the computer is used for management, controlling, transaction, operation and maintaining record of the various users.

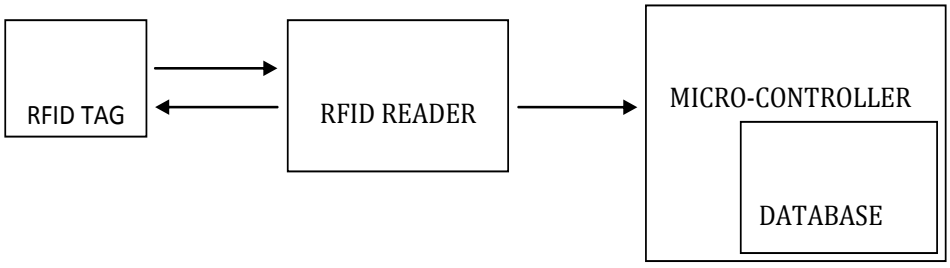

Fig 1: Overview of RFID based System

The functionality of a security system involves a chain of procedures of acquiring a unique set of information supplied by a user, which is expected of every legitimate user of that system to have for authentication. Onboard computer or microcontroller compares the acquired information with sets of data having similar attributes and type but different values in a database, then it only returns a success if a match is found in the data base. This data can be in form of image data, ASCII codes or numeric.

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The objective of every security system is to create an effective access control over users. Every security systemwith access control requires two or more information acquisition and authentication methods to identify users based on information provided by them. These procedures can be grouped in two: Traditional method and Biometrics. Traditional way uses external things such as keys, passwords, RFID cards and smartcards, while Biometrics considered the use of physiological or behavioral feature for automatic identification of the individuals [3]. Such features are fingerprint, pupil recognition, face and voice. In any case each method requires specific hardware device.These devices function majorly as input deviceandan output device is necessary to provide audio or visual feedback to users of the system.Some devices used in security systems depending on the authentication method, includes keypads, microphone for voice recognition and authentication security system, swipe pattern recognition, RFID reader, smart card reader and camera for face recognition.

In practice some identification and authentication method may not be suitable enough to be implemented due to the cost ratio of technology used to what is actually being secured. In this case, to achieve a higher level of security a less costly combination of two or more traditional way of identification maybe considered. For example, the use of RFID card and Passwords entered from a keypad provides two levels of security. The two levels of security must be successful before access can be granted.

1.1 Related Work

A digital security code lock using 8051 microcontroller was implemented in [4]. The project consisted of an 8051 microcontroller, a 4x4 keypad and a 16x2LCD display and it was used to provide access to a restricted area, by controlling a door. The project required users to enter a unique code from the matrix keypad to gain access to the restricted area. This project uses a single security level which can be vulnerable if a user's password is carelessly left in an open environment or disclosed. This limitation could be solved if another level of security was added which would create extra measures. RFID technology can be a better choice in this case.

1.2 What Is RFID

Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects [5].RFID would be better described as a technology that enables data collection with contactless electronic tags and wireless transmitters (readers) for identification and other purposes [1].

An RFID system is always made up of two components:

Firstly, the transponder, which is located on the object to be identified, the detector or reader, which, depending upon design and the technology used, may be a read or write/read device.Secondly, a reader typically contains a high frequency module (transmitter and receiver), a control unit and a coupling element to the transponder. In addition, many readers are fitted with an additional interface (RS 232, RS 485 or USB) to enable it to forward the data received to another system [6].

The transponder, which represents the actual data carrying device of an RFID system, normally consists of a coupling element and an electronic microchip. When the transponder, which does not usually possess its own voltage supply (battery), is not within the response range of a reader it is totally passive. The transponder is only activated when it is within the response range of a reader. The power required to activate the transponder is supplied to the transponder through the coupling unit (contactless) as is the timing pulse and data.

1.3 The Keypad

The keypad over the years has been the most popular input device to a computer. Keypad consist array of switches arranged in a logical manner which are electrically wired to serve a purpose of input interface device. Two major methods exist by which data can be read from a keypad: Polling method and Interrupt service. In polling method, software continuously checks for key presses to read key values which at a time consumes processor power and increases latency. A better technique is to design a keypad which produces an interrupt signal whenever a key is pressed, software only uses interrupt signal to read key values[7].

