An Intelligent Digital Door Security System with Password Recovery

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ABSTRACT— This research implements an Intelligent Digital Door Security System with Password Recovery. The security system is designed on the principle of accessibility by a password code and provides an extended and user-friendly security features to security interfaces. Many door security systems have been proposed and implemented by different system designers but fails to proffer integrated combinations of security features to help beat security breaches. Here presented in this research work is a system that has a door sensor, a customized keypad with special keys, password recovery capability, alarm system, password change and a proximity sensor to flicker the LCD back to life as someone approaches. It is expected that the microcontroller unit scans the keypad continuously for a four-digit numeric string. When the ENTER button is pressed, the microcontroller unit compares it with the predetermined code saved in the EEPROM, if it corresponds, access is granted else access is denied and an SMS alert reading: "Illegal Entry Attempt" is sent to the facility owner. After three consecutive attempts, the screen of the LCD is frozen and the alarm system is activated. It will blare continuously until a master override code is entered. When access is granted and the door is not pushed open, it locks up after ten (10) seconds.

KEYWORDS—password, GSM module, microcontroller, stepper motor

INTRODUCTION

Optimum security of life and property has been man's major challenge in his existence. Right from time immemorial, man has employed diverse means of protecting himself and his valuables. Traditional techniques of bolts, chains, padlock etc, were employed in the past.

An Electronic Security System refers to any electronic equipment that can perform security operations like surveillance, alarming, or controlling access to a particular facility or an area. Depending upon the area to be protected and possible threats associated with it, security systems may be classified into Access Control Systems and Surveillance Systems [1].

The security sector is experiencing diversification as it has never seen before. This has brought about the need to review the reliability of already existing systems and look into the possibility of creating better systems that are smarter and more secure [2]. Presently, embedded systems are used to design security systems due to advanced technologies in microcontrollers' architectures and breakthrough in GSM applications.

An access control for security interfaces forms a key link in a security chain. The microcontroller based digital lock for doors is an access control system that allows only authorized persons to access a restricted area. An electronic lock or digital lock is a device that has an electronic assembly attached to it and are provided with access control.

I. WORKING CONCEPT OF THE PROPOSED SYSTEM

1. When the system is powered, it activates the door sensor to determine whether the door is closed or opened. If the door is open, the LCD displays "DOOR OPEN" and no further activity is carried out by the door. If the door is closed, the LCD displays "DOOR CLOSED" it delays for ten (10) seconds then the intelligent unit activates the stepper motor controller and instructs it to rotate forward to lock the door then followed by a display "DOOR LOCKED". After a while the screen clears and control shifts to the keypad awaiting any input.

2. The keypad continuously scans through the keys for key press. If a numeric key is pressed it enters a string which takes a maximum of four characters and is displayed on the LCD screen. When the maximum is reached, no any number can be inputted. The string is only processed when the ENTER key is stroke. After pressing ENTER, the inputted string is compared with the stored password, if it is correct: door is unlocked and the LCD screen displays "WELCOME: ACCESS GRANTED". The system waits for ten (10) seconds, if the door is pushed open, LCD screen displays "DOOR OPEN" and remains open. If the door is not pushed open, the intelligent unit activates the stepper motor controller and instructs it to rotate forward to lock the door then followed by a display "DOOR LOCKED". Then control shifts to the keypad awaiting any input. If the comparison is not correct: an SMS that reads "ILLEGAL ENTRY ATTEMPT" is sent to the home or facility owner and the LCD displays "WRONG PASSWORD: ACCESS DENIED".

3. Same sequence of actions is taken each time an attempt is made and control returns to the keypad awaiting any input. On the third attempt, an alarm system is activated by the intelligence unit and it keeps blaring until a master override code is entered by the home or facility owner.

