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DEVELOPMENT OF SECURITY ACCESS CONTROL SYSTEM BASED ON RFID

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ABSTRACT

Security is the major concern in today's world due to which the present industries are continuously shifting towards automation. RFID is supposed to be one of the fast and reliable member in the family of Automatic Identification and Data Capture (AIDC) technologies. This research work can be used for security purposes because it gives information about the authorized persons and unauthorized persons. Basically, this work is aimed at developing a wireless system to detect and allow only the authorized persons. Recognizing the need of security, an automated security access control system with user friendly access based on RFID has been developed here and only authorized personnel are permitted to enter to a secure area. In order to accomplish this task, the serial interface of a 125 KHz RFID Reader module is used. When the RFID reader reads any RFID tag, the card authentication is done. If the card is authorized, then the user will be asked to enter the password and if the password is found correct, the access is granted. On the other hand, if the card is unauthorized, then the access is denied and the system turns on the alarm. Hence, suspicious persons can be detected, caught, and punished.

Keywords: Security, RFID Tag, RFID Reader, Atmeg16 Microcontroller, Motor Driver IC, H-bridge.

I. INTRODUCTION

In the field of electronics, automation is one of the most frequently & commonly used term and the need for automation brought many revolutions in the existing technologies. One among these technologies which had greater developments is RF communications and Radio frequency identification (RFID) is one of the smart member in the family of Automatic Identification and Data Capture (AIDC) technologies. From the security point of view, automatic identification and access control system is needed at various places to overcome the security threats. In this research work, such a system is developed that can be installed at the entrance which will allow only the authorized persons to enter into the secured area and unauthorized or, suspicious persons can be caught. In this way, the level of security is improved.

In 1948, RFID was invented and since then the continuous and rapid growth in RFID products and applications have been reported. In the 20th century, the industry as well as academic sector both found increasing interest in RFID due to the huge development in RFID technology and the continuous decrease in the rate of RFID tags [1]. RFID applications focus on logistic, toll system, ticket, health care and security &identification systems [2]. In fact, it is a wireless technology which helps in developing the security access control system. Actually, it identifies/reads a device that is RFID tag / sticker / label wirelessly by an RFID reader using radio frequency. The main objectives of this research work are:

- RFID based authentication system.
- Automatic opening of the door when RFID tag and password match.

II. AN OVERVIEW OF RFID TECHNOLOGY

The technology in which data is saved and recovered from an identification chip through radio waves is referred to as an RFID (Radio Frequency IDentification) technology [3]. A basic RFID system consists of three main components namely transponder or RFID tag, interrogator or RFID reader/writer with an antenna and the computer or processor containing the database as shown in figure (1).

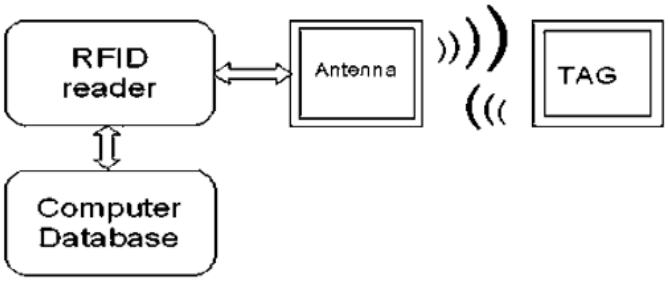

Fig. (1) A Basic RFID System

An RFID tag actually includes a microchip with an antenna and each RFID tag holds a unique code & other information which can be sent over radio frequency and thus the target object can be easily identified. In this system, the interrogator reads the data from the RFID tag and sends this information to the computer for authentication. This particular information is processed by the computer or processor and after verification, access is granted and it starts interacting with the user through radio frequency signals. The RFID system can be operated on various bands of frequencies lying between low and microwave frequencies. These bands are listed below [4]:

- Low Frequency: 125-134 KHz
- High Frequency: 13.56 MHz
- Ultra High Frequency: 902-928 MHz
- Microwave Frequency: 2.4 GHz

The hardware components used in a basic RFID system are usually common to all RFID applications but various softwares are used depending on various RFID applications. However, RFID systems are becoming an important part of everyday life but still the security threat becomes serious and puts a severe limitation to the promotion and deployment of RFID applications as the RFID tags are easy to clone and fragile [5-7].

