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Design and Implementation of a Microcontroller Based Three Tier Security Lock System

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***Abstract*— Security has being a major concern for humans since time immemorial. Several approaches towards protecting our homes and offices have being used over time. But there has being consistent failure in the security apparatus employed. This research employs the use of a three tier approach that uses a combination of secret multiuser card, voice recognition and code which will be controlled by an arduino microcontroller. It also uses a master code in case of emergency should the other approaches fail. The system performance was evaluated and the results gotten showed that it has more reliable as compare to other existing system.**

***Index Terms*— Code, Lock, Microcontroller, RFID, Security, Voice.**

I. INTRODUCTION

Security is the degree of resistance to, or protection from any form of threats. It applies to any vulnerable asset, item such as a person, community, nation or organization. Thus, theresearch,Design and Implementation of aMicrocontroller Based Three Tier Security Lock System.When fully constructed, a security system with 'master code' as an alternative password will be developed to perform a specific task and behave as expected for the security purpose of providing protection of lives and properties. This is a security system which is designed to function continuously (24/7) as long as there is power supply. With this system, one can guarantee the safety of his assets at home or office from criminal threat and vandalism and live comfortably without worrying about external threats. This security system is automated and that makes it far more reliable than the outdated basic security practice; such as door locked, closed windows and alarm activation is no longer effective against external threats in present days.

Due to security challenges in our communities and offices today worldwide, it has stricken fear in our lives; and also personal security practices, such as ensuring doors are locked, alarm are activated and all windows are closed are vulnerable. With regard to insecurity and recognizing the effect of recent date security challenges, there is high need for developing a security system that is reliable on security purposes and behave as expected. To develop a security system that is affordable by considering class of living, easy to install and maintain and also uses a low supply voltage. Majorly, this research hopes to design and construct a Top Secret Security System with Master Code using Arduino board, 4×4 Alphanumeric Keypad, RFID Card and Speech Recognition module. In achieving this, milestones to be achieved include interfacing RFID Card Reader to Arduino, to authenticate and validate authorize personnel, interfacing 4×4 Alphanumeric Keypad to Arduino, and to interface Voice Recognition Module to Arduino to identify and verify a personnel.

Basically, the research will implement three levels which will be as follows:

Level 1: RFID Card: This is the multi-user card stage where the user will have to swap his card on the RFID Card reader, the system check if the card number exist then access will be granted to next level. It also enables the system to fetch specific personnel information.

Level 2: 4×4 Alphanumeric Keypad: This is where the user will enter a 4 digit password known by user.

Level 3: Speech Recognition: This is the final stage and the most sensible part of the system. In this level the system confirm authorized personnel by reading his voice and compare it with the stored one in the memory. A small variation in a personnel voice access will be denied.

Alternatively,a master code will be used by the master card holder, for emergency used only, that is, when all the other approaches fail.

II. RELATED WORKS

Security is a priority for most individuals. Alarm systems, gated properties and communities, and surveillance systems have become popular amenities for most dwellings. Individuals often feel safer if access to entrances of a dwelling, property, neighborhood, or complex is restricted,[2].

Advances in security equipment technology have been numerous. Some of the noteworthy examples include personnel-identification and access control system that directly "read" unique personnel characteristics such as voice quality, hand geometry and password, sensor devices that report unauthorized entry or removal of items, Surveillance devices that can scan premises at night, devices that permit surveillance at considerable distance,[3].

It is common knowledge that using passwords only to secure our entries does not guarantee the needed security as it is poise to several disadvantages which include forgetting them, forcing the genuine user to let access, easily hacked, e.tc.

Ref [4] stated that Radio Frequency Identification, (RFID)

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has also been used to implement security in so many areas, including offices, homes and several other places.

According to [5], the advantage of using passive RFID in door security system, is to implement a security system containing door locking system which can activate, authenticate, and validate the personnel and unlock the door in real time for secure access.

Biometrics has also helped in solving a lot of security problems. [3] reported that the advantage of biometrics system is that, it can be more reliable than the othersecurity based systems such as pin (personal identification number)-based system, RFID based security system or surveillance security etc. Because, biometric security system identify and validate a personnel by his unique characteristics such as voice, face, hand geometric and eye, and cannot be stolen like the others.

Home security is top when it comes to issues of security because human existence at home is far more than any other human dwelling. Today, breaking and entering into residential and business premise is all too common. It is necessary to argument the conventional types of locks, which skilled burglars can easily circumvent.