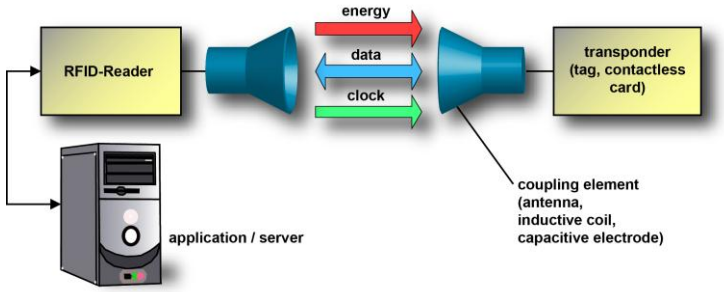

Fig 2: components of RFID system [8].

2.0 Approach and Methodology

In this project we look at the implementation of an RFID based security system with keypad which created an access control that allowed only authorized persons to access a restricted division. This work presents the combination of two-level security system. We combined RFID identification and password entered from a 4x3 keypad to gain access to a restricted environment. This requires that users must possess a registered RFID tags and respective uniquely registered password.

The entire project unit consisted of a 28 pin ATmega328 microcontroller, 4x3 matrix keypad, and 16x2 Liquid Crystal Display (LCD), ID-12 RFID Reader, RFID Tags, SN754410 H-Bridge, and Bipolar Stepper Motor.

When a tag is moved across the reader, the reader senses and read a unique code from the card which is present in the reader's electromagnetic field. If this card is an accepted card in the database, the user is prompted through the LCD to input a user password. If the password is correct, the h-bridge drives the stepper motor and it delays for a few seconds to simulate the time passing to permit the user to pass through the door. After the delay, the motor rotates back to indicate the door is closing. Fig. 3 shows the flow chart of the code controlling the system.

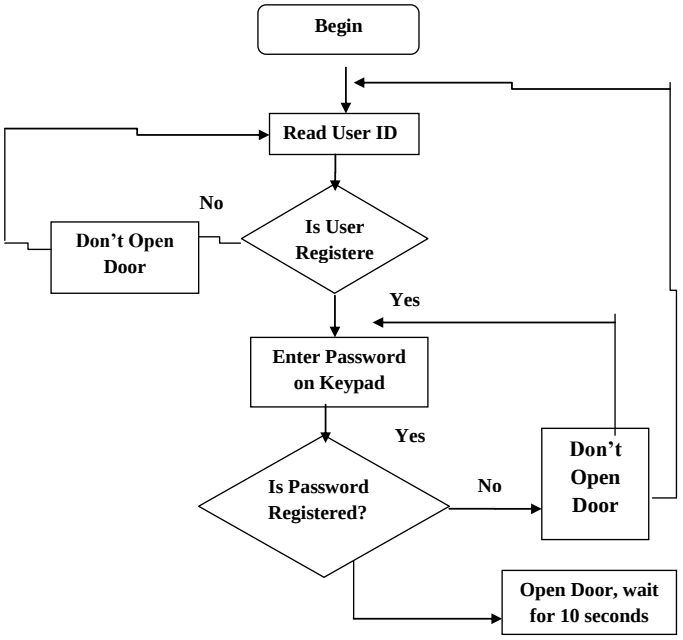

Fig 3: Flow chart of RFID based security system

3 .0 Design of the RFID Based Security System

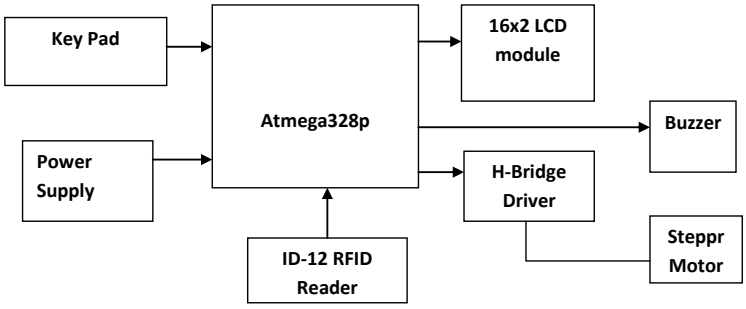

Fig 4: Block Diagram of RFID based security system

3.1 Keypad Unit

The keypad is a 4x3 matrix of pushbuttons with each column connected to a pull-down resistor. If a button is pressed, the pin corresponding to the intersection of that row and column goes high and this value is identified by a particular number. This keypad uses the polling method to access and decode correct key presses. When no key is pressed, the pull-down resistors

ensure this value is grounded. The polling method used required us to implement a function in the software to continuously check for key presses. The connection to the microcontroller is shown in Fig. 5.