III. DESCRIPTION OF SYSTEM COMPONENTS

In order to develop the proposed security access control system, various important components are used which can be explained as follow:

3.1 RFID READER

In order to track individual objects, information is gathered from an RFID tag. This can be done by a device known as an RFID reader wherein the radio waves help in transferring the data from the tag to a reader. Here, an EM-18 RFID card reader has been used which has the operating frequency of the order of 125 KHz and around 4 inches/ 10 cm reading distance. This card reader module comes with both Serial & Weigand interfaces. As far as the RS232 format is concerned, it is actually the Serial interface and it delivers the tag information serially that is suitable both for indoor as well as outdoor operations [8]. In this research work, the serial interface of EM-18 RFID reader has been used in order to interface it with the USART of AVR ATmega16 microcontroller in asynchronous mode. In serial interface, the EM-18 RFID reader delivers a 12 byte data when it comes closer to any RFID tag. When the RFID reader encounters any RFID tag, it provides the 12 byte data. The ATmega16 microcontroller reads this particular 12 byte data transmitted from RFID reader and these card readers are generally installed at the entrance gates of a secured area [9].

There are four ways by which the RFID readers can be applied and the possible combinations of RFID readers & tagged devices are listed below and it is also depicted in figure (2).

- A stationary RFID reader scans stationary objects
- A stationary RFID reader scans moving/ mobile tags
- A moving/ mobile RFID reader scans stationary objects
- A moving/ mobile RFID reader scans moving/ mobile tags [10].

As far as an EM-18 RFID reader is concerned, it is used just like as any other sensor module. It has nine pins and among nine pins, 2 pins i.e. NC pins are not connected pins as shown in figure (3), so it is actually a device with seven operating pins.

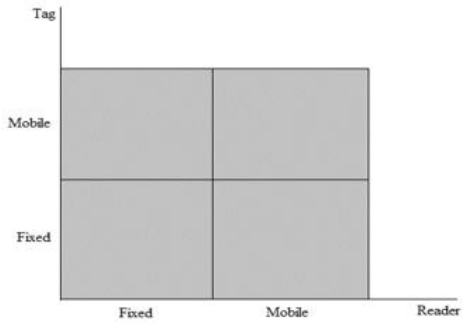

Fig. (2) Possible combinations of RFID readers and tagged devices

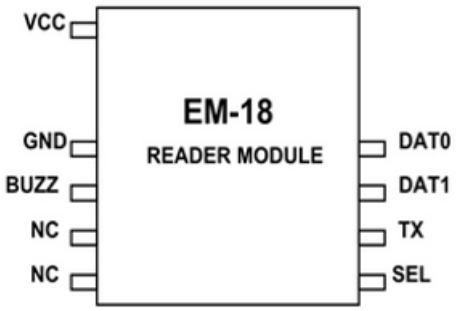

Fig. (3) Pin configuration of EM-18 RFID reader

Here, the VCC pin of EM-18 is connected to positive terminal of the power source, GND pin is connected to the common ground of the circuit and BUZZ pin is connected to the buzzer or, beeper. Here, SEL pin of EM-18 is kept high which indicates that form of communication selected for output is serial or, RS232 and TX pin of EM-18 is connected to the RX pin. It means that the data from the card reader is connected to the pin no. 14 of ATmega16 microcontroller. On the other hand, if SEL pin is kept low then the selected interface is weigand and the remaining two pins i.e., DAT1 & DAT0 are used as weigand interface data high pin & data low pin.

