Design and Development of a Microcontroller Based Security System for Smart Home

I.B. Oluwafemi and O.J. Femi-Jemilohun

Department of Electrical and Electronic Engineering, Ekiti State University, Ado Ekiti, Nigeria

ABSTRACT

The threats and damages done through criminal activities in our society make it imperative to blend technology to provide sensitive security. This paper designed a micro-controller based SMS alert system for intruder detection. The system is built around a PIC16F876A microcontroller programmed with Global System for Mobile Communication (GSM) to GSM module connected through MAX 232 integrated Circuit (MAX 32IC), to the microcontroller. The design takes information of intrusion from proximity sensor and vibration sensor. The system was programmed with the user's mobile number for a customized SMS notification of intrusion for each of the sensor. The response time between intrusion and SMS alert was tested to be 20 seconds under normal available network.

Keywords*: PIC16F876A Microcontroller, Proximity and Vibration Sensors, GSM Module Security System.*

1. INTRODUCTION

Security alert system and communication electronics device in this century have been proven useful and needful as the only solution to frequent threat to live and properties of individual especially when the user are not available. The frequent break in of intruders into various houses during the working hour can be prevented through security devices. This work has provided a relaxed mind for home users over their properties especially when they are away from home. Since peace and rest remain the basic need of every society and individual, therefore, a need for this device become imperative.

The implication of frequent intrusion has proved the insufficiencies of insurance scheme as it may involve lost of life and other severe damage. Hence, effort to apply technology for security need must be enhanced several design on security system have been proposed in the literature ranging from the application of analogue devices, to micro-controller system

In [1] a security system alerting VIA SMS was designed using vibration sensor, PIC16F877 microcontroller, GSM modem and hand phone. This system was designed to detect single intrusion, which can be classified as point detector as it can only indicate intrusion at a specific point In [2], A remote home security system based on wireless sensor network and GSM technology was proposed The system was designed to detect theft, fire leakage and alarm remotely but the system cannot alert the owner remotely. In [3],a Remote Home Security System Based on Wired Sensor Network Using NS2 was presented while a home security system based on WSN and GSM was proposed in [4]. The work in [4]employed a microcontroller with voice recording to detect intruder like theft and fire. A modular home security system with SMS was also proposed in [5] which employs a pssive infra red sensor for motion detection and a camera for capturing image and in [6] an security alarm system was designed based on the amount of light falling of a photodiode

fixed at the door and window to be protected. The work in [7] proposed a double notification system during security breaches. It alert the owner through an email and through SMS. In [9], a multiple optimization system was formulated as a multiple object decision making for a modeled smart home system by using the multiple ANFIS.

In this work, we proposed a microcontroller based security detection system with SMS alert system. The system which is a multi point detection system employs, vibration sensor and proximity sensor for intruder detection. The proposed system integrate a buzzer alarm system that can be triggered at the user's discretion after receiving SMS of intrusion from either of the sensor.

2. SYSTEM DESIGN

Hardware Design

Hardware of the system consists of the PIC16F876A microcontroller, GSM module, Vibration sensor, Proximity sensor and GSM phone, Buzzer, in system programmer and relays to control the appliances. The design is shown in Figure 1.0
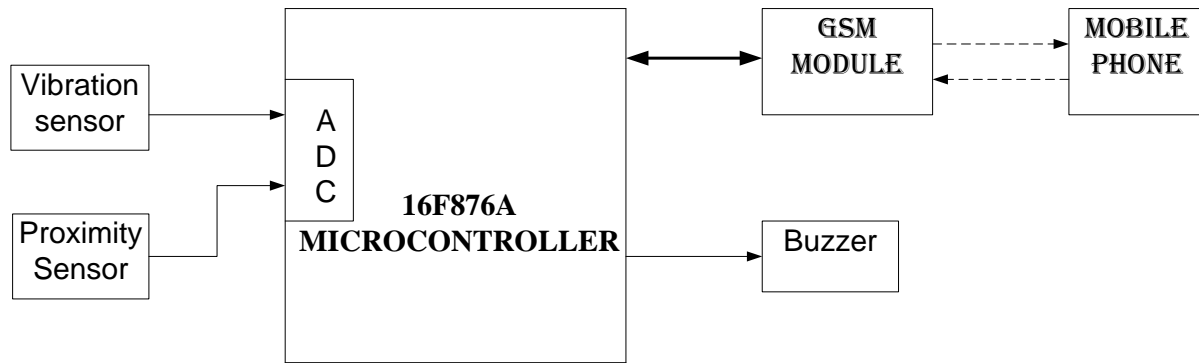
Figure 1 The block diagram of the security system

The output of all the sensors are connected to ADC. The vibration sensor is connected into a window and the proximity sensor is connected along a secured path is the home. If there is a signal from any of the sensors, a SMS is sent ("INTRUSION") to the home owner. The home owner can then trigger an alarm by sending an SMS to the module.