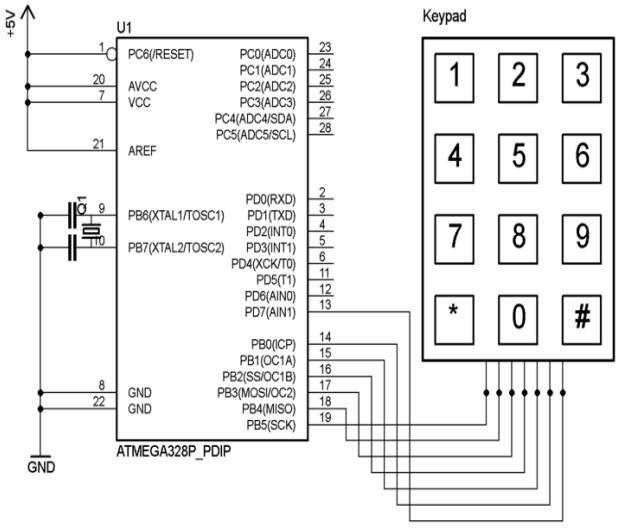

Fig 5: Schematic Diagram of the Keypad Unit

3.2 The Liquid Crystal Display

A 2x16 LCD was used in this project both to show keys that were being typed by the user and to show verification details whether security pass was granted or not. The LCD module hosts HD44780 LCD controller driver. It supports 2 rows by 16 columns of character making it capable of displaying 32 ASCII characters at once on the screen. Fig.6shows the circuitry of the keypad and the LCD.

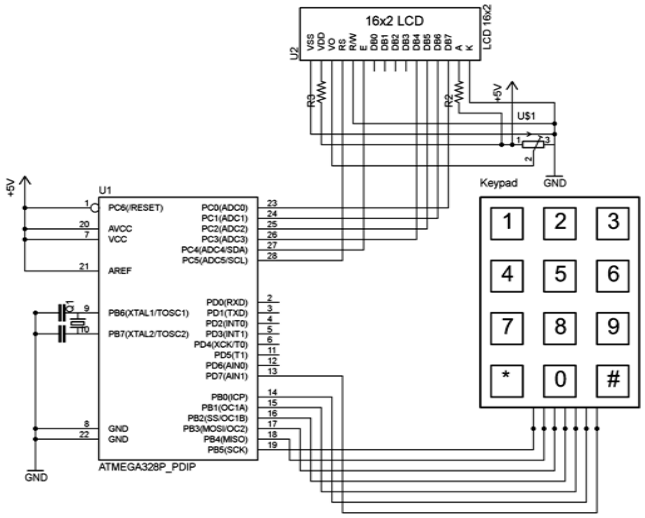

Fig 6: Schematic of the complete keypad and LCD unit

3.3 The RFID Module (ID-12)

The RFID reader module used for this project was ID-12, from ID innovation. The ID-12 module uses a 5V supply at 125 kHz read frequency, with a 100mm read range and outputs at 9600bps TTL and RS232 output. It is compatible with 64-bit RFID tags. It works based on the principle of electromagnetism. In order for a tag to be read correctly, it needs to match the polarization of the reader. The ID-12 is a mono-static RFID reader using just one port for reception and transmission. When the RFID interrogates a transponder a unique code is read from the transponder, and read codes are transferred using RS232 serial protocol connection inside the module ID-12. The RS232Communication interface made it easier for read codes to be transferred to a computer. In the implementation of this project, read codes are decoded by the microcontroller configured in software to communicate with the RFID module using the inbuilt UART module.

3.3.1 The RFID Reader Basic

The RFID reader module with the on board transceiver (ID-12) is used to read identification cards (RFID cards) using radio waves.TheRFIDreader continuously transmits a 125 KHz carrier signal using its antenna. The passive RFID tag, embedded in an id card for example, powers on from the carrier signal. Once powered on, the tag transmits, back to the reader, an FSK encoded signal containing the data stored on the card. The FSK signal is 125 kHz carrier, with 12.5 kHz as the mark frequency, and a 15.625 kHz as the space frequency. The encoded signal is picked up by the reader's antenna, filtered, and processed on the embedded microcontroller to extract the tag's unique identity. At this point the identity can be matched against the records stored on the reader.