3.2 RFID TAG

The tag that exchanges data with an RFID reader by means of radio waves is called an Electronic tag/ RFID tag and it is also known as an RFID chip/ RFID card. An RFID tag generally comprises of a chip, memory and an antenna as shown in figure (4) and these tags may be either active or passive depending upon the source of electrical energy. The active tags contain their own power source/a battery for powering the circuit on the tag. Such type of tags are very expensive and rarely used. Whereas the passive tags obtain power/energy from the signal of the RFID reader to power their circuit. Such type of tags are very cost-effective/cheap as compared to active tags and hence they are generally used in most of the applications [11-12]. As far as frequency is concerned, active tags commonly operate at higher frequencies i.e., 455 MHz, 2.45 GHz, or 5.8 GHz depending on the required read range and memory of a particular application and RFID readers can communicate with active RFID tags up to 500 meters away. On the other hand, the operating frequencies of the passive tags are typically 128 kHz, 13.6 MHz, 915 MHz or, 2.45 GHz and they have read ranges from few centimeters to 10 meters [13-14]. Table 1 gives the comparison of active and passive tags including some important features [15].

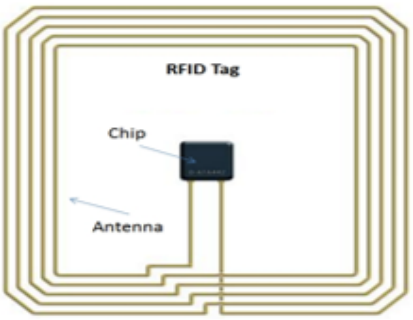

Fig. (4) Construction of an RFID tag

Table 1: Comparison of RFID tags

Characteristics	Active Tags	Passive Tags
Power Source	Battery	From reader
Read Range	< 100 m	< 10 m
Frequency	433 MHz, 2.4 GHz	125 kHz, 13, 56 MHz, 860–960 MHz
Size	Large	Small
Weight	Heavy	Light

In this research work, passive RFID tags have been used and these are simply 125 KHz RFID cards/RFID chips. When this particular RFID tag/card/chip comes closer to the electromagnetic field produced by an RFID reader, information is transmitted to the reader by this tag and this whole phenomenon actually depends on Faraday's law of electromagnetic induction [16].

3.3 ATMEGA16 MICROCONTROLLER

A Microcontroller is a single chip micro-computer consisting of CPU, RAM, some form of ROM, I/O (input/output) ports and timers. Microcontrollers are sometimes called embedded microcontrollers and they are designed for a specific task to control a particular system. In this research work, USART (Universal Synchronous Asynchronous Receiver Transmitter) part of Atmega16 microcontroller is used for serial communication. It is an 8-bit high performance microcontroller of Atmel's Mega AVR family having low power consumption and can work on a maximum frequency of 16 MHz. This particular microcontroller uses enhanced RISC (Reduced Instruction Set Computing) architecture. It is a 40 pin microcontroller as shown in figure (5) and it consists of 131 powerful instructions, 16 KB Programmable flash memory, 1 KB static RAM and 512 Bytes EEPROM. The flash memory

and EEPROM has an endurance cycle of 10,000 and 100,000 respectively. It has 32 I/O lines and these I/O lines are divided into four 8-bit ports namely PORTA, PORTB, PORTC and PORTD respectively. There are various in-built peripherals available in Atmega16 microcontroller such as USART, ADC, Analog Comparator, SPI, JTAG etc. and each I/O pin has also an alternative task that is associated to in-built peripherals.

3.4 POWER SUPPLY

The power supply section consists of a step down transformer, rectifier, filters and regulator to obtain regulated power supply. Here, the function of the step down transformer is to step down the voltage from 220 volts ac to 6 volts ac which is connected to the full wave rectifier circuit followed by a capacitor to filter out the ripples. Hence, the 9 volts dc is obtained. Now, this 9 volts dc is regulated by the IC 7805 regulator that provides a regulated 5 volts dc power supply which is then connected to the supply pins of RFID reader and ATmega16 microcontroller.

3.5 4*4 KEYPAD

Here, the 4*4 matrix keypad is used to enter the password when the authorized card is swiped and it requires eight input/output ports for interfacing. The rows are connected to the peripheral input/output (PIO) pins configured as output and the columns are connected to the PIO pins configured as input with interrupts of the microcontroller and four pull-up resistors are also used to apply a high level on the corresponding input pins.

