International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 12 No. 1 Nov. 2014, pp. 65-69

http://www.ijisr.issr-journals.org/

Design and Construction of a World-Wide-Mobile-Call-Back Burglar Alarm System

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ABSTRACT: This paper presents the design, construction and testing of a world-wide-mobile-call-back burglar alarm system. The principle of operation of this burglar alarm is based on that of a Passive Infrared Sensor as motion detector to sense movement of people, as well as, versatility of an Arduino board and a Global System for Mobile Communications Shield. When the motion of a person is detected by the PIR sensor, the alarm is triggered and a signal is sent to the Arduino board which in turn activates the shield. The shield interfaces with mobile network whose Subscriber Identity Module is used to make call to a pre-programmed mobile line of a property owner. The received call from the particular line thus alert the property owner and/or security personnel of the presence of an intruder on the monitored property.

KEYWORDS: Motion, Sensor, Arduino, Programmed, Shield, Module, Global, Alarm.

1 INTRODUCTION

Security of live and properties is an aspect of existence that cannot be handled with flippancy. Individuals, Corporate bodies and Governments desire to know the conditions of their properties every second daily despite the disperseness of these properties across the globe.

Alarms as the name implies are used to alert in the event of any situation that is a threat. There are several kinds of alarms [1]. A security alarm is a system designed to detect intrusion – unauthorized entry – into a building or area. Security alarms are used in residential, commercial, industrial, and military properties for protection against burglary (theft) or property damage, as well as personal protection against intruders. Car alarms likewise protect vehicles and their contents. Prisons also use security systems for control of inmates. [2]

Burglar alarms systems are increasingly being used in private homes, offices, stores and other businesses. They have become standard equipments especially in stores, warehouses etc. The system is also suitable for use in jewelry stores, artifacts in museums and for safe guarding drawings, paintings and sculpture in art galleries and also to detect unauthorized access. [3].

2 MATERIAL AND METHOD

My design uses; among others; Passive Infrared (PIR) Sensor, 555 Timer, Arduino board (Arduino Uno) and Global System for Mobile Communications (GSM) Shield, Subscriber Identity Module (SIM) cards, mobile phone. In this work the modular approach - where the overall design was first broken into functional block diagrams- was employed and each block represents a functional section of the circuit that performs a specific function, as shown in Fig. 1. below and depicts the interconnection between these blocks. Each section of the block is analyzed below.

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Fig. 1. Block diagram of the burglar alarm system

2.1 SENSOR

A PIR sensor, that is, an electronic sensor that measures infrared (IR) light radiating from objects in its field of view was used as a motion detector.

The PIR-based motion detector was used to sense movement of people; when an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature. [4]

2.2 ALERTING CIRCUITRY

The alerting circuitry consists of LM555 Integrated Circuit (IC) wired in monostable mode; shown in figure 2; to create a minimum time delay of three seconds (≥ 3s). In this mode an external trigger from the PIR sensor causes the 555 timer to output a pulse of this duration into the transmitting circuitry to enable establishment of complete and successful connection.

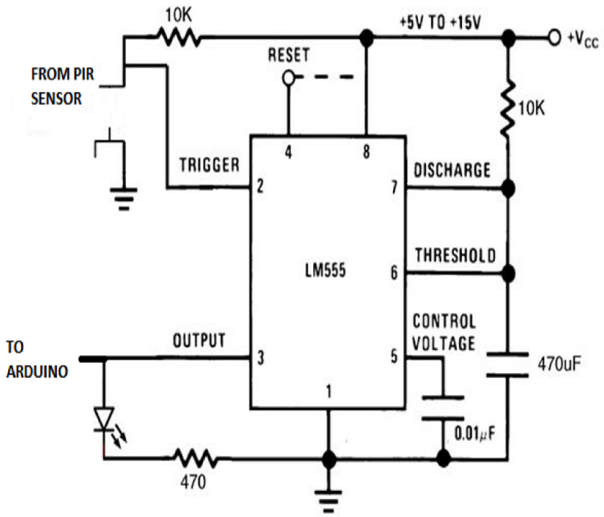

Fig. 2. Circuit Design for an LM555monostable mode

2.3 TRANSMITING CIRCUITRY

The transmitting circuitry was built around an Arduino Uno which was programmed to and capable of communicating or interacting with a GSM Shield connected to it. The GSM Shield in turn; works as a modem; and has the capability of initializing a call to a pre-programmed mobile phone of a property owner; through a SIM card of a preferred communication network provider inserted into it.

2.4 INTERFACE

GSM is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity. Macro cell is regarded as a cell where the base station antenna is installed on a mast or a building above average rooftop level which are very common within our environment. [5] These masts, Fig. 3a, serve as antenna holder and an interface

through which the GSM shield communicates with base stations, Fig. 3b, and through which the base station communicates with the property owner's mobile phone.

Fig. 3a. Communication Mast

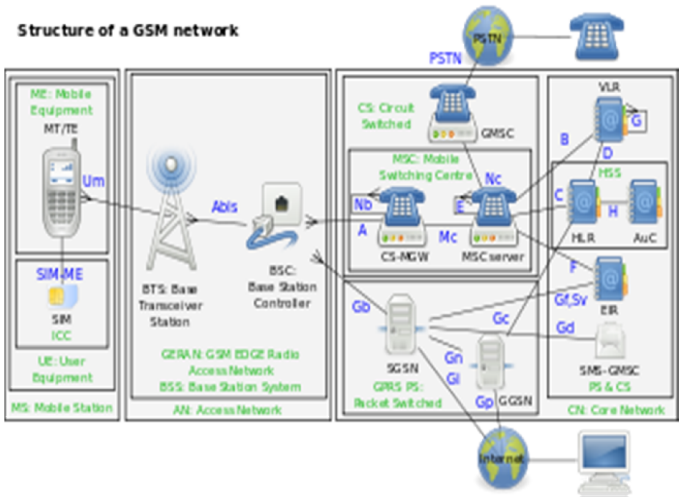

Fig. 3b. GSM network structure

Sources: [5]

2.5 MOBILE ALERT

Mobile Alerts is the last section of this system. Readily availabilities of mobile phones of different types and specifications makes this system realizable and complete, though any phone that can received calls can be used here. Once the alarm is triggered a call is initiated by the alarm system and this call is received on the owner's phone, having pre-stored the incoming mobile SIM number on her/his phone, he/she is able to identify where the call is emanating from.