4. Now, if instead of the numeric key the MENU key is pressed, the LCD screen displays four (4) options: 1: NEW PASSWORD, 2: GET PASSWORD, 3: FREEZE, 4: EXIT. If 1 is selected, LCD screen displays "ENTER OLD PASSWORD". The typed string is compared with the old password and if it is correct, LCD screen displays "ENTER NEW PASSWORD". The four-digit string typed and entered is now stored as the new password, the LCD screen displays "PASSWORD CHANGED" and an SMS containing the new password is sent to the home or facility owner the control is shifted to the keypad awaiting any input. In this case, if the

comparison is not correct: an SMS that reads "ILLEGAL ENTRY ATTEMPT" is sent to the home or facility owner and the LCD displays "WRONG PASSWORD: ACCESS DENIED". Same sequence of actions is taken each time an attempt is made and control returns to the keypad awaiting any input. On the third attempt, an alarm system is activated by the intelligence unit and it keeps blaring until a master override code is entered by the home or facility owner. If 2 is selected, the stored password is sent to the home or facility owner, and the LCD screen displays "CHECK YOUR PHONE". Then control is shifted to the keypad awaiting any input. If 3 is selected, the LCD screen is frozen, only a master code can bring it back up. If 4 is selected, control returns to the keypad awaiting any input.

II. BLOCK DIAGRAM AND UNIT DESCRIPTION

Figure 1.1 shows the block diagram of the door security system.

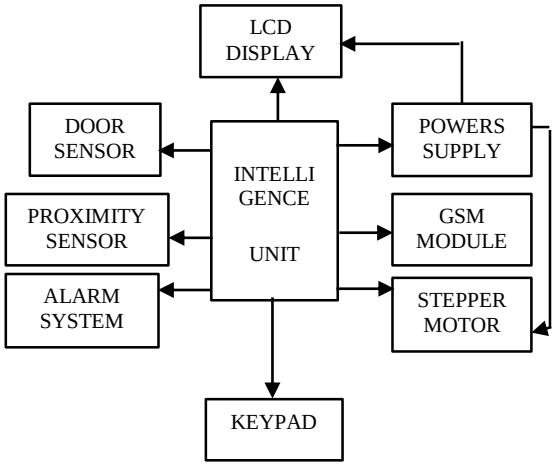

Figure 1.1: Block Diagram of the System

A. Power Supply Unit

The power supply supplies variable voltages to different parts of the circuit. It functions in two modes: AC mode and DC mode. In the AC mode, the AC volyage is stepped down to 12V and is rectified with the aid of diodes. A capacitor is used to filter out the ripples. The filtered output is further stepped down and conditioned to 5Vusing a voltage regulator 7805, for the intelligence and GSM Module. In the DC mode, the +12V from the battery is fed directly into the unit and is regulated at the second stage into +5V.

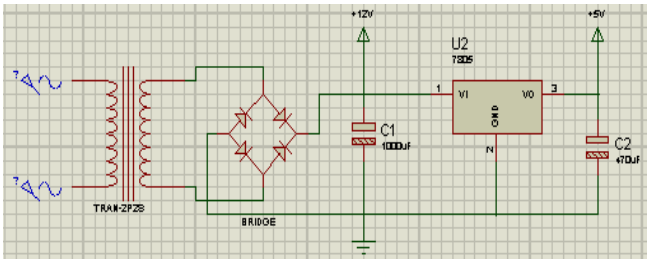

Figure 1.2: Power Supply Circuit Diagram

B. Intelligence Unit

The main component of this unit is the ATmega 32 microcontroller which controls the logic flow of the program. The ATmega16 provides the following features: 16 Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 512 bytes EEPROM, 1 Kbyte SRAM, 32general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain (TQFP package only), a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes[3].The microcontroller contains the hex file in a flash memory and stores the password and authorized phone number.

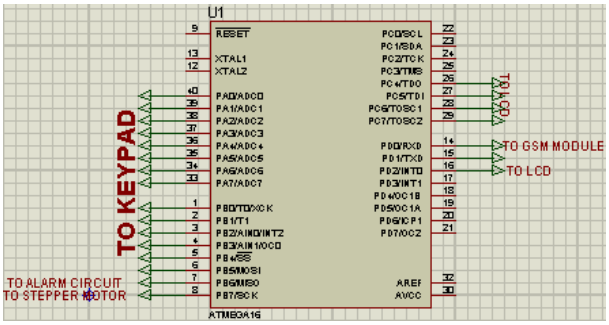

Figure 1.3: Intelligence Unit Circuit Diagram

C. Door Sensor

This is fixed to the door and senses when the door is closed or pushed open. Whatever the status of the door, it sends signal to the intelligence unit for appropriate action.