2.1.1. Pic 16f876a Microcontroller

The control module is built with the microcontroller IC. The central controller is the PIC **16F876A MICROCONTROLLER.** The PIC16F876A is a low power, high-speed FLASH/EEPROM using CMOS technology. PIC16F876A Microcontroller features 128 bytes of EEPROM data memory, self programming, an ICD, 2 comparators, 5 channels of 10-bit Analog-to-Digital (A/D) converter. The synchronous serial port can be configured as either 3-wire Serial peripheral interface (SPI^{TM}) or the 2-wire inter-integrated Circuit (I^{2}c) bus and a Universal Asynchronous Receiver Transmitter (USART).

3. GSM/GPRS MODULE UNIT

The GSM modem unit is built using the SIMCOM SIM 900 modem that specialized for Arduino uno controller and support GPS technology for satellite navigation. This module takes care of all GSM/GPRS based communication requirements as well as provide live GPS data.

Like a GSM mobile phone, a GSM module requires a SIM card from a wireless carrier in order to operate Both GSM modules and dial-up modules support a common set of standard AT commands. You can use a GSM module just like a dial-up module. In addition to the standard AT commands, GSM modules support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, the following operations can be performed:

i. Reading, writing and deleting SMS messages.

ii. Sending SMS messages.

iii. Monitoring the signal strength.

iv. Monitoring the charging status and charge level of the battery.

v. Reading, writing and searching phone book entries.

AT commands are instructions used to control a module. AT is the abbreviation of Attention. Every command line starts with "AT" or "at". That's why module commands are called AT commands. Many of the commands that are used to control wired dial-up modules, such as ATD (Dial), ATA (Answer), ATH (Hook control) and ATO (Return to online data state), are also supported by GSM/GPRS modules and mobile phones.

Besides this common AT command set, GSM/GPRS modules and mobile phones support an AT command set that is specific to the GSM technology, which includes SMS-related commands like AT+CMGS (Send SMS message), AT+CMSS (Send SMS message from storage), AT+CMGL (List SMS messages) and AT+CMGR (Read SMS messages).

3.1. Operating Mode: SMS Text and SMS Protocol Data Unit (PDU)

The SMS specification has defined two modes in which a GSM/GPRS module or mobile phone can operate. They are called SMS text mode and SMS PDU mode. The mode that a GSM/GPRS module or mobile phone is operating determines the syntax of some SMS AT commands and the format of the responses returned after execution. The following are some of the SMS AT commands:

i. +CMGS (Send Message)

ii. +CMSS (Send Message from Storage)

iii. +CMGR (Read Message)

iv. +CMGL (List Messages)

v. +CMGW (Write Message to Memory)

vi. +CNMA (New Message Acknowledgement to ME/TA)

vii. +CMGC (Send Command)

4. SENSOR USED IN THE SYSTEM

A sensor is a device which measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. Two sensors were employed in this design, which are the vibration sensor and the proximity sensor.

4.2.1. A Proximity Sensor

"Proximity Sensor" includes all sensors that perform non-contact detection in comparison to sensors, such as limit switches, that detect objects by physically contacting them. Proximity Sensors convert information on the movement or presence of an object into an electrical signal. There are three types of detection systems that do this conversion: systems that use the eddy currents that are generated in metallic sensing objects by electromagnetic induction, systems that detect changes in electrical capacity when approaching the sensing object, and systems that use magnets and reed switches.

4.2.2. Vibration Sensor

The three parameters representing motion detected by vibration monitors are displacement, velocity, and acceleration. These parameters can be measured by a variety of motion sensors and are mathematically related Selection of a sensor proportional to displacement, velocity or acceleration depends on the frequencies of interest and the signal levels involved. Piezoelectric accelerometers having a constant signal over a wide frequency range, up to 20 kHz, for a given mechanical acceleration level are very useful for all types of vibration measurements.

