A Critical Review for Blooming Multi-Home Alarm Structure for Mobile Technology

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Abstract—The paper is presenting development of a microcontroller-based multi-home alarm system that can be detect smoking. Addition of local materials are considered. The text message is displayed by developed prototype whenever smoke or intrusion was detected. Developmental research design was used to come up with a working prototype of the designing. For testing the smoke alarm, the system was exposed to different burning materials such as paper, wood, plastic, cloth and rubber; and to test the intrusion alarm, the system was placed at different distances. Based from the findings of the study, all materials acquired locally were able to function properly. The system was found to be consistent and efficient with data transmission, processing and reception. Response time of less than 20 seconds for smoke alarm and less than 2 seconds for lock mechanism were recorded. The system instantly sent notification messages to the user after fire and proximity sensors were triggered.

Index Terms: Mobile technology, smoking detector, smoking alarm, microcontroller, US sensor, ionization sensor device.

I. INTRODUCTION

Theft and fire are two life tragedies that are sometimes unavoidable, but because of technology, theft and fire can be prevented. In 2012, 78,092 crimes against property in the Philippines were recorded by the National Statistics Office which included robbery, theft, carnapping and castle rustling. In the same year, 8,798 fire incidents in the Philippines were recorded which were caused by faulty electrical connections and electrical appliances, open flame due to torch, unattended cooking or stove, lighted candles, gas leak and explosions [1].

Early detection of fire and intrusions can minimize the damages to the home owner. As the saying goes, "If there is smoke, there is fire." One of the common preventive devices used in determining the presence of fire is a smoke detector or alarm system. Fire or smoke alarm system was defined as any devices that warn occupants of the presence or danger of fire to enable them undertake immediate actions [2]. The primary goals of this system are to protect life, property, business and environment. These goals were accomplished by smoke alarm system through early detection of fire, limiting spread of fire and smoke, occupant notification and notification of emergency forces [3]. On the other hand, intrusion detector is used to minimize cases of theft. Intrusion alarm system is used to detect any attempt of breaking in into residences. In designing such system, more sophisticated motion detectors may be used. This may also employ same alarm and notification principles as fire or smoke alarm systems [4].

Some literary reviews were considered in the study which provides the proponents knowledge of home alarm system designs. Javale *et al.* presented design also implementation of automation system that can monitor and control home appliances using android phone or tablet [5]. Azid *et al.* studied about the performance of a home security system based on a low cost Short Message System (SMS) equipped with sensors and controlled by a microprocessor through the SMS [6]. Guan noted in his study that response time was one of the most important technical parameters for smoke detector [7]. Manjula *et al.* project implemented a security system with a feature of motion and password detection. Using GSM the administrator was informed through SMS about the people moving into the secured places in order to take necessary actions which saves time during emergencies Oke *et al.* paper presented the development and implementation of a Global System for Mobile Communication (GSM) based control system for electrical appliances which enables control to it [9].

Although there were some existing home alarm systems, the study still aimed to develop a cost effective home alarm system that integrates smoke and intrusion alarms. Notification was based on GSM technology where user can receive alarm notification and can process actions such as triggering the lock mechanism and contacting appropriate departments.

II. OBJECTIVE

The aim of the study was to integrate intrusion and smoke alarm systems, and to develop a cost effective prototype of a multi-home alarm system that can send notification to users using GSM technology. Small scale simulation tests were conducted to determine the response time of the prototype.

III. METHODOLOGY

Developmental research method was used in the study to come up with a working prototype of the system. It was comprised of hardware and firmware designs. Hardware design consisted of ardware assembly, interface, testing and troubleshooting; and firmware design consisted of writing codes using C-language programming, error debugging and testing.

