



Global Advanced Research Journal of Educational Research and Review (ISSN: 2315-5132) Vol. 13(1) pp. 001-005, January, 2025
Available online <http://garj.org/garjerr>
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DOI: 10.5281/zenodo.14641599

Full Length Research Paper

Design and Implementation of a Remote Home-Based Security System Using Arduino Mega Software

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Accepted 10 January, 2025

The need to protect home facilities has in recent times being a matter of great concerns to individual and government, considering the dramatic rise in crimes such as house theft, robbery kidnappings and rapes among others. Advancement in technology has enhanced the ubiquity of smart home security systems resulting in safety of lives and properties and by extension improved standard of living. The emergence of cheap and affordable microcontroller, like Arduino has enabled the design and implementation of a remote home-based security system that enhance comfort, energy saving, and convenience of home appliances. The study designs and implements a remote home security system that uses cheap hardware and software such as Arduino boards, passive infrared sensor, highly sensitive camera, GSM modem, Buzzer alarm, SD card, jumper wire and a 9v battery among others to collect information from PIR sensors, process the information and send SMS to corresponding GSM mobile phone number of the homeowner. The choice of Arduino mega was due to it affordability, user-friendly, good memory size and large number of input/output pins that guarantee accuracy and reliability. The working principle of the PIR motion sensor is based on changes in the infrared level emitted by surrounding objects when an intruder moves around a house. The microcontroller is programmed on the open-source Arduino Integrated Development Environment, which makes it easy to write code in C-like language and verifies test cases. The remote home-based security system using Arduino mega software is capable of integrating appliance and equipment automation with minimal energy that ensure home safety.

Keywords: Remote home, Arduino, microcontroller, sensor, security system

INTRODUCTION

Security is an essential requirement that determine how human beings live and their conduct routine activities on the earth. The safety of lives and properties are fundamental right that every responsible government

should provide to its citizens. Today, we live in a society where crime rate has risen astronomically owing to economic crises occasioned by poverty, illiteracy, corruption, starvation among other factors. There are lot of incidences of theft, rape, robbery and kidnapping carryout in broad daylight or when everyone is asleep at night (Abdullahi, 2021). Thus, various kind of development in the technology field is designed to provide security at all times

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to goods and humans wherever they may live. The proactiveness of the security personnel to incidence of crime at homes are limited owing to inadequate funding, manpower shortage and poor intelligence gathering techniques. Unemployment is another key factor that accounted for growing number of crime and criminal activities within our society. The need to conveniently protect our houses and properties has been a subject of great discuss at both local and international fora. Consequently, efforts are made by stakeholders to convert normal homes into a smart home using a carefully designed automation system that is proactive, low-cost and flexible to different conditions or weather. Home automation consist of automatic control of lighting, electrical fittings, temperature and other appliance that enhance living standard (Shehu, 2019 and Wasiu, 2022).

Home automation system are designed to guarantee safety, convenience, comfort, security in addition to energy efficiency by integrating sensor that will monitor various parameters and actuators that carry out predetermined tasks. In Nigeria and other developing nations, an automated security network is needed to provide security when the user is away from home or in workplace through technology that generate and send information easily and quickly in a systematic manner. Thus, the use of Short Message Service (SMS) through mobile phones that can perform remote function of sending and receiving messages at faster speed and low cost. Based on the increasing crime across human society mostly in day time or at night, an integrated security system is required that will be able to send information without using personal computer and can monitor situations at home quickly and cheaply (Zeglier, 2020). Thus, the use of C- programming language especially the Arduino program can guarantee two-way communication with home user mobile phone when there is a security breach or unauthorized access. This is best achieve using buzzer for voice recognition, microcontroller for detection and monitoring, and a sensor for relative communication among electronic devices. There is urgent need to develop a remotely controlled home based security device that is highly scalable and efficient with basic features that safeguards the resident comfort and ensure safety of home appliance. Thus, the designed system consists of sensors and appliance actuators to respectively sought information from home and control the environment using Arduino microcontrollers.

Statement of the Problem

The inability of home users to access and control the security of home appliance from remote location is one of the major reasons for unauthorized access and untoward incidents like fire outbreak, theft and other discomforts associated with human abode. These challenges lead to loss of lives and properties worth millions of Naira due to the activities of men of the underworld. Thus, the

emergence of cheap microcontrollers like the Arduinio has enabled the implementation of a low-cost smart home security systems that employed features that are capable of transmitting signals and information through smart phone to home users. One way of achieving safety at home is the use of an open-source electronic platform such as Arduino application as the user interface and transmission of signals between home devices and users. Hence, the need to design and implement remote home-based security system.

Objective of the Study

This paper was conceived on the following objectives which include to design and implement remote home-based security device using Arduino mega software that controls various actuators based on the data gathered by multiple active and passive component sensors installed at strategic location. It improves the quality of life and convenience of home users at workplaces or in any part of the town/city. The objective of the paper also includes to fast-track and control home appliances using mobile phones/devices such as tablets, laptops especially by elderly and people with physical challenges.