Discussion on power supply to the circuit is omitted.

3 CONSTRUCTION AND TESTING

The world-wide-mobile-call-back burglar alarm system was constructed in accordance with the circuit and block diagram illustrated by Fig. 1. The design was simulated on electronics work bench [6]. The testing followed the modular pattern used in the design with each functional block being tested as described below.

The sensor stage was tested for the output voltage level, using the multimeter. It was wired to an LED via a 220Ω resistor and worked perfectly.

The monostable circuit was, tested and gave a time delay of about 5.1s, then connected to the transmitting circuitry which was built around an Arduino Uno programmed to communicate with a GSM Shield connected to it. Into the GSM shield was slotted a SIM card – of a preferred network provider – that had already being programmed with a property owner's number to be dialed or called on detection of an intruder.

The entire circuit was checked for short circuit and open circuit faults that could result into problems and later tested by allowing a person to move in front of the PIR sensor, shortly after this, a call was received on the phone whose line was programmed to be called indicating accomplishment of the aims of this paper.

4 RESULTS

The system has been implemented as described above. The following results were obtained for the processing time, Table 1. and Fig. 4; for which the Alarm System was triggered, as human distances (u) from the sensor and the time (t) it takes for a call to be received on the property owner's mobile phone were considered.

Table 1. Alarm test for different distance

HUMAN DISTANCE, u (m)	TIME, t (s)
10.00	-
9.00	22
8.00	20
7.00	19
6.00	18
5.00	15
4.00	15
3.00	14
2.00	13
1.00	13

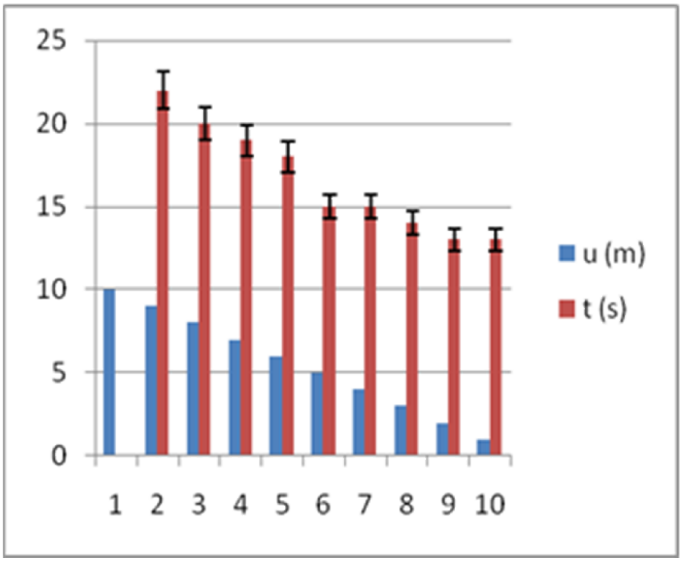

Fig. 4. Processing time

Fig. 4. above, shows that at a distance of about ten meters (10m) away from the PIR sensor nothing happened which might be due to combination of several factors like variation in component makeup, GSM network problem and so on, though at distance slightly shorter than 10m, the response was perfect. It is also clear that distance from the PIR sensor affects the processing time of the system, that is, the closer a person is to the sensor, shorter time it takes to be alerted of trespass of an intruder. Hence, Initial tests suggest that this method of burglar detection is effective. The Arduino Uno is small and light weight and the whole system is portable.

5 CONCLUSION

Conclusively, the basic goal of this project was met; a world-wide-mobile-call-back burglar alarm system that calls property owner's mobile phone anywhere he may be in the world has been designed, constructed and tested. It is suitable for residential or official property, supermarket, artifacts in museums, jewelry stores and art galleries security. This burglar alarm is thus very good for safe guarding valuable properties, so the owner can call a neighbor to check happenings on her/his property or inform police directly.

5.1 RECOMENDATIONS

This work is not without its limitations as its accuracy and sensitivity is dependent on the service performances of GSM network provider, it is therefore, recommended that communication networks keep improving on their service provision level.

This alarm system could be programmed to call Police distress line directly as well and relay a pre-programmed message with the address of the burglary scene for better efficiency, that is, save time and police can terminate burglary at its earliest stage.

For wider coverage in more practical situations, it is recommended that a multichannel and multi-sensor programming is possible with this system to monitor different locations of an apartment together. It could also be adapted to monitor other alarm conditions like, fire, heat and smoke, flood and so on.

Above all, there is no gainsaying in recommending that provision for a security alarm system should be included in the electrical services design of every house, industry, office and shops/store.

ACKNOWLEDGMENT

Thanks to Mr. O. Olasoji for layout training, Mr. Sunmonu for the usage of his laboratory, as well as, Mr. O.R. Bello and Dr. S.S. Oluyamon for always being there, in the course of this work. And, to my adversaries for keeping me on my toes.

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