Fig. 1 shows the block diagram of the system. It was divided into modules to easily troubleshoot and detect errors. 9Vdc was used to power the system. A back-up battery was included in case of power interruption. When the ionized smoke sensor detected smoke or the ultrasonic sensor encountered any disturbances in its signal, data was transmitted to the microcontroller unit to trigger the GSM to send a notification message to the owner. In case of intrusion, the owner can reply to the system to alarm and lock the door. However, in case of fire, the alarm unit was immediately activated. comprised of green, red and orange LED. The green LED indicated that the system is powered on while the red LED indicated that the system is ready to send message. Blinking orange LED indicated that the system is searching for network signal. For smoke detector, red and green LED were used. Red LED implied smoke was detected within the sensors range. However green LED implied that no ions of smoke were detected. Buzzer was also included for alarm.
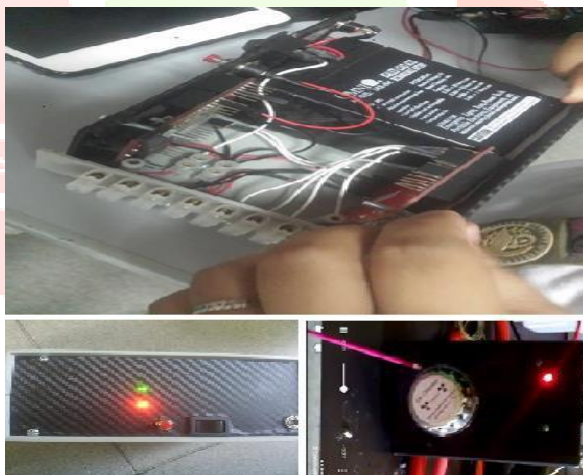

Figure 1. Project structure of the multi-home alarm system

To test the system, it was exposed to different materials that can cause fire at home as shown in Fig. 2 and the ultrasonic sensor was obstructed as shown in Fig.3. Three trials were conducted and the response time of the sensors was recorded.
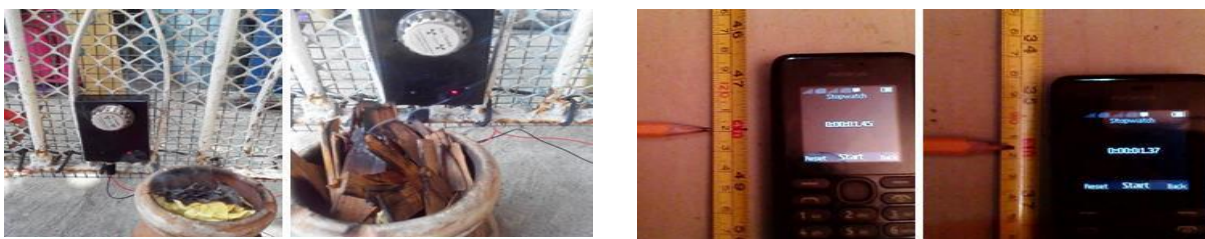
Figure 2. Test set-up for the smoke alarm   Figure 3. Test set-up for intrusion alarm.

Actual connection of the pins of the backup battery, microcontroller, sensor modules and GSM shield module was placed inside a holder. This was done to ensure stability of connections. Light Emitting Diodes (LEDs) were used as indicators. GSM LED indicators were

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IV.   HARDWARE DESIGN

The system was comprised of two alarms, smoke and intrusion. For smoke, ionization type sensor was used as shown in Fig. 4. It is based on ionization from radioactive elements. Alpha particles are emitted by radioactive isotopes into an ionization chamber, comprised of electrodes. The alpha particles ionizes the air inside the chamber, causing current between the electrodes. If smoke particles of fire passes through the chamber, the ions get attached to smoke particles, interrupting the current between the electrodes, and activating the sensor [10].   This sensor is suited for fast flaming fire, cheaper and readily available.

Figure 4. Ionization type smoke sensor used in the prototype.