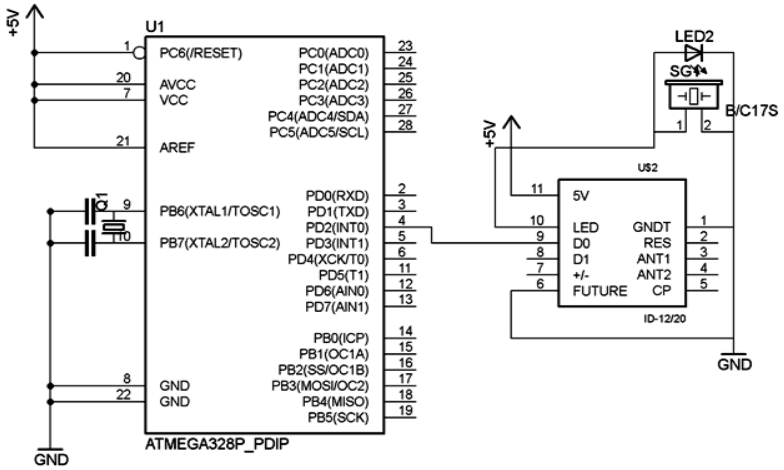

Fig. 7: Schematic of the RFID unit

3.4 Door lock System

The door was modeled using the stepper motor. The stepper motor was chosen because it can rotate to precise number of steps and it can effectively simulate the opening and closing of doors.

The H-bridge was used as a driver for this stepper motor. The h-bridge receives logic signals from the microcontroller and depending on the signal received; the h-bridge will drive the stepper motor clockwise or counter-clockwise using the specified stepping. The SN754410 can take up to 30V at 1A and the SM-42BYG011-25 stepper motor requires a 12V at 330mA. This fact makes this h-bridge well suited for this project. The circuit diagram for the connection is shownFig. 8.

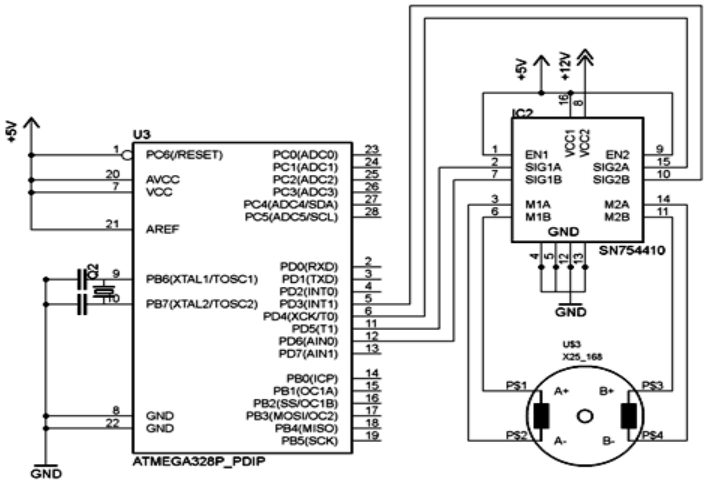

Fig. 8: Doors lock system.

4.0 Discussion and Recommendation

In the implementation of this project, all modules used were tested to ensure their correct functionality and different sections of code were written and tested

4.1 Keypad Testing

To ensure the proper operation of the keypad, the components for the keypad unit was assembled on the Breadboard and the resulting circuitry was tested to check if the appropriate characters on the keypad that were pressed were displayed on the Liquid Crystal Display (LCD) screen.

