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DESIGN AND DEVELOPMENT OF A FINGERPRINT DOOR ACCESS CONTROL SYSTEM WITH A BUZZER ALARM

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ABSTRACT

A door access control system using fingerprint a buzzer alarm is proposed to solve confidentiality and security issue is presented in this paper. Several secured access control methods and protocols have been proposed all over the globe; nevertheless all of them have their own deficits. The keys and padlock would have solved the issues of access control but the world at large has overgrown such method because it can be easily manipulated and does not guarantee personal security. This is one of the reasons why the fingerprints biometrics system was employed in most developing countries. The approach to this work mainly involves capturing the fingerprint of different users which will be used as their password to gain access to a secured area. The false acceptance rate (FAR) and false rejection rate (FRR) performance metrics was used to evaluate the system performance and the result shows that the FAR yielded 10% compared to the FRR that gave 20%. The widespread adoption and implementation of the developed access control system will provide a platform to enhance personal safety and high level of confidentiality in door access control system.

Key words: *Biometrics, fingerprint recognition, access control, false acceptance rate, false rejection, Minutia*

1. BACKGROUND TO THE STUDY

Access control over the years has been a major challenge to different organizations and residential buildings. This security challenge has caused large amount of resources to be invested for the improvement on the security system [6]. In response to the deplorable situation of the security system, organizations need to develop and update personal security program to prevent unauthorized access to control systems and secret information. Efficient methods need to be developed for personal security and control systems integrity, [3]. Reliable and efficient verification of individual has been a major goal every organization had been longing to achieve over the years as the needs for security grows. Biometrics has been introduced into the security system and this has led to proper verification and identification of individual using either their distinct physical or behavioural properties [4]. Fingerprint Biometrics has come to occupy an increasingly important role in human identification due to its universality and uniqueness [4]. Due to the advancement in the introduction of the biometrics technology, different techniques and methods for user identity, recognition and verification has evolved based on the biometrics features that are unique to individuals [8]. In many door access control systems that are used in banks, hotels, schools and residential buildings, their doors are controlled manually by different security agencies that are employed by the various organizations through the use of handles and locks with keys to operate the locks [7], this system reliability, authenticity and security is not guaranteed as an intruder can easily manipulate the lock by either destroying the key or duplicating it to gain access into a building. The use of keys can be damaged and there might be need for replacement on several occasions, thereby incurring additional cost for the owner. Several organizations make use of biometrics such as facial recognition which has proven to have lesser reliability because the face changes with increase in age of individual and getting the

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position of the face tends to be difficult [2]. The use of voice can be imitated and there can be similar patterns. Using the iris from the eyes can be challenging as most people cannot expose their eyes to illumination because of the rays of light that might be dangerous for their sight [6]. To overcome the problems listed above, we presents a fingerprint biometrics for door access control system coupled with a buzzer alarm. In this work, we apply subject fingerprints as the password for the door lock. Fingerprint based biometric system is the most secured form for controlling the access to a door because of its uniqueness, acceptability and its universality[1].Our proposed system provides a low cost, reliable, low complexity and a fast response time of not more than 10secs.

The rest of the paper is organized as follows: In section two we the review of related works, the system hardware and software design considerations are presented in section three, Results and discussions as well as system performance evaluation were presented in section four, Conclusion and Recommendation were presented in section five.

2   REVIEW OF RELATED WORKS

This section describes some related works and their limitations that have been reviewed in relation to this system design. The design and implementation of a biometric access control system using fingerprint and Gabor filter restricted areas was proposed in [1], The work was based on the individual fingerprints and Gabor filter for enhancement process, they uses the unique property of the fingerprints enhancement to obtain a better image quality, the system design was coded in Matlab and C to implement the algorithm for enhancement, minutia extraction and matching process. Minutia result was used for identification of matching fingerprints. Though the system was designed for multiple users, limited numbers of templates can be registered because the system database is not robust.

Authors in [7] designed a microcontroller based access control system, the design was a low cost and low complexity based door access control system. The design was based on smart card for authenticating or denying access to a user, the development cost and operational cost will be high if it were to be implemented where high level of security is required like banks and investment organizations. The limitations of proposition in [7] include: the use of smart cards can easily be manipulated by an intruder, also, the cost and difficulty involve in replacing misplaced card is high.