With the rapid advancement in technology, smart homes have become applicable and so the need arise to solve the security challenges that are accompanied with its operation, [6].

Voice recognition is another way of providing security to our home and offices. This works by identifying the stored voices of the people who are to have access to the location. But for this to effective, the voices has to be learned and trained and subsequently matched to authentic a genuine user. The matching of the voices is done by a voice matching algorithm.

A.Voice Matching Algorithm

One of the major components of the system is voice recognition. But for voice recognition to be effectively done, the voices of the genuine users has to be trained and learned and stored so that it can be identified at any given time a user wants to have access. Several algorithms are applied in voice matching. One of such algorithm is the genetic algorithm. It has advantages over other voice matching algorithms which include:

- objective function is not smooth (so derivative methods cannot be applied)
- number of parameters is very large
- objective function is noisy or stochastic.

Ref [1] proposed a genetic voice matching algorithm with is given as shown below:

```
Algorithm VOICE_MATCHING
Begin
input1=sound1; (* initialize a sound *)
refference1=sound2; (*sound from database*)
input1_score=SCORE (input1);
refference1_score=SCORE (refference1);
if (input1= refference1)
PRINT "two voices are same";
Exit;
end if
/*if the two sounds are not same*/
refference2=sound3;(*another sound from database*)
repeat
(* crossover section *)
Offspring1=CROSSOVER(refference1,refference2);
Offspring1_score=SCORE(Offspring1);
until (better offspring is not found)
repeat
(* mutation section *)
Offspring2=MUTATION(Offspring1);
Offspring2_score=SCORE(Offspring1);
until (better offspring is not found)
if(Offspring2=input1)
PRINT "same voice";
else
PRINT "not same voice";
end if
End.
```

It is common knowledge that most of the security measures above have been implemented but they lack the combined approach of using the three methods towards having a more sophisticated, trusted and reliable security system, as such, the implementation of this system which also has a master key in case all the others fail.

III. MATERIALS AND METHOD

The circuitry of this research will comprise of integrated circuit (IC) components like an Arduino Board (Arduino Uno R3), RFID Card and Voice Recognition module V3.1. It will also have other components such as Hex Keypad, Resistors, LCD (16x2), bread boards for initial testing of circuit, Vero boards for final circuit soldering and connecting wires (jumper wires). Brief description and function of the electronics components used in the construction of the top secret multi-user card, voice recognition and code lock system is presented below:

A. Arduino Platform

Arduino UNO is a simple and sophisticated electronics prototyping platform combined with flexible hardware and software. This platform is based on Atmel's ATmega microcontroller. The software is supported by various operating systems like Windows, Macintosh OSX and Linux, though Windows operating system is mostly supported and used. The Arduino Uno can be programmed with the (Arduino software (IDE)), the software language adopted is AVR C programming language and can be expanded through C++ libraries. Several types of Arduino microcontroller boards are available in the market like UNO, Mega, etc.

The ATmega328 microcontroller on the Arduino Uno comes preprogrammed with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C hesder files).

B. 4x4 Hex Keypad

The hex keypad is a peripheral that connects to the Arduino through cable. It has 16 buttons in a 4 by 4 grid (Matrix), labeled with the hexadecimal digits 0 to F.

Matrix keypads 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 pushbutton, with one end connected to one row, and the other end connected to one column. In order for the microcontroller to determine which button is pressed, it first needs to pull each of the four columns (pins 1-4) either low or high one at a time, and then poll the states of the four rows (pins 5 8). Depending on the states of the columns, the microcontroller can tell which button is pressed.

C. *Liquid Crystal Display (LCD)*

Liquid Crystal Display (LCD) is an electronic display module that has a wide range of application. A 20x4 LCD display is a common module that is used in various devices and circuits. This display is preferred to seven segment display and other multi-segment LEDs. The reason being LCDs are economical, easily programmed and have no limitation of displaying special and even custom characters (unlike in seven segment display), animations and so on. A 20x4 LCD means it can display 16 characters per line and there are two such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two (2) registers namely command and data register.

D. *Voice Recognition Module*

The voice recognition module V3.1 supports up to 80 voice commands in all. A maximum of seven (7) voices commands could work at the same time. Any sound could be trained as command. Users need to train the module first before let it recognizing any voice command. On V3, voice commands are stored in one large group like a library. Any seven voice commands in the library could be imported into recognizer. It means seven commands are effective at the same time.