Proximity sensor shown in Fig. 5 was used for intrusion alarm. The ultrasonic sensor emits and receives sounds. To measure the distance of an object, the emitter sends out a high frequency sound pulse which strikes the objects and reflects back to the ultransonic sensor. Then, the receiver measures the amount of time that it takes the sound to return and uses this data to calculate for the distance [11]. SIM900D was the GSM module used in the system as shown in Fig.5. SIM900D delivers a quad-band GSM/GPRS which can easily be embedded in electronic applications. It has low power consumption and can fit easily in space compact designs [12].

Figure 5. SIM900D module used in the prototype

For the lock mechanism, 9 gram Tower Pro servo motor was used in the design. The implementation of this device was based from its size and rotation. SG90 servo motor is tiny and lightweight which has high output power. This can rotate approximately 180 degrees, 90 in each direction [13].

The microcontroller used was Atmega328. This was selected because of its compatibility with module interfacing, direct program coding and modification. The microcontroller ATMEGA328 with 328kBytes memory capacity stores the program for operation of the system. Backup power supply, SRB-6V4-AH/20hrs was used in the system because of its portability, ability to recharge and considerable energy life span.

V. Firmware Design

Firmware is defined as the low-level software or programs that are written onto programmable device which enables it to determine its capabilities, render them functional, and coordinate operations [14]. In order for the developed prototype to work, the microcontroller should be burnt with a firmware. For the multi-home alarm system, the firmware was programmed using C language. Each module was tested if working properly. When confirmed functioning, the system was programmed and conditions were set.
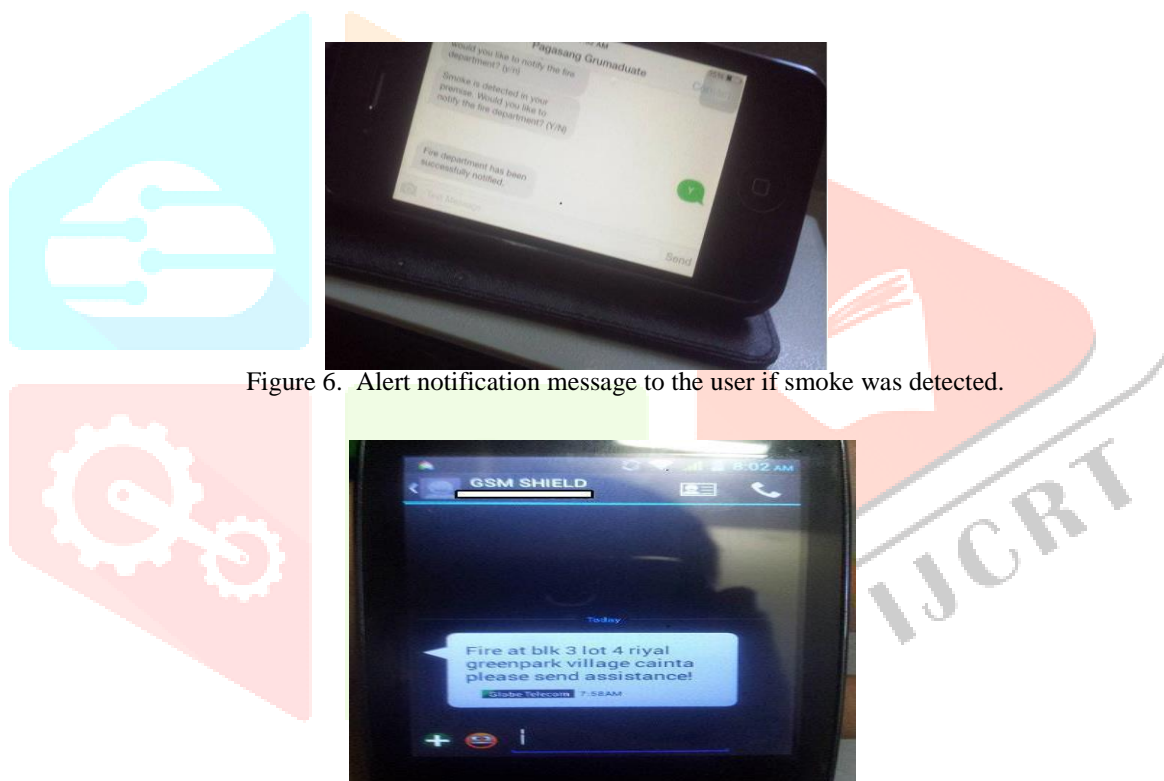

Figure 6. Alert notification message to the user if smoke was detected.