The design and implementation of an automated door access control using facial recognition was proposed in [9]. The system made use of the Facial recognition out of every other biometrics because it is easy to operate and user friendly. The Eigen faces method was used to ensure the system security. A cost effective and SMS home security system was designed and their work was tested with a home network. Some of the problems encountered during the course of the study are: the face changes with increase in age of individual and getting the position of the face tends to be difficult, also the reliability and robustness of the work needed to be concentrated on for improvement in the level of security desired. An electronic lock using fingerprint was carried out by [6], the design uses fingerprints recognition system for the identification and verification of users using the Gabor filter, the design comprises of a system level design, algorithm level design and the fingerprints image pre-processing stage where the fingerprints image enhancement, binarization and the image segmentation was implemented, the design uses the

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minutia extraction as the preferred method for the work, The work performance was verified using the false acceptance ratio, false rejection rate and the equal error rate. (FAR, FRR, ERR). The limitation of this work is in the use of a unimodal means of security, however, the use of bimodal means of security was suggested to be adopted in subsequent work. This research work is an improvement on [6].

From the history of systems and methodology used as mentioned above, this indicates that there is a need to improve on these past works, since most of them had their own limitations. Some of these limitations includes ability to manipulate the smart cards, problem in getting the position of the face, inconsistency in the parameters for securing an area.
In lieu of the above mentioned works, this design therefore, strives to solve the problems associated with security such system reliability and confidentiality by using a bimodal means of security using fingerprint for door access control coupled with a buzzer alarm.

3   SYSTEM DESIGN

This section shows the methodology involved in the design of a fingerprint door access control system with a buzzer alarm. The design and development of the system were described based on the system overview, system objectives, hardware design consideration and software design consideration.

3.1 System Overview

The access control system consists of different parts, among these parts are: buzzer alarm D.C motor, LED, microcontroller and the fingerprint sensor. Once an authorized user places his/her print on the sensor, the door automatically will open and will be closed manually. If an unauthorized user places his/her print on the sensor, the user will be denied access and if the attempts is beyond three times, the alarm will trigger on to alert the owner. The access control system consists of the Input and output subsystem, the microcontroller unit and the power supply unit. The microcontroller unit sits in between the input and the output subsystems. The input subsystems include keypad buttons, fingerprint detection circuit. The output subsystem is interfaced on the output ports of the microcontroller unit. The output subsystems include: 12V relay, dc motor, status LED displays, buzzer alarm subsystem. The system should be able and capable of granting access to a registered user at any point in time and should be able to raise an alarm when an intruder is attempting to gain access.
 Figure 3.1 shows the block diagram of the system.

3.1 block diagram of fingerprint access control system

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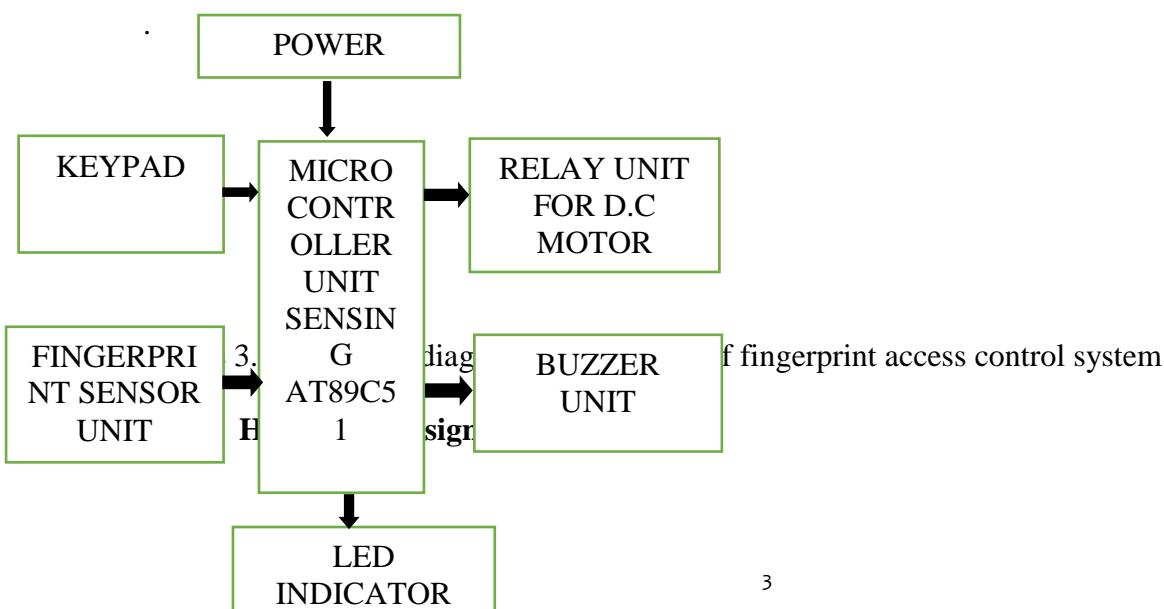
The hardware system consists of the Input and output subsystem, the microcontroller unit and the power supply unit. The microcontroller unit sits in between the input and the output subsystems. The input subsystems include keypad buttons, fingerprint detection circuit. The output subsystem is interfaced on the output ports of the microcontroller unit. The output subsystems include: 12V relay, dc motor, status LED displays, buzzer alarm subsystem.