3.6 LCD

Here, 16x2 alphanumeric LCD has been used as the screen of the system and for each line, it can display 16 characters. This particular LCD involves 2 such lines and each character is displayed in 5x7 pixel matrix. As the circuit is switched on, the system starts working and accordingly various messages are displayed on the LCD display.

3.7 MOTOR DRIVER

In order to drive/excite the dc motors properly, motor driver is required since the control signals generated by microcontroller in the form of High (+5 volts) or, Low (0 volt) are not sufficient to drive the motors. A motor driver always has an external battery input/voltage source that depends upon the rating of the motor and it actually directs this voltage to the motors connected to its output pins. Thus the motors behave according to the control signals generated by the microcontroller with the excitation from the external battery voltage. Here, an IC L293D has been used as the motor driver. An L293D is a typical motor controller/driver IC which can drive dc motor in both the directions and it can control a set of two dc motors simultaneously in any direction. It means that the two dc motors can be controlled with a single L293D IC and this particular IC is capable of driving small as well as quite big motors. As far as an L293D motor driver IC is concerned, it works on the H-bridge concept. Here, it is required that the voltage must change its direction so that the motor can be rotated in clockwise or, anticlockwise direction and H-bridge does this work as it allows the voltage to be flown in either direction. Thus, H-bridge IC is ideal for driving a dc motor. An L293D IC chip consists of two H-bridge circuits which is capable of driving two dc motors independently and it is widely used in robotic applications for controlling dc motors. It is a 16 pin IC that comes in a DIP package and its pin configuration is shown in figure (6). It has two enable pins namely Enable1 i.e., pin no.1 & Enable2 i.e., pin no.9 and these two pins need to be high to enable the motor driving. This particular IC actually acts

like a switch. In order to drive the motor with left H-bridge, pin no.1 is kept high and for right H-Bridge, pin no.9 is kept high. If anyone of these pins goes low, then the motor in the corresponding section stops working.

Fig. (5) Pin configuration of an Atmega16 Microcontroller

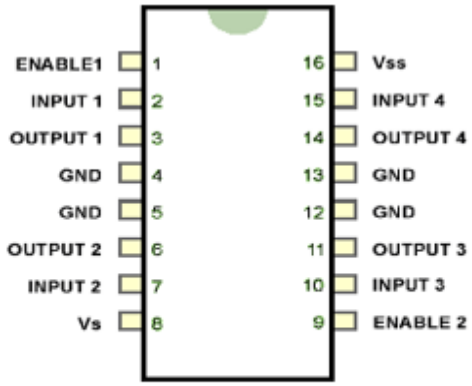

Fig. (6) Pin configuration of an L293D motor driver/controller IC

3.8 DC MOTORS

Most of the dc motors are generally very easy to reverse i.e., by simply changing the polarity of the dc input, the direction of the drive shaft can be easily reversed. This property makes them very popular to be used in various applications such as robotics etc. In this research work, microcontroller has been used in the developed circuit/system due to which there is no need to use a relay. The control signals generated by the microcontroller are fed to a motor driver IC which in turn drives the motor. When an RFID tag/card comes in the vicinity of an RFID reader, firstly the card is swiped and then the authentication of the card is done. If the card is found to be authentic, password is entered and the motor moves according to the entered password. When the password is correct, the motor moves in the clockwise direction that results in the opening of the door, otherwise the door will be closed.

IV. SYSTEM MODEL& OPERATION

In this research work, RFID based security access control system has been developed. The block diagram and the circuit diagram of the proposed system are shown in figure (7) and figure (8) respectively.