E. *Block Diagram for the System.*

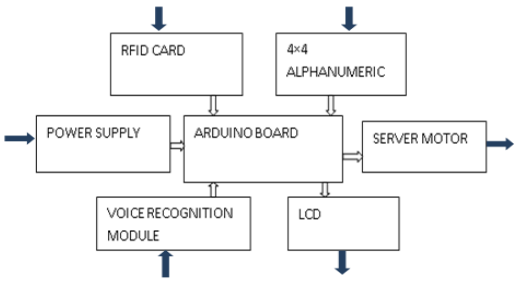
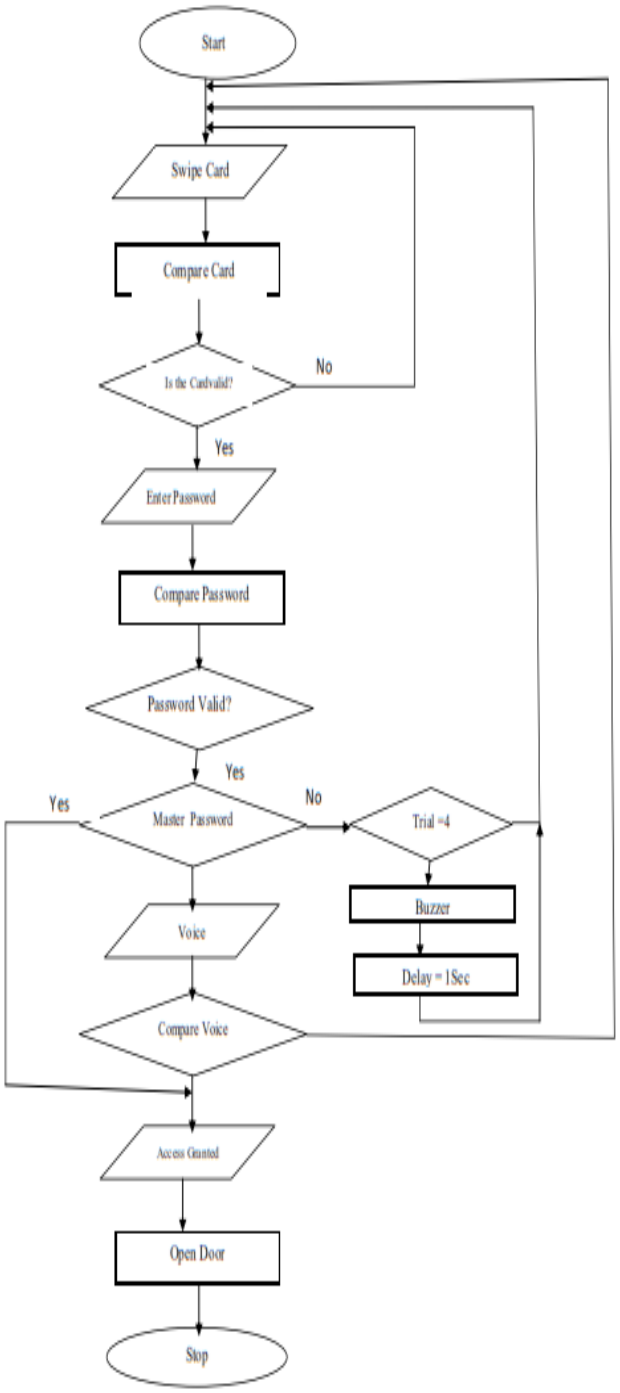