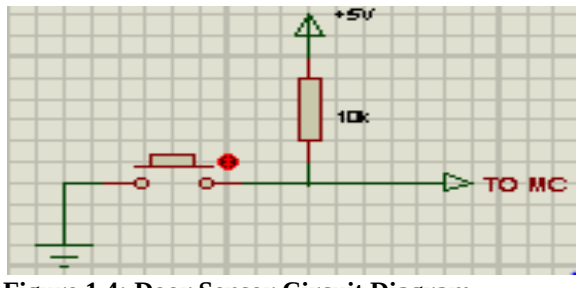

Figure 1.4: Door Sensor Circuit Diagram

D. Proximity Sensor

This senses the presence of a person within range and wakes up the system from sleep. The system goes to sleep immediately the door locked and the person is outside the range.

Figure 1.5: Proximity Sensor[4]

E. Alarm System

This unit is responsible for blaring sound continuously whenever there is a security breach. It consists of a speaker connected to and controlled by the intelligence unit.

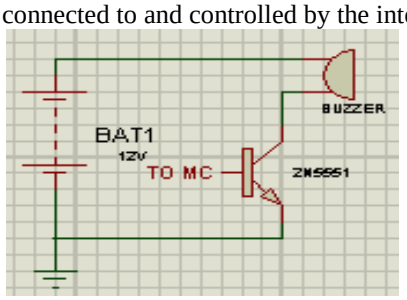

Figure 1.6: Alarm System Circuit Diagram

F. Customized Keypad

This is a non matrix keypad which primarily serves as an interfacial input to the intelligent door lock security system. It consist of 13 keys altogether, 0 – 9 and three special function keys: enter, delete and menu. It is customized in the sense that it has a specific number of functional keys to serve the purpose of this project.

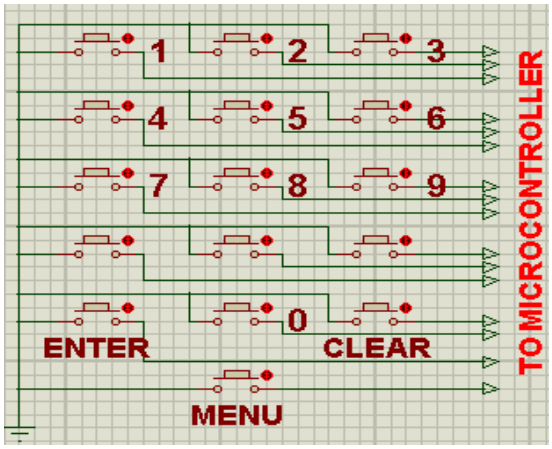

Figure 1.7: Keypad Circuit Diagram

G. Stepper Motor

This engine that provides mechanical motion to the bolt. It makes calculated motion at a determined speed. Depending on instruction received, it either moves the bolt forward to lock or backwards to unlock.

Figure 1.8: Stepper Motor[5]

H. GSM SIM800L

SIM800L is a quad-band GSM/GPRS module, that works on frequencies GSM850MHz EGSM900MHz, DCS1800MHZ and PCS1900MHz. SIM800L features GPRS multi-slot class 12/class 10 (optional) and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. Other features include:

- Real Time Clock
- Power voltage 3.4 ~ 4.4V DC
- Supports 2.8 to 5V logic level
- Supports 5 x 5 x 2 keypad
- One full modem serial port, user can configure two serial ports
- One USB, the USB interfaces can debug, download software
- Audio channels which includes two microphone input, a receiver output and a speaker output
- Programmable general purpose input and output
- A SIM card interface
- Support FM
- Support PWM[6]

GSM Module constitutes the secondary interface of the intelligent door lock security system. It permits a two-way communication between the home or facility owner and the Security Lock system. The GSM Module is responsible for sending real-time SMS alerts to the owner, in the event of an unauthorized attempt to access the device.

Figure 1.9: GSM SIM800L[6]

III. HARDWARE AND SOFTWARE INTEGRATION

The circuit schematic is designed and will be simulated on proteus while the source code will be written in Atmel studio environment. After the construction and coupling of the various blocks that makes up the project, the hex file of the source code will be loaded on the microcontroller unit using FlyPro software, tested and cased. Figure 1.9 shows the overall circuit diagram.

