

Ultrasonic Intruder Detection System with Short Message Service (SMS) Feedback

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To cite this article

Joseph Abiodun Amusan, Augustine Amadi. Ultrasonic Intruder Detection System with Short Message Service (SMS) Feedback. *Open Science Journal of Electrical and Electronic Engineering*. Vol. 5, No. 3, 2018, pp. 24-29.

Received: July 30, 2018; **Accepted:** August 17, 2018; **Published:** September 13, 2018

Abstract

Ultrasonic intruder detection System with SMS feedback is constructed. The system is used to detect any intruder around a restricted area and send a Short Message Service (SMS) feedback to the authorized personnel or the user of the device and also to sound an alarm to alert the immediate environment. The intruder system is built using a Global System Mobile (GSM) module as a feedback system, the power supply to the system is 220V ac. This voltage is stepped down by a transformer, rectified, filtered and regulated by a dc power supply unit and the regulated voltages are sent to other part of the circuit. The intruder is detected using an ultrasonic device which serves as the input unit. The signals from the input unit are fed into the control unit. The control unit is made with an AT98C52 micro controller chip which is programmed to send voltage and current to the output unit in order to control the output devices. The output devices are buzzer and a GSM feedback system. The buzzer is to sound alarm to the surrounding while the GSM module send SMS to a phone number programmed in the micro-controller chip. The device was tested and it functioned well. The device can thus find application in banks, companies among other places where security is paramount.

Keywords

Ultrasonic, Detector System, Buzzer Alarm, Micro-controller, Short Message Service

1. Introduction

Security is a prime concern in day-to-day life. As much as possible, everyone desires to be secured. In recent times, the world has experienced an exponential increase in the rate of crime. Criminals break into houses on a daily basis around the world carting away huge amount of money and precious items. Sensitive and confidential documents, materials and equipment by corporation are constantly declared missing from where they are kept. So there is a need to provide a device that can detect unauthorized persons in an environment.

In a network or a system, any kind of unauthorized or unapproved activity is called intrusions. An Intruder Detection System (IDS) is a collection of the tools, methods, and resources that assist to identify, assess, and report intrusions.

Intrusion detection is typically one part of an overall protection system that is installed around a system or device and it is not a stand-alone protection measure [1]. Intrusion is also defined as any set of actions that attempt to compromise the integrity, confidentiality, or availability of a resource [2] and intrusion prevention techniques (such as encryption, authentication, access control, secure routing, etc.) are presented as the first line of defence against intrusions.

Although, it has been observed that the intrusion may not be totally prevented because of compromise on the part of some security personnel. These personnel may conspire with intruders which may lead to release of security keys and revelation of confidential information. This results in the failure of the preventive security mechanism. Therefore, IDSs are designed to reveal intrusions, before they can disclose the secured system resources. IDSs are always

considered as a second wall of defence from the security point of view. IDSs are cyberspace equivalent of the burglar alarms that are being used in physical security systems today [3]. The expected operational requirement of IDSs is given as low false positive rate, calculated as the percentage of normalcy variations detected as anomalies, and high true positive rate, calculated as the percentage of anomalies detected [2].

Several types of security locks such as magnetic locks [4], electric strikes, electric mortise and cylindrical locks, motor operated locks [5] have been reported by some researchers.

In digital access system, the user authentication device is introduced to allow access by the owner or authorized persons. The authentication could be numerical codes, password or pass-phrases. The correct code must be entered in order for the lock to deactivate. Such locks typically provide a keypad, and some feature of an audible response to each press. A major hindrance however is the fact that users are capable of forgetting their codes. Other authentication methods are scan or swipe security tokens, biometrics [6]. The architecture, design and experimental results for a fully prototyped security system that utilizes ultrasonic sensors operating in the pulse echo mode for the perimeter control and ZigBee transceivers for wireless networking was described [7]. Also, an ultrasonic motion detector system that

uses a transmitter transducer which generates a signal at a frequency of 40kHz was developed. When the signal is blocked by any moving object, the buzzer is triggered via a timing circuit [8]. [9] describes a new intrusion detection system in the indoor environment, which is based on the airborne sonar technology and pattern classification. It utilizes an ultrasonic transmitter and a receiver to receive the pulse-echo. The simplest feature of echoes, envelope is extracted to train and test the pattern classifiers. The correct classification rates of K-nearest-neighbor (KNN) and Back-Propagation (BP) network classifiers were compared. An ultrasonic security system that sends off sound alarm and updates the authorized owner via email in case of intruders had been designed [10].