3.4   Power Supply Design

This system uses a 9V battery as the power source through the power supply so that the system will remain on and working even if the ac power source is gone or unplugged, the dc power through the 9V battery will keep the system functionality on until the power in the battery is drained.

The forward voltage drop of LED's is 2V and forward current of 13.6mA. From Ohm's law,

$$V = IR \qquad .3.1$$

V=voltage

I=current

R=resistance

$$V_{CC} - V_{LED} = IR \qquad 3.2$$

$$R = \frac{V_{CC} - V_{LED}}{I} \qquad 3.3$$

Therefore,

$$R = \frac{9-2}{13.6} \qquad 3.4$$

$$R = 220.5\ \Omega$$

$$P = I^2 R \qquad 3.5$$

$$P = (13.6 \times 10^{-3})^2 \times 220.5$$

$$P = 406912 \times 10^{-3} W$$

$$P = 40.69\ W$$

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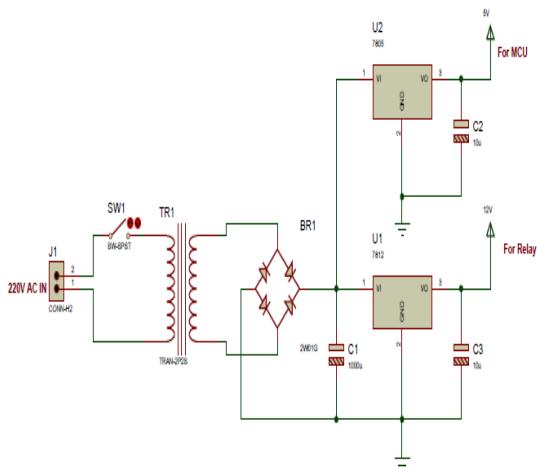
Fig 3.2   Regulated power supply unit

3.5   Software Design Considerations

The control program for this project was written in C language. The embedded C program implements the system flowchart. Simply put, it reads in binary patterns from the input subsystems and sends out binary patterns that would cause the required actions to be taken by the output subsystems
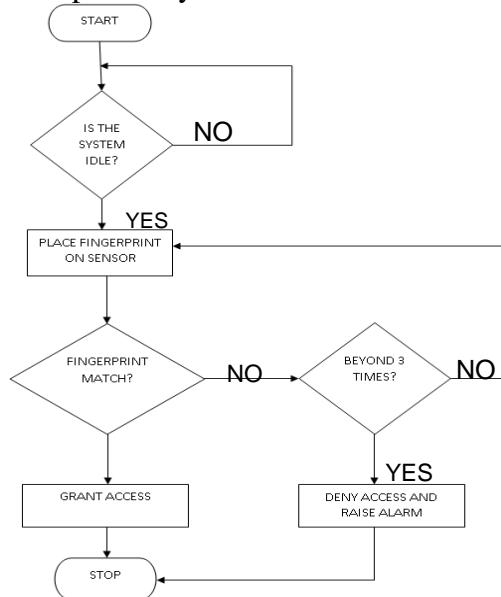
Fig. 3.3   Flow chart design of fingerprint access control system

3.6   System Working Principle

The system operates by placing the designed model close to the door to be controlled, and it should be placed face up where the user will be able to place his finger on it to register his prints into the system database, he does this by pressing the add new button the keypad and enrolling his finger to register the prints. When a registered user places his fingerprints on the device when the system is idle, the microcontroller sends a message to the relay unit which controls the opening of the door to grant access to the user, the door is closed manually by the user. If an unregistered user places his finger on the device, he will be denied access and if he

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continues, after three consecutive trials, the system will raise an alarm form the buzzer alert unit to notify the owner that an intruder is making an attempt to forcefully gain entrance to the secured area.