Figure 7. Simulated notification message to the authority

The microcontroller would command GSM to send an alarm message to the user notifying that smoke was detected in the area where it was installed and would prompt the user if he would like to notify the fire department. If the user replied 'Y' (yes), the system would dispatch a text message to concern authority and would reply to the user notifying him of the action as shown in the test simulation of Fig.6. An actual test simulation of the text message sent to authority requesting assistance was shown in Fig. 7.

Fig. 8 shows the flowchart of the intrusion alarm system. A default range for the proximity sensor was set in the program. Once altered, the microprocessor would receive the changes and would immediately dispatch a notification to the user. Simultaneously, the lock mechanism of the device would be activated.
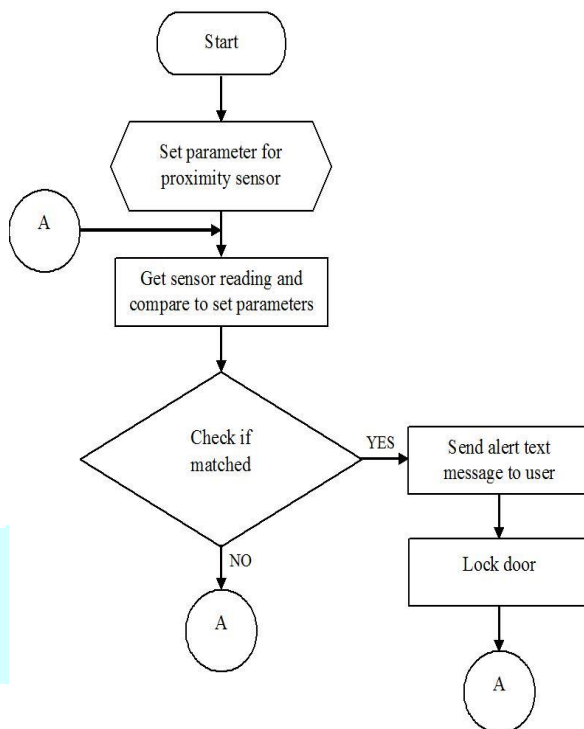
Figure 8. Flowchart of intrusion alarm system

VI. RESULTS AND DISCUSSIONS

   Table III shows the response of the servo motor after an intrusion was detected. The servo motor immediately locked the door after the lock command text message was received by the system.

Table I Intrusion Detection and Sms Notification Test

Distance (ft.)	Response Time (seconds)			SMS Notification
	Trial 1	Trial 1	Trial 1	
1.0	19.6	14.2	1	All Successful
2.0	14.1	15.6	13.2	All Successful
3.0	10.0	13.7	13.3	All Successful
4.0	12.2	18.0	14.7	All Successful

Table II Lock Mechanism Response Time

Distance (ft.)	Response To Intrusion		
	Trial 1	Trial 1	Trial 1
1.0	Instantly	Instantly	Instantly
2.0	Instantly	Instantly	Instantly
3.0	Instantly	Instantly	Instantly
4.0	Instantly	Instantly	Instantly

VII. CONCLUSIONS

Based from the findings of the study, the developed system was cost-effective since all materials acquired locally were able to function properly. It was able to detect smoke and intruder; and was able to alarm and send text message notification to the user. The ability of the system to receive text message command from the user expanded the option for security measures. The system exhibited a consistent quick response time of less than 20 seconds for fire detection and less than 2 seconds for enabling lock mechanism. The system also instantly sent notification messages to the user after smoke and intrusion were detected.

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