The limitations of these famous intruder and security systems are the reason for improvement in this work. This paper thus proposed a design to reduce the intrusions by alerting the appropriate quarters through Short Message Service (SMS) when an unauthorized entrance into a restricted area occurs.

2. Methods

The block diagram in figure 1 shows the sections and the path of the signal flow in the design.

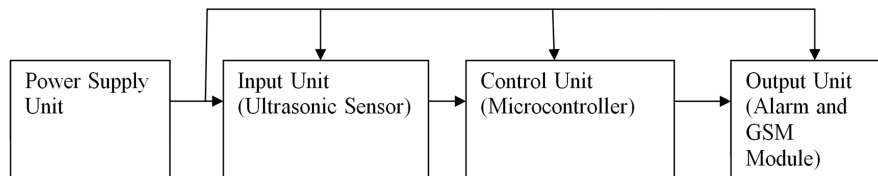


Figure 1. Block diagram of the infrared and ultrasonic detector system.

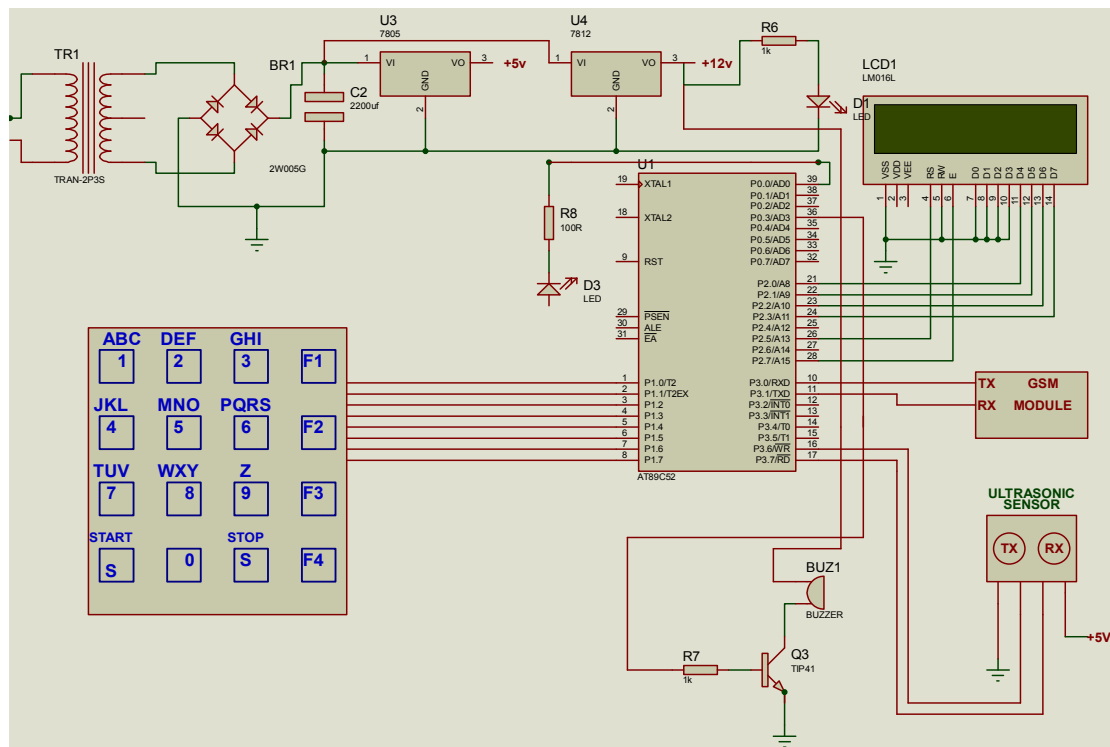


Figure 2. Circuit layout of infrared and ultrasonic detector system.