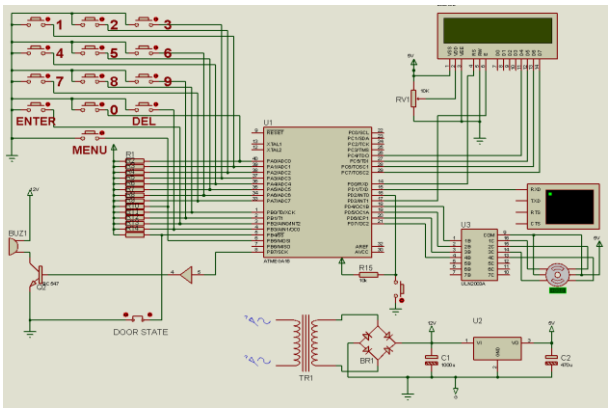

Figure 1.10: Circuit Diagram

V. RESULTS AND DISCUSSION

1. Computer Simulation

When the over all circuit was designed on proteus and the source code was written in Atmel Studio. Then it was simulated and it succeeded with no warnings. Figure 1.10 shows a screen shot of the simulation result.

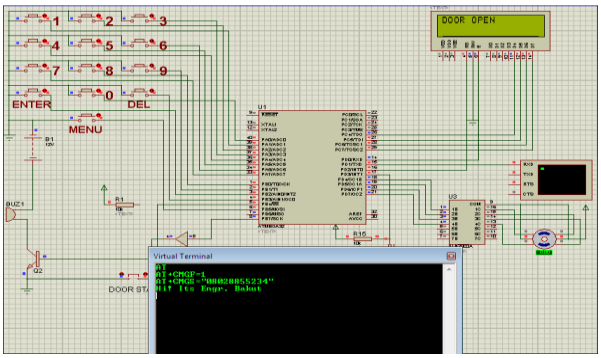

Figure 1.11: Simulated Result

2. Temporary Construction

The power supply unit was first of all constructed on a bread board. Two outputs are supplied by the power supply unit: +12V and regulated +5V.

3. Permanent Construction

The permanent construction was done on a Vero Board. All the units were constructed in modular form and connected together by header connectors. Figure 1.11 shows the final construction.

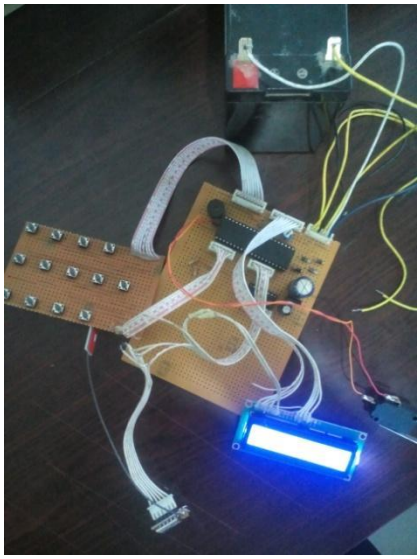

Figure 1.12: Final Construction

VI. CONCLUSION AND RECOMMENDATIONS

The prototype of an intelligent digital door security system was designed, constructed and implemented successfully. All the components and modules that make up the entire project are working well.

This design gives the flexibility of changing the password in situations where the initial password is compromised.

In instances where a wrong character or characters is or are entered during typing of the password, a special button can be used to delete these characters.

The beeping unit provides continues blaring of sound in a case where a wrong password is entered more than three times. This is to notify neighbours of an illegal entry attempt on a nearby facility.

The GSM module sends the desired message irrespective of whether GLO, MTN or AIRTEL is been used in the module. The GSM module also makes the recovery of password possible by sending the current password as a text to the facility owner only on demand.

RECOMMENDATION

The design and simulation of this project uses only one destination phone number, future work can add more destination phone numbers so that more people can receive text message of an illegal entry.

This project can further be enhanced by including bio-metrics security features. This increases the security features but it comes with an increased cost.

Also, a camera can be integrated in the design to give a facial identification of people accessing the facility.

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