5. SOFT WARE DESIGN

In this design, arduino developer is used to develop program for arduino controller. The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the **Tools>Board** menu. The flow chart of the whole system is shown in Fig. 2
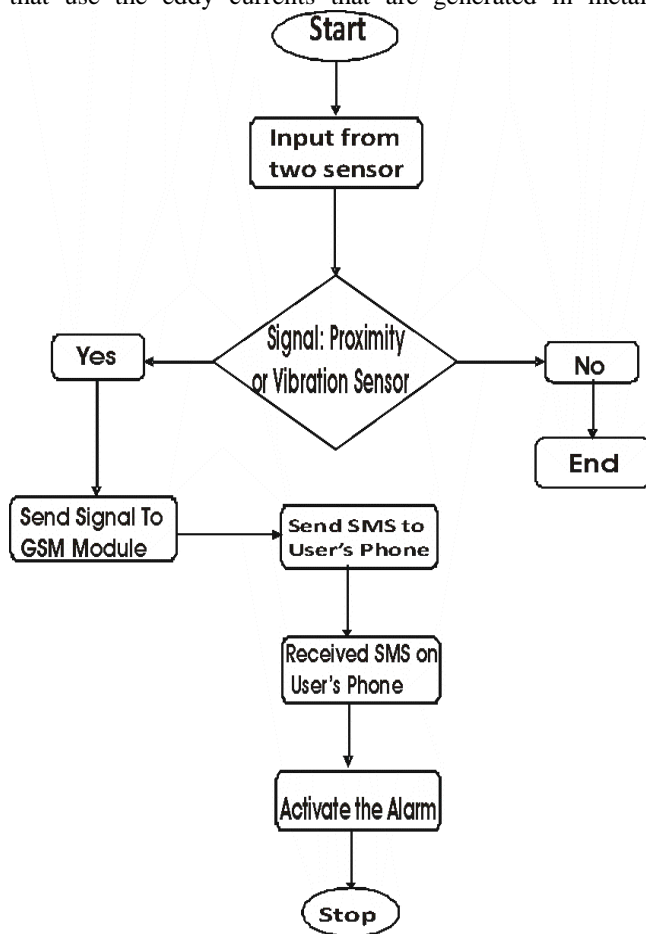

Fig. 2. Flowchart of the system

6. RESULT AND DISCUSSION

The developed GSM based security system gives good response to the sensor and sends SMS when it detects intrusion and vibration on the door and window where the vibration sensor was fixed. The time taken by the system to deliver the SMS is dependent on the coverage area or range of the specified mobile network. If the mobile is in the range of the system then the SMS is delivered in 25-30 seconds. The message delivered to the mobile is "intrusion". An alarm can also be triggered through an SMS from the hand held phone.

7. CONCLUSION

In this paper, a micro controller based security system with SMS alert system is proposed. The system is based on the integration of vibration and proximity sensor that senses motion and attempted forceful entry into any guarded property. The system, upon sensing either motion or vibration is designed to send a SMS to the owner and the owner at his discretion can trigger an alarm system via a SMS to the designed module. The system is designed using modularity making it a flexible system than can accommodate more sensors without changing the whole system.

REFERENCES

Huang, H., Xiao, S., Meng X. and Xiong, Y., "A Remote Home Security System Based on Wireless Sensor Network and GSM Technology", Proceedings of Second International Conference on Networks Security, Wireless Communications and Trusted Computing, 2010.

Nurmarizah Binti Umar [2011] Security System Alert Via SMS

Huiping huang Shidxiao, Xiangyin meng and Ying Xiong (2010) "A Remote Home Security System Based on Wireless Sensor Network and GSM Technology"

Kajesh Banala and D. Upender "Remote Home Security System Based on Wired Sensor Network Using NS2

Aayush Aggarwal and R.C Joshi "WSN and GSM Based Remote Home Security System"

S. Budijono, J. Andrianto and M. A. N Noor, "Design and implementation of modular home security system withshort messaging system" EPJ Web of conferences 68, 00025 2014, pp. 1-5

N, Agarwal and G. S. Nayak, " Microcontroller based Home security system with Remote Monitoring" International Journal of Computer Apllications, (0975-8887), pp. 38-41

J Bangali and A Shaligram, "Design and Impletation of security systems for Smart Home based on GSM technology" International Journal of Smart Home vol. 7 no.6 2013, pp. 201-208

L. Sang-Hyun, J Lee, M Kyung-II, " Smart Home security system using multiple ANFIS" Internation Journal of Smart Home, vol. 7, no 3, May 2013,pp.121-132.

Ginzburg Iya. S.A, Lekhtman and Malov V.S "Fundamentals of Automation and Remote Control", 1982]

Atmel Corporation, "Atmega8/L Datasheet", available http://www.atmel.com/dyn/resources/prod_documents/doc2486.pdf