The circuit layout in figure 2 shows the different components employed in the design and construction of the device. The intruder and ultrasonic detector system is made up of the following stages:

- i. Input stage which comprises of:
Power Supply
Keypad
Ultrasonic module
- ii. Control stage which consists:
Microcontroller
- iii. Output stage which comprises:
GSM modem

Buzzer

LCD Screen

The power supply (Figure 3) serves as the main supply of electrical power to the system. The supply voltage was 220Vac that was stepped down by a 220Vac/12Vac, 500mA transformer. The 12V AC voltage was then rectified by a bridge rectifier to have a DC output. After the rectification process the remaining AC ripples were filtered off by a bypass capacitor. The output from the bypass capacitor was unregulated thereby causing a drastic voltage drop when a load was connected. To solve this problem an integrated IC chip voltage regulator was used to get fixed output.

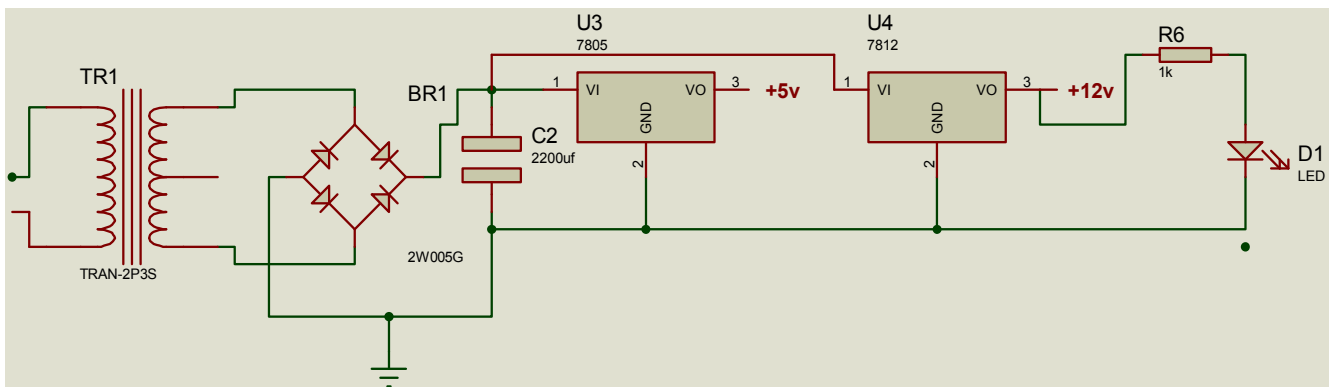


Figure 3. Circuit Diagram of Power Supply Unit.

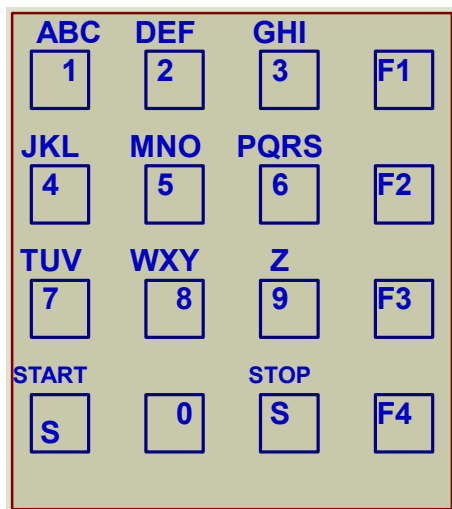


Figure 4. Schematic of the Keypad.

The matrix keypad (Figure 4) was used to send number to the micro controller. This number is a user phone identification number so that when there is an intruder a message will be sent to the number.