Figure 1. Block Diagram for the System

E. *Flowchart for the Three Tier Security System*



F.*Circuit Diagram for the System*

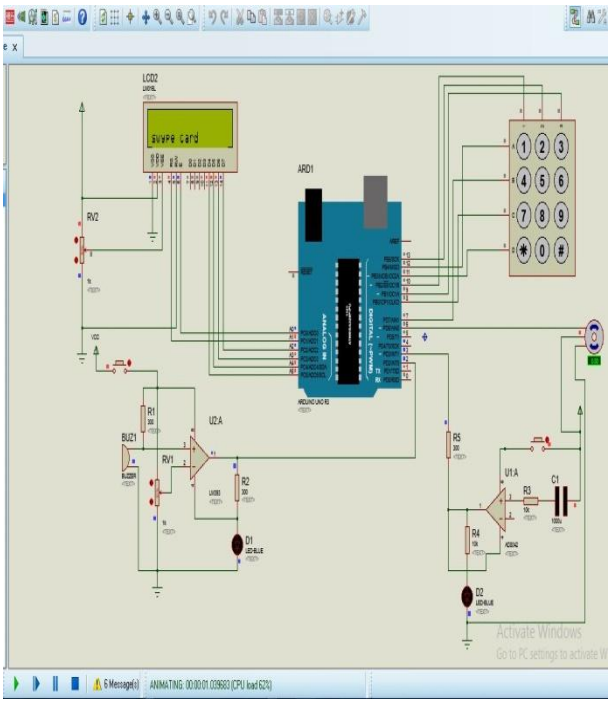


Figure 2: Circuit Diagram at RFID Stage

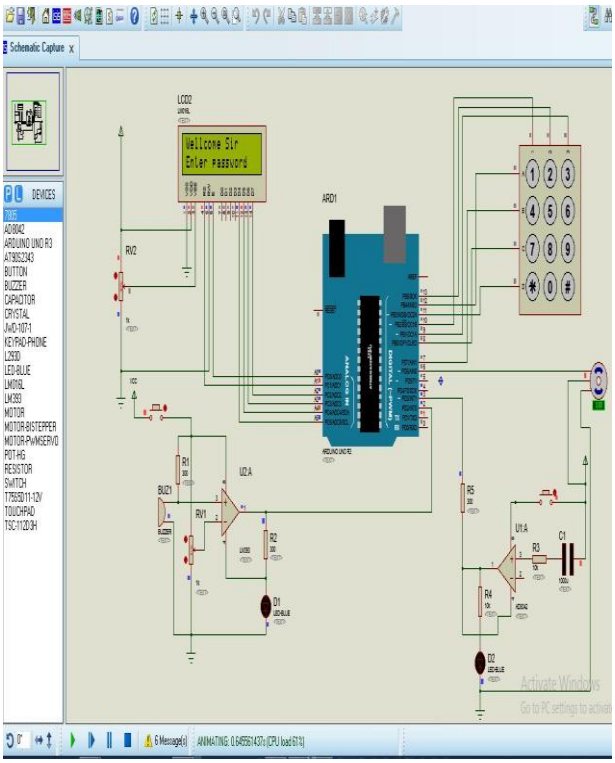


Figure 3: Circuit Diagram at Password Stage

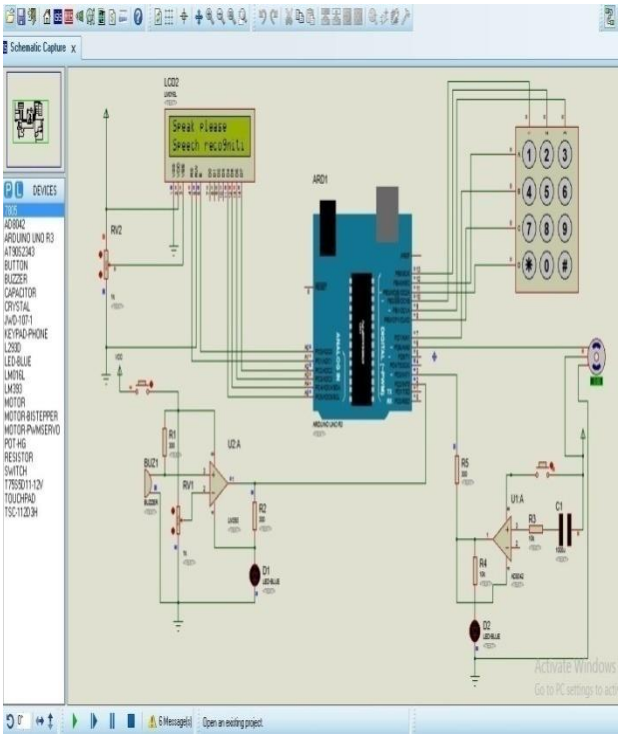


Figure 4: Circuit Diagram at Voice Stage

IV. COMPONENTS TEST RESULTS

This test was carried out on each of the three components separately, the result is as follows.