4.0   RESULTS AND DISCUSSION

This section contains the results obtained and discussion based on these results. The implemented system was tested by collecting the fingerprints of some students and register them in the system database which makes them an authorized user of the system to test for the false rejection rate of the system, immediately the sensor scan their fingerprints, it grants them access. Students that were registered in the database were also asked to place their finger on the sensor to test for the false acceptance rate, the system denied access to these set of student to show the accuracy and the confidentiality of the designed system.

4.1   System Performance Evaluation

Two types of performance evaluation metrics were used to evaluate the performance of the system, these are:

4.1.1 False Acceptance Rate (FAR)

Sometimes the biometric system security may incorrectly accept the access attempt of an unauthorized user. To measure this type of incident, FAR is basically used.

A system's FAR basically states the ratio between the number of false acceptances and the number of identification attempts.

$$\% \text{ FAR} = \frac{FA}{N} * 100 \qquad\qquad 4.1$$

Where

FA = No of incidence of false acceptance.

N =   Total no of fingerprints sample in the database.

4.1.2 False Rejection Rate (FRR)

Sometimes the biometric security system may incorrectly reject an access attempt by an authorized user. To measure these types of incidents FAR is basically used. A system's FRR basically states the ratio between the number of false rejections and the number of identification attempts.

$$\% \text{ FRR} = \frac{FR}{N} \times 100 \qquad\qquad 4.2$$

Where

FR = No of inceidence of false rejections

N = Total number of samples

4.2   SystemResult

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% FRR

This was gotten by adding 10 enrollee and asking them to try to gain access, out of these 10, 2 people were rejected due to some reasons.

Using the formular in equation 4.1,

% FRR = (2/10) * 100%
= 20%

%FAR

Using other 10 people that does not have their prints in the database, out of the 10 enrollee, 1 person was granted access wrongly. Therefore;

% FAR = (1/10) * 100%
= 10%

4.2.1 Table of result

Table 4.2 Result from testing the system

MEASURED QUANTITY	VALUE IN PERCENTAGE
FALSE ACCEPTANCE RATE	10
FALSE REJECTION RATE	20

The bar graph below shows the graphical representation of the result

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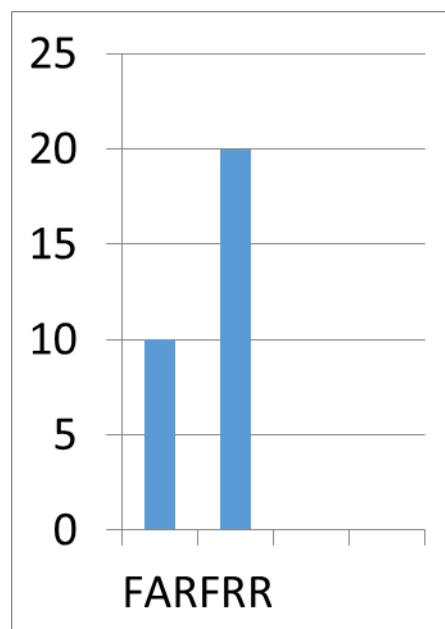
Fig. 4.1graphical representation of the result

The system responded according to the result shown in figure 4.1. Thereby, having a false acceptance of 20% and false rejection rate of 20%. The false rejection rate was observed to be due to some reasons like the physiological problems such as wet skin, injury on the fingertips, dry skin.

Fig 4.2   System fabrication

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This design will aid the development of a fingerprint door access control system with a buzzer alarm. This system will help the user to maintain high level of confidentiality and security of life and properties thereby reducing the rate at which intruders access other peoples belongings or asset.

5.2 Recommendations for future works

There is no engineering design that does not create room for improvement or future work. This design can be further improved on by incorporating the access control with a GSM module so that it can be able to send a warning message to the owner in the absence of the owner.

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