The ultrasonic (Figure 5) module is used to detect a human motion. The ultrasonic module consists of a transmitter and

receiver sensor. The transmitter sends signal at a frequency of 40 kHz generated by the micro controller and waits for the reflection of the sound by the intruder. When an intruder stands like an obstacle, the sound reflects back to the receiver and sends a signal to the micro controller. The echo and receiver terminals of the module were connected to the pin 16 and pin 17 of the IC respectively.

The control unit Schematic (Figure 6) handles all processor control signals. It directs all input and output flow, fetches code for instructions from micro-programs and directs other units and models by providing control and timing signals. A control unit component is considered the processor brain because it issues orders to just about everything and ensures correct instructions are executed. The control unit makes use of an AT89C52 micro-controller chip which main function is to check the signal from the intruder sensor. This is done by sending a 40 kHz signal from the micro-controller port 3.6 to the ultrasonic module and waits for the echo pin to receive and send the signal back to the microcontroller. The microcontroller switches on the buzzer and sends a text message through the GSM modem to a phone number stored and programmed in the GSM modem.

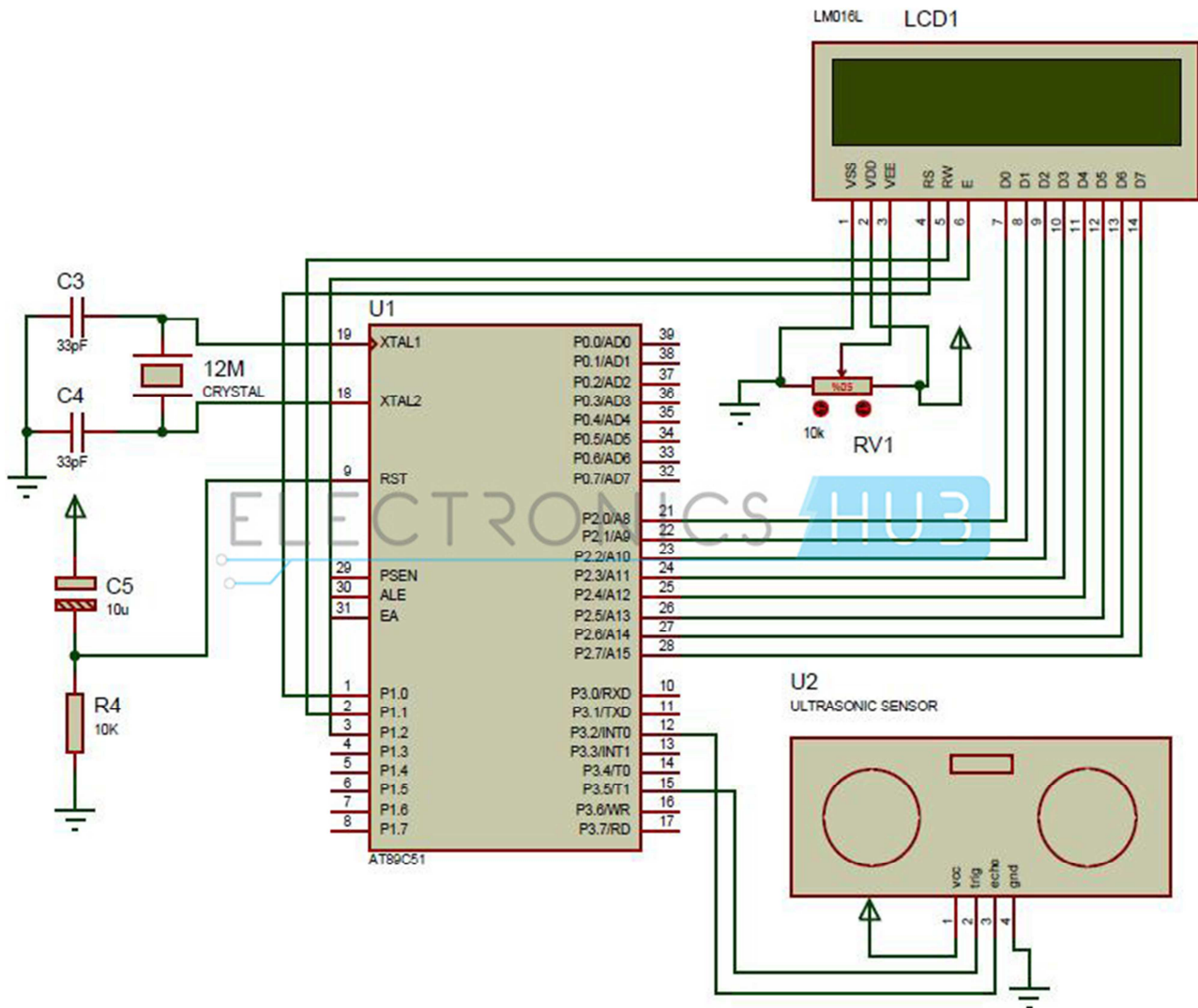


Figure 5. Ultrasonic Module System.

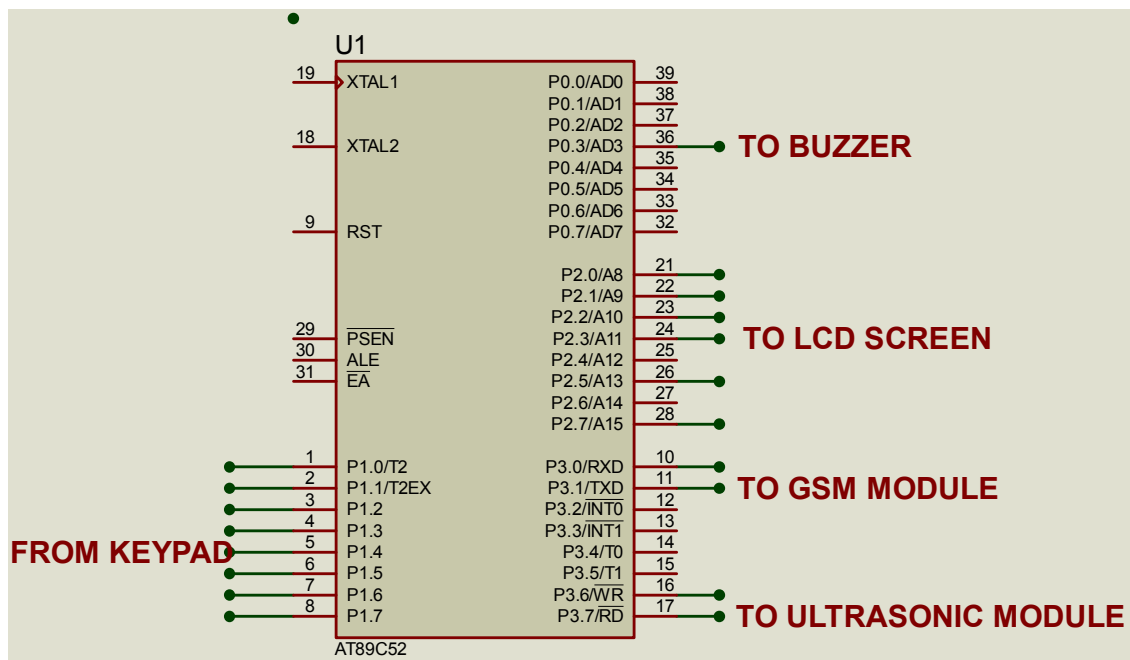


Figure 6. Schematic of Control Unit.

The LCD screen was used to display that an intruder has been detected. This was possible due to its data terminals and command register through which micro-controller was connected.

The buzzer sounds an alarm when an intruder is detected either from the infrared sensing system or the ultrasonic module.

The GSM module was used to send SMS from the micro-controller to phone number stored in the micro-controller.

3. Analysis

The following analyses were done in the course of implementation of circuit design and construction.

3.1. Power Supply

A 220V/12V step – down transformer was used, to feed 24V to the circuit.