A. Radio Frequency Identity Card (RFID)

Table 1: RFID test result

S/N	Tag Number	Registered	Number of Test	Recognized	Failure	Percentage of success
1	"20 22 DD A4"	Yes	2	2	0	100
2	"75 BF B8 79"	Yes	2	2	0	100
3	"09 0B 74 5B"	No	3	0	3	0
4	"50 0F D3 B5"	Yes	3	3	0	100

Each of the tags has two different numbers in Hexadecimal and decimal. In this research, the number in Hexadecimal is used, because is simple to write in code. Each of the above tests was carried out separately by different users.

Table 2: Key pad test result

S/N	Combination	Registered	Accepted	Tried	Accepted	Failure	%of success
1	1234	Yes	Yes	2	2	0	100
2	5678	Yes	Yes	3	3	0	100
3	7356	No	No	5	0	5	0
4	1989	Yes	Yes	3	3	0	100
5	1111	Yes	Yes	2	2	0	100
6	2121	No	No	5	0	5	0
7	1717	No	No	5	0	5	0

The test was carried out for different combination. That is 7 combinations, 4 are registered and 3 unregistered were tested. And all the registered combinations were accepted, while unregistered ones were rejected.

B. Voice Recognition Module

Table 3: Voice Recognition Module test result

88S/N	Name	Trial	Recognize	Failure	% of success
1	Iliya H. Mailabari	5	4	1	400
2	Irmiya N. Bwala	4	2	2	50
3	Jerimaya Y. Bassi	4	0	4	0
4	Ayo Yusuf Suleiman	3	2	1	67
5	Kile Samuel Awuna	6	0	6	0
6	Aliyu Musa Kida	5	0	5	0

The failure percentage of the Voice Recognition Module is high because, this is the most sensible part of this work, small variation in voice and or noisy area access will be denied. Among those that participated in the test not everybody could pronounce the command exactly as stored in the module memory. Also noise is one of the major factors that distract the module from distinguishing the voice command.

A graphical illustration of the trials against tests is presented below:

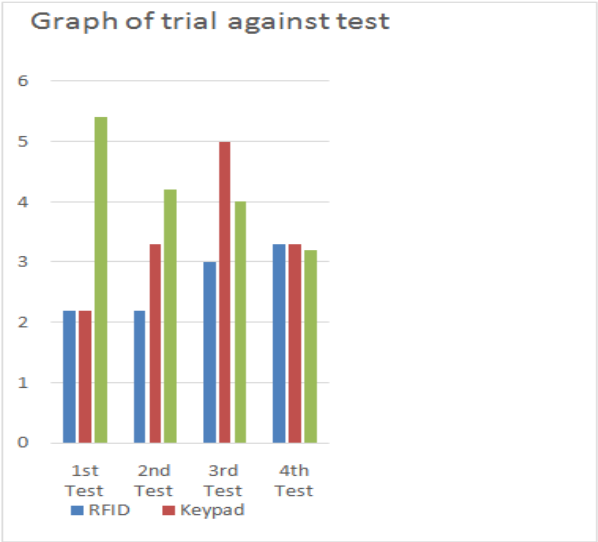


Figure 5: Graph of Trials against Tests

IV. SUMMARY, CONCLUSION AND RECOMMENDATION

A. Summary

The aim of this research, Design and Implementation of a Microcontroller Based Three TierSecurity is to develop security system that is reliable, economical and affordable, to perform a specific task to provide protection for life and properties. A security system that is applicable in places where security is essential, places such as office, homes, school, industries, etc.

The security system is cost effective, that is, affordable, reliable, economical and easy to operate, easy to install and maintain and also make power consumption less. The system is fully and properly constructed to perform a specific task for security purpose. The system is designed to have an operating time of 24/7as long as there is power to the system. Also, a backup battery is provided in case of power failure.

B. Conclusion

The system was successfully constructed and is functioning and behaving as simulated on proteus. Therefore in conclusion, the security system "Design and Implementation of a Microcontroller Based Three Tier Security Systemwhich is the enhancement of the other similar existing systems is more reliable, economical, maintainable and efficient than others.

C. Recommendations

The research recommends that the system master password would be much better, reliable and secure if the system can generate the master password automatic each time the master password is used, and the new master password generated should be different from the expired one used. The master password should be known only by the administrator. Also more advance voice recognition module should be used, so as to accommodate more number of users in case of organization with a large number of staff and to avoid complication or been compromised.

It is also recommended that, the system should have provision for registering new staff or users by theadministrator.

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