Literature Review

Studies on the design and application of home automation system using Arduino software had been seen as revolutionary step in curbing insecurity and violence particularly at homes, offices and business premises. This development has reduced the burden of workload on security personnel by providing sufficient details about crime and criminal activities (Ado, 2018; Segun, 2020). In a similarly study by Dangana and Joseph (2021) on the viability of developing and implementing technology-based security device for home/office protection in semi-urban communities. The study affirms the case of a motion detection, where ultrasonic sensor is normally used. The point indicator can be used in the coercion of a criminal alarm, theft or illegal access of individual at certain point such as door on window. This provides immediate information of unauthorized access/intrusion of homes and business premises by Vandals.

The importance of smart home-based security system has continued to gain acceptance in view of its ability to monitor and protect home appliances and gadgets using Arduino mega software. One of such studies was conducted by Yusuf (2022) on the efficiency of an intrusion detection system on home safety and was implemented using the GSM module, serve motor, buzzer, light-dependent resistor and a light emitting diode. Thus, the system was run using Arduino codes to drive the hardware and trigger light, sand and SMS to the home owners. The designed system was able to lock and unlock doors, detect intruders using passive infrared sensor and send appropriate signals on the security situation of the home

environment. The finding of this study shows that the infrared sensor can detect obstacle and generates an interrupt signal which is then send to the speaker to alert the user. Thus, the device functions as an electronic watch dog for residential, commercial and industrial apartment.

METHODOLOGY

The design of a Remote Home-based Security System (RHSS) consists of a voice recognition system that controls the switching of lights (bulbs and florescent), the opening and closing of windows and doors, automation of electronically based folding of bed. To effectively achieve these operations, it is important to monitor parameters such as rain, gas leakage, temperature, humidity, presence and movement of people in the room in addition to the alternating of day or night condition. To develop a remote home-based security system, an open-source Arduino board, web-based security application, GSM module, Passive Infrared (PIR) sensor, Piezo Buzzer will be needed. The integration of the rain, light intensity pressure, temperature, motion sensors are essential so that the data acquired by these sensors are displayed on an LCD screen in order to get the home owner information about the parameters being observed. Thus, data is processed by a microcontroller which accordingly sends command to various actuators to take appropriate action depending on the value of the controlled conditions. The RHSS collects all information from 2 PIR sensors, process the information and send SMS to corresponding GSM mobile phone using modem. The use of 2PIR sensor for more accurate when detect any obstacle at covered areas sensors. If the PIR sensor detects obstacles, then the controller capture image to SD Card after that Arduino controller active Buzzer alarm and thus communicate with the user through SMS. A schematic block representation of the organization of component and their interfacing is shown in figure 1.

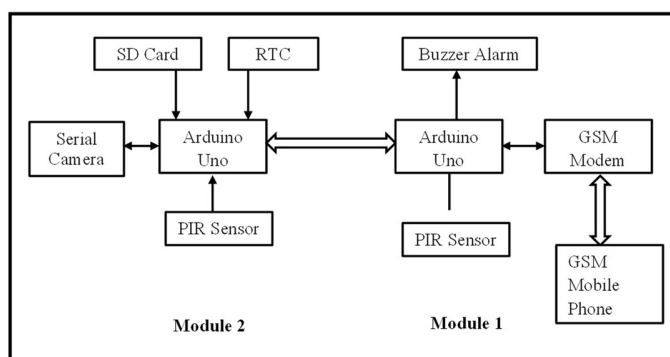


Figure 1. Schematic representation of a Home Security System proposed

A remote home security system is usually made up of two essential components that is the control centre and the subsystems. The control centre is made up of the Arduino board which is the central processor for the security system designed. It has a prototype board that can be programmed with an easy-to-use Arduino integrated development environment that honsed relevant software needed to interact between devices and the home owner mobile phone. The Arduino IDE employs the program to convert the executable code into a text rule in hexadecimal notation. The board has essential hardware and software needed to read inputs-light on a sensor, a finger on a button or a twitter message and turn it to an output.

The subsystems are other tiny electronic hardware that are either attached or soldered to the control center. They include ultrasonic sensor, GSM module, jumper wire among others. The ultrasonic-sensor is used to measure the distance of a target object by emitting ultrasonic sound waves, and then covert the reflected sound into an electrical signal. This wave travel faster than the speed of audible sound. The presence of transmitter and receiver in ultrasonic sensor platform guarantee safety and cohesiveness of the signals.

The jumper wire is used to connect two points in a closed circuit. All electronics stock jumper wire in a variety of lengths and assortments. The jumper wires are in varied degree of thickness and thermal conductivity. Thus, the jumper wire is frequently used with bread board and other prototyping tools to effectively change circuit for optimal performance.

The GSM shield SIM 800, SI 750, SIM 550 is variety of GSM modem that can be integrated into a great number of internet of things. The GSM shield is capable of performing all functions of a normal cell phone such as sending and receiving SMS, calls and above all, support squad-brand GSM Network.

The Buzzer alarm is the DFRobot buzzer unit that is able to control sounds generated within the control center. The unit can generate sound through arduino controller instruction.