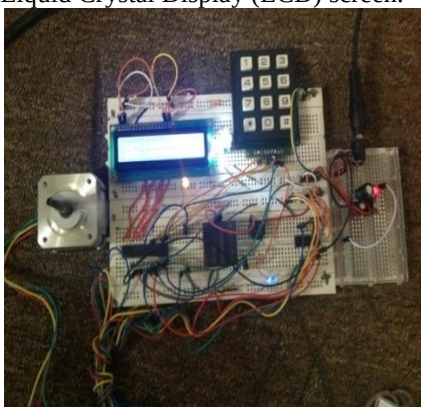

Fig. 9: Keypad Testing

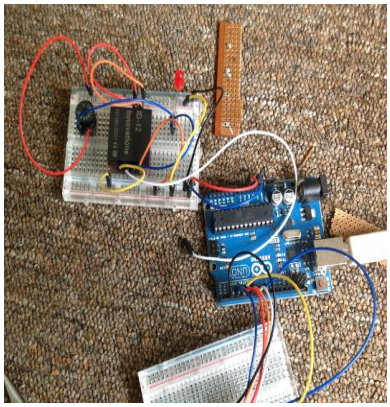

Fig 10: The RFID unit during testing using the Arduino Uno board

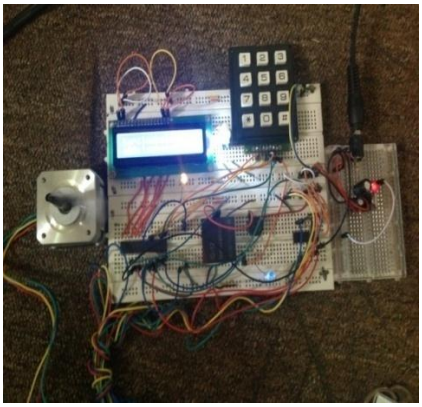

Fig 11: Fully functional Integrated Security System prototype on breadboard

4.2 RFID Module Testing

We checked the codes and ensured that they worked well with the ID-12 RFID module and also, noise interference was tested for. Since there was no simulator that we could use for testing the ID-12 module, we had to assemble it on the Breadboard and we carried out the tests that were required.

4.3 Stepper Motor Testing

In this test, the stepper motor was tested with respect to its functionality in response to the microcontroller signals. This test was done using Proteus for software simulation as well as carrying out the physical test on the breadboard. Due to the fact that Proteus did not have the SN754410 h-bridge in its library, we used a similar h-bridge (L293D) that had the same functionality and pin numbering.

4.4 Results

After all the necessary testing and adjustments have been made, the project worked according to the laid out objective.
As soon as the RFID card/tag was passed over the reader, the buzzer gave a tone that indicated that a card was read. If this card was valid, the user was prompted for a password on the LCD. If the password was correct, the stepper motor rotated.

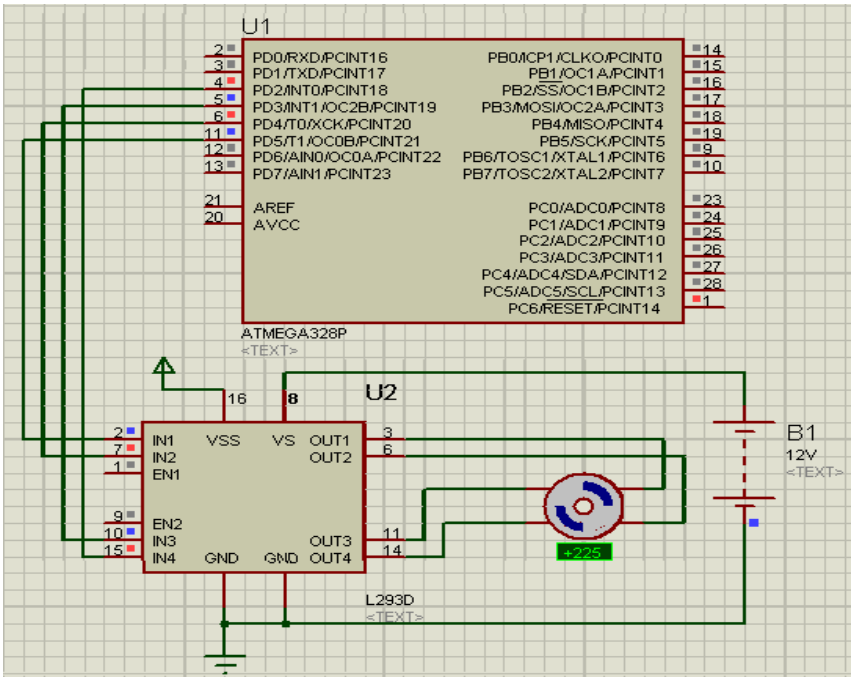

Fig.12: Simulation of the stepper motor in Proteus.

5.0 Conclusion

The Integrated Security System was designed to provide a means of security check using Radio Frequency Identification (RFID) as the primary parameter. The project was designed such that it can provide a high level of security while reducing the number of components that are used. The system utilized the unique ability of the RFID in keeping track of the amount of individuals who had access to the location and thus checked for authorization thereby increasing the security level.

The entire system from the conception, designing, coding and construction was done following a carefully laid out plan. The individual components were tested and the entire system was tested on a breadboard. Through much debugging of both code and circuit, the system functioned as was intended.

6.0 References

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