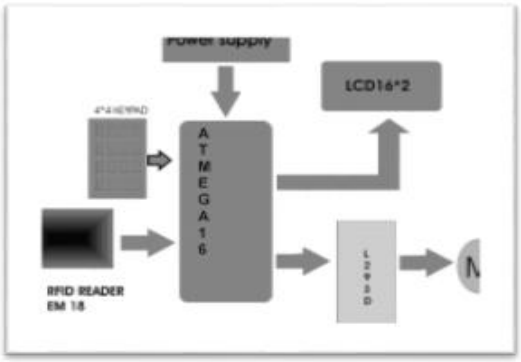

Fig. (7) Block Diagram of an RFID based security access control system

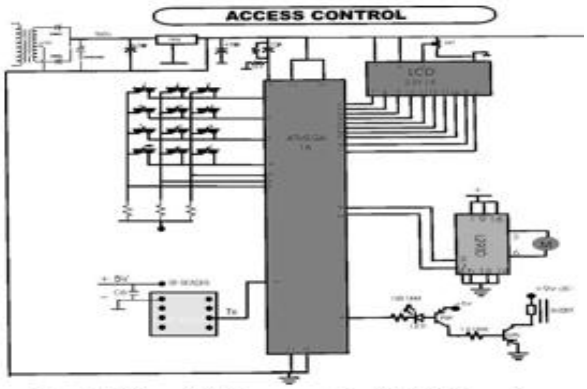

Fig. (8) Circuit Diagram of an RFID based security access control system

The developed circuit/system consists of various important sections namely RFID reader, Atmega16 microcontroller, Keypad, LCD, Power supply section, L293D motor driver/controller IC, DC motor, buzzer and RFID tag is ofcourse one of the part of the system. In this work, an EM-18 RFID reader has been used which is a 125 KHz RFID reader module and it comes with both Serial and Weigand interfaces. Here, an EM-18 RFID reader has been interfaced with AVR ATmega16 microcontroller. The AVR is an 8-bit RISC single chip microcontroller developed by Atmel. AVR stands for Alf-Egil Bogen Vegard Wollan RISC microcontroller which is also known as Advanced Virtual RISC and the architecture of AVR was developed by Alf-Egil Bogen and Vegard Wollan. The serial interface of EM-18 RFID reader has been used to interface the reader with the USART (Universal Synchronous Asynchronous Receiver Transmitter) of the microcontroller in asynchronous mode and an EM-18 RFID reader provides a 12-byte data in the serial interface when it reads any RFID tag. Here, these tags simply mean 125 KHz RFID cards/RFID chips and these are actually the passive tags. The keypad is used to enter/type the password. The LCD is the screen of the system and various messages & password are displayed on it. As far as the power supply section is concerned, it provides 9 volts dc and regulated 5 volts dc power supply which is then fed to the supply pins of RFID reader, ATmega16 microcontroller, L293D motor driver/controller IC, dc motor, keypad, buzzer and LCD respectively. Apart from this, an L293D IC has been used as the motor driver/controller that is able to control two dc motors simultaneously in clockwise as well as in anticlockwise direction. Thus, the opening and closing of the door can be automatically controlled by controlling the dc motor as per the control signals being generated by the microcontroller. Here, a buzzer or beeper works as an alarming device of the system that produces an alarming/buzzer sound when the right card is not swiped or, the password is incorrect. The flow chart describing the operation of an RFID based security access control system is shown in figure (9).

In the proposed RFID based security & access control system, whenever any RFID tag comes in the range/contact of an RFID reader, the RFID reader reads the unique ID/code stored in the tag and the 12 byte data is transmitted from the RFID reader to the ATmega16 microcontroller. The microcontroller reads the data and checks the authenticity of the card. If the card is authorized then the user is asked to enter the password. When the password is correct, the door will get opened. On the other hand, if the card is unauthorized then the door will remain closed. In this situation, the circuit will produce an alarm and hence the access is denied.

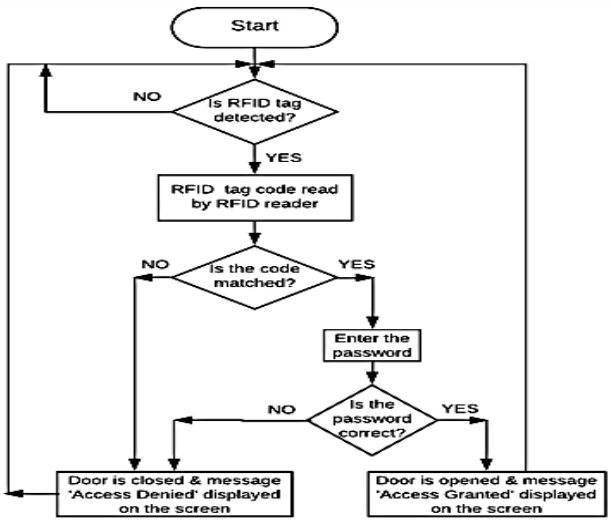

Fig. (9) Flow chart for RFID based security access control system

V. SOFTWARE SPECIFICATIONS

The technical specifications of the proposed system actually consists of two main parts namely Hardware specifications and Software specifications. When these specifications are met, the desired results are achieved. The softwares used in this particular system are listed below:

- **AVR Studio 4 Software:** The AVR Studio is an Integrated Development Environment (IDE) given by ATMEL for developing various applications based on 8 bit AVR microcontroller.
- **WinAVR 2010 Software:** The compiler WinAVR is installed prior to the installation of AVR Studio as this allows the AVR Studio to detect the compiler.
- **AVRDUDE Hex Downloader Software:** The AVRDUDE is a utility program to download/upload/manipulate the ROM and EEPROM contents of AVR microcontrollers using the in-system programming technique (ISP). Here, it has been used to upload the program/code written in AVR studio to the circuit board of the developed system through AVR programmer.
- **USBasp Driver:** The USBasp is a USB in-circuit programmer for Atmel AVR microcontrollers. There is no need to use any special USB controller while the programmer uses a USB driver.

VI. RESULT & DISCUSSION

The circuit has been developed & tested successfully and it has been found that the proposed circuit/system is working satisfactorily. The desired results are obtained as discussed below:

- When the circuit/system is powered ON or, any RFID card/tag/chip comes in the vicinity of an RFID reader, a message ‘Swipe the Card’ is initially displayed by the microcontroller on the screen of the LCD.
- When this particular RFID tag is swiped against the RFID reader, firstly it detects the ID card and then, it sends this unique card number via serial terminal to the microcontroller. After that, the received card number is compared with the numbers already stored in the microcontroller or, any database such as external memory unit with the help of appropriate programming.
- When the received card number is matched with the already stored number, the card is authorized and the microcontroller displays another message ‘Enter the Password’.
- When the password entered is correct, the microcontroller generates the high control signal that activates the motor driver/controller IC which results in the dc motor to be rotated in clockwise direction. The message ‘Access Granted’ is displayed on the screen and hence the door is opened for a predefined time duration. After this time duration, the dc motor rotates in anticlockwise direction and the door is automatically closed.
- On the other hand when the password is incorrect, the microcontroller generates the low control signal due to which the door remains closed. The message ‘Access Denied’ is displayed on the screen and at the same time buzzer also sounds. Thus the suspicious persons are caught and punished.

- When the RFID tag is swiped against the RFID reader and the received card number does not match with the already stored number in the microcontroller, the card is unauthorized. The microcontroller generates the low control signal due to which the motor driver/controller IC remains deactivated. The message 'Access Denied' is displayed on the screen and the door remains closed. At the same time, alarm gets activated and buzzer sound is produced. Thus the unauthorized persons are caught and punished.

VII. CONCLUSION

In this research work, the development of an RFID based security access control system for use in domestic and industrial applications is presented and this particular system is generally installed at the entrance gates of a secured area. Here, microcontroller Atmega16 has been used to generate the control signals and the permission to enter to a secure area is given to only authorized personnel.

In this paper, whenever an EM-18 RFID card reader having operating frequency of 125 kHz reads any passive RFID tag of frequency 125 kHz, the Atmega16 microcontroller reads the 12 byte data transmitted from RFID reader serially by using RS232 serial interface. If the received 12 byte card number is matched with the already stored card numbers in the microcontroller, it shows that the card is valid. Then, the microcontroller asks to enter the password. If the password is correct, the microcontroller activates the L293D motor driver/controller IC that results in the opening of the door and the message 'Access Granted' is displayed on the screen which allows a valid user to enter into the secured area.

On the other hand, when the card is invalid or the password is incorrect, then the microcontroller disables the L293D motor driver IC and the door remains closed. The message 'Access Denied' is also appeared on the screen which shows that an invalid user can't enter into the secured area and at the same time, buzzer also beeps. Thus the unauthorized/invalid users are caught and punished.

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