The Passive Infra-Red (PIR) sensor has a voltage measuring device potentiometer that calibrate distance and delay time. The PIR sensor requires 100NA – 150NA and voltage conditions of 3v-5v to operate with high precision and speed.

The serial camera is a JPEG colour camera module with DSP image processing to generate 320*240 or 640*480 JPEG image, picture stored in internal buffer and transferred via UART port.

The arduino software was used to articulate and manage resources via arduino controller through series of program downloaded via select "Arduino from Tools > Board menu. The AT mega 310 has a bootloader that allows smooth upload of new code easily. The communication and transfer of signals are done via STK550 protocol.

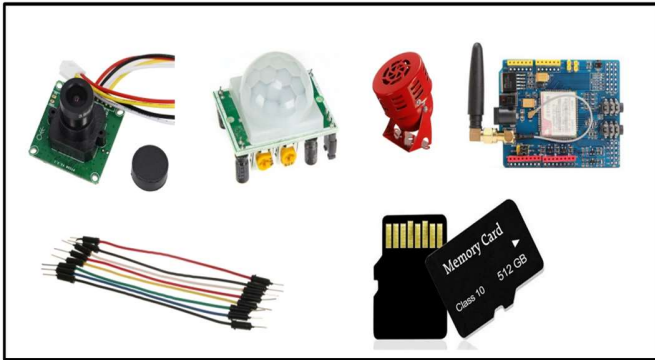


Figure 2. Diagram showing relevant components of RHSS

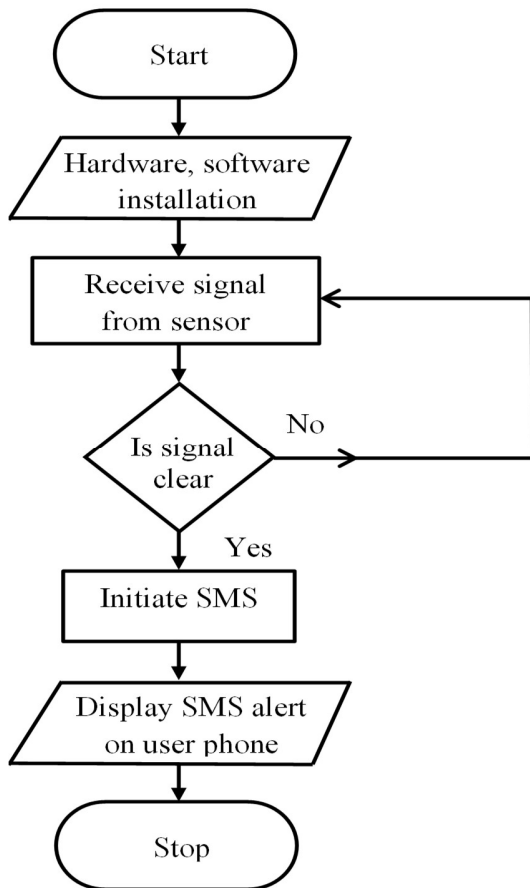


Figure 3. System flowchart for RHSS configured

A flowchart for the configured Arduino controller and essential requirements needed for it functionalities, logical sequence and implementation procedure is shown below

Table 1. Result of test cases of remote home-based security system

S/No	Test	Expected Decision	Result shown
1.	Intruder within home environment/premise	Image captured and trigger SMS alert	SMS "intruder within home"
2.	Intruder at home	Trigger SMS alert and buzzer alarm	Home-user attention drawn SMS "intruder at home"
3.	No intruder close by or at home	Surveillance SMS alert not initiated	No message display

RESULT AND DISCUSSION

The proposed home security system was designed and tested to determine its correctness and operational efficiency of each subsystems using various circumstance to ensure its works as intended. The voice recognition module, the Arduino board and buzzer were successfully implemented using spoken words, push buttons switches or a smart phone via the internet. The result of the study shows there is a good communication between the system security and the galaxy tab via SMS. The PIR captured any attack on home facilities by intruder, as the funding revealed that logical condition and decision statements are error free using variable test data. The actual result of this study was obtained from 3 test cases within the study environment.

From the result in the table 1. above and other sufficient testing, the RHSS has met the design objective and implementation by carrying appropriate monitoring function for protection of lives and properties. It shows the expected outcome/result of the study is favourable and within acceptable limit.

CONCLUSION

The need for a cheap and easy-to-use home-based security device for protection of lives and properties against robbery, theft, kidnapping and other crimes at homes have been acknowledged by individual, government and concern citizens across the globe. Thus, the design and implementation of RHSS as electronic watch dog using Arduino microcontrollers, sensors, PIR, GSM phones, buzzer, stepper motor, jumper wire,

ultrasonic sensor had significantly improved safety of properties within homes and can be used for business purposes. Results from test cases has proved the efficacy and efficiency of the RHSS usage as an essential home security device. It can be improved upon by using a technological standardized GSM module that enhance faster and easier transmission of signals in addition to combating security sophistication.

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