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AN IMPROVED GSM TECHNOLOGY-BASED MICROCONTROLLER MULTI-SENSOR HOME SECURITY AND MONITORING SYSTEM

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ABSTRACT

With increasing rate of crime all over the world, and with no pointer to this rate of crime abating anytime soon, home security has now become a major concern. Therefore most people; rich or poor are taking measures from highly sophisticated to very crude methods to prevent intrusion. This work presents a GSM technology-based home security and monitoring system. However, unlike the traditional magnetic switch alarms equipped on doors and windows, this system has incorporated a fire detector, a motion sensor and a moisture (rainfall) sensor. On any attempt of a break in, rainfall or possible smoke or fire a short message service (SMS) is sent to the house owner. The system is built using a programmed microcontroller interfaced with mobile phone (NOKIA 1209) such that the three major buttons of the mobile phone are switched at intervals to send a message to the owner of the house anytime there is an intruder, rainfall or fire accident. The system was tested and it worked on attempt of intrusion, rainfall (water) and smoke.

Keywords:*GSM, SMS, Sensor, Microcontroller, Mobile phone, Intrusion.*

1. INTRODUCTION

Security has always been an unavoidable part of the human lives right from the olden days down to our contemporary world. However security measures taken by Man has evolved over the Ages, from the use of animals like dogs, parrots, and human beings; padlocks, and also alarm systems to highly sophisticated unmanned security systems as we have them today. In the same vein, the methods as well as the amount of intelligence required to achieve the desired result has also changed from the olden days to the present day. Modern day security ranges from motion detection sensor which can be used for door control and to check intrusion, moisture detecting sensor which can be used to detect high degree of moisture or rain from getting into the home to fire sensor which can be used to detect fire accidents when it senses abnormal rise in temperature in the house or even smoke (Mike, 2012).

Communication is a very important aspect of human life.With advances in technology, smart homes now employ the use of communication systems to provide enhanced and efficient security measures to homes. These smart homes have the capability of allowing the home owner control devices with a single system that could either be local or remote (Raghavendran, 2011; Rosslin and Tai-hoon, 2010).

In this work, modern day security techniques and advancements in communication technology have been explored to build an automated security system capable of detecting intrusion, detecting fire outbreaks and also detecting rainfall in the protected building and reporting same through a short message to a mobile phone that will alert the appropriate authorities to take preventive and corrective measures. The rest of work is presented as follows, section two presents the design and implementation, and section three highlights the testing and results while section four concludes the work.

2. DESIGN AND IMPLEMENTATION

The design is made up of three major blocks, the power supply, the sensing section and the Microcontroller/Communication section. Each of these sections is tasked with functions that contribute to the performance of the entire unit. The block diagram of the

home security and monitoring system showing the different aspect of the design is presented in Figure 1.

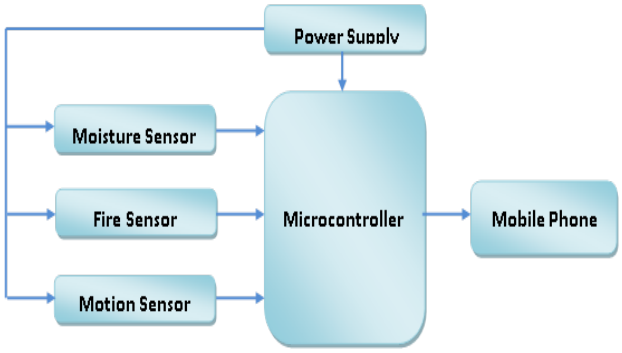

Fig.1: Block Diagram of the Home Security System

2.1. Power Supply Unit

Most electronic devices and circuits require a direct current (DC) source for their proper operation, and a voltage regulator to fix the voltage and make it constant for the load. In line with this principle, the power supply unit in this work was designed to include the following listed subcomponents to achieve a smooth DC for the operation of the system: A step down transformer, a bridge rectifier, filtering capacitors, and voltage regulators as shown in Figure 2.

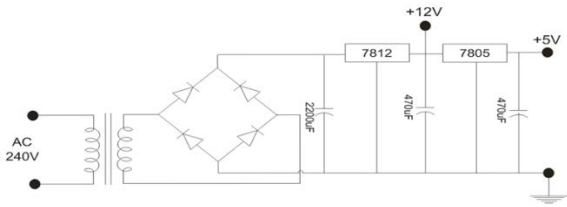

Fig. 2: Power supply unit

Design of Sensing Units

Three separate sensing units were designed in this work, one for preventing intrusion and the other two for monitoring the home. A temperature sensor was used in detecting the accidental occurrence of fire and it works on the principle that any fire accident will immediately increase the temperature of the surrounding environment. A laser-light dependent resistor sensor was used for motion sensing to detect movement in restricted areas. A printed circuit board together with ferric acid was used to make the rainfall sensor for sensing moisture in the home; the preceding sessions explain the design of the different sensing units in this work in details.

Design of Sensing Units

The sensing unit forfire outbreak detection was effectively designed by the use of a thermistor. A thermistor works on the principle of variance of resistance of some materials with temperature. In this work, a Negative-Temperature-Coefficient (NTC) thermistor was used. Its resistance reduces with decrease in temperature, however to set the analog output of the thermistor to a logic output needed for proper operation of the system, a LM555 operational amplifier was used. The circuit diagram of the fire sensing unit is shown in Figure 3.

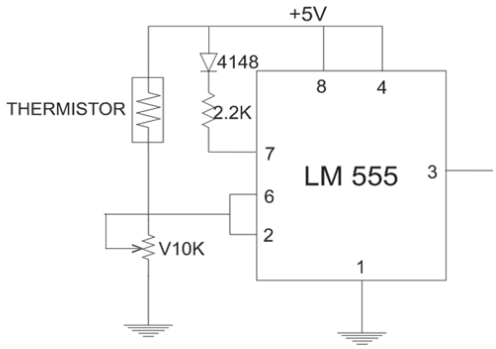

Fig.3:Circuit Diagram Of fire Sensor

Design of Laser Based Motion Sensor

The motion sensing unit was designed by the use of a laser light dependent resistor (LDR). The LDR was connected to a 555 timer that was neither a monostable nor astable connection, because no timing or frequency is required but intrusion detection. The LM 555 is designed to deliver a logic output any time the PIN 2 and 6 is HIGH or LOW, the IN4148 diode is to prevent back flow of current to PIN 7, the variable resistor was connected to set the sensitivity of the LDR, and PIN 6 was loop with

PIN 2 to make its output remain HIGH as long as the PIN 2 is HIGH and LOW immediately PIN 2 goes LOW, PIN 2 needs about 2V to be HIGH while the voltage produced at the output is 5V which was interfaced with the microcontroller for monitoring (Fire Sensor, 2010). The circuit of the motion sensor is shown in Figure 4.

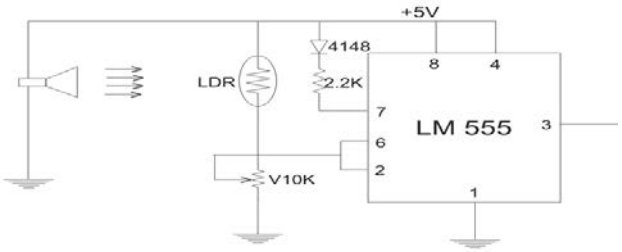

Fig.4:Circuit Diagram Of The Motion Sensor

Design of Moisture Sensor

The moisture sensor was designed by the use of a printed circuit board which was achieved by the use of a software called the printed circuit board wizard (PCB wizard) and ferric acid. The PCB was connected to an LM555 timer that is neither in monostable