Secondary voltage of transformer = $24V(V_{rms})$

The peak secondary voltage,

$$V_m = \sqrt{2} \times V_{rms} \quad (1)$$

$$V_m = \sqrt{2} \times 24 = 33.9V$$

The bridge circuit rectified the 24V from the secondary of the step down transformer. The full-wave bridge rectifier 5W001 was used, having a PIV of 100V and passed a peak current of 2A.

$$V_{L(peak)} = V_{m(max)} - 2V_{d(on)} \quad (2)$$

$$V_{L(peak)} = [33.9 - 2(0.7)] V$$

$$V_{L(peak)} = 32.5V$$

The PIV rating of the diode to be used should be at least

$$PIV = V_{m(max)} - V_{D(on)} \quad (3)$$

$$PIV = 33.9 - 0.7$$

$$PIV = 33.2V$$

Therefore, the 50V PIV is far greater than this value 33.2V, thus making it suitable for this design.

For a suitable filter capacitor value to be employed the following calculation was considered:

$$V_{i(peak)} = V_m - V_{rect} \quad (4)$$

$$V_{i(peak)} = 33.9 - 2(0.7)$$

$$V = 32.5V$$

A capacitor that would withstand at least 32.5V was chosen. The capacitor value should be high to be able to filter off ac ripple voltage from the circuits. A 2200μF, 50V PRV capacitor was used.

Two voltage regulators were used to regulate the voltage to 12V and 5V respectively. A light emitting diode was connected to the voltage regulator to indicate that there was power in the circuit.

3.2. Microcontroller Connections

The Port 2 terminals were used to send data to the LCD screen. Port 2.0, 2.1, 2.2 were connected to the command register of the LCD display, register select (RS), read and write (RW) and the enable (EN). These command registers were configured to make the microcontroller able to display words on the LCD screen. When an intruder has been detected the microcontroller sounds an alarm to alert the environs.

This is achieved by using assembly language programming through MIDE-51 compiler. The program was burnt into the microcontroller chip by a universal programmer Topwin 2007. The code was written in a compiler, after the completion of the code the program was run and three file formats were gotten from the compiler software with extension of hex, asm and list. The hex file was burnt into the microcontroller using the TOPWIN programmer.

The ASM file is the code file that was used by the program to edit or improve on the program when necessary. The list file shows all the address of the programming code and the number cycles needed for the execution of each of the code.

4. Testing

The testing of individual component (such as capacitor, resistor and transformer e.t.c) was carried out before soldering and then each stage was tested. This approach enables one to trace fault and easily adjust it. The power supply unit was checked for proper voltage level from its output pins with a multimeter. The infrared transmitter/receiver unit was tested and the entire circuitry was tested. The software programmed was simulated and checked, to show no error in the assembler before burning it into the microcontroller chip. Table 1 shows the power supply test results using DC Multimeter.

Table 1. Voltage Regulator Testing results.

Voltage regulator	Voltage (dc)
7812	11.87
7805	5.01
7805	4.98

Table 2 shows the results of signal gotten from the ultrasonic sensor.

Table 2. Voltage of signal during reception and non-reception.

Ultrasonic sensor	Signal sent	Action
Signal is sent out	Receiver has not received reflected signal.	Buzzer turn off
Signal is sent out	Receiver has received reflected signal.	Buzzer turns on for 1 minute then goes off.

This signal was sent to the microcontroller, and then each part of the circuit was tested and integrated. The overall circuit test is shown in Table 3.

Table 3. Obtained Test Results.

Process	Component	Action
Power is turn in the circuit	Power indicator led, program indicator led	Both LEDs turn on
Signal is sent out	Receiver has not received reflected signal.	Buzzer turn off
Signal is sent out	Receiver has received reflected signal.	Buzzer turns on for 1 minute goes off.

5. Conclusion

The ultrasonic intruder detection system with SMS feedback was designed and constructed as an innovative device that is active in detecting an intruder and alerting the owner. The ultrasonic intruder detection system device can be used at homes, schools, churches, etc. It will promote security of lives and property with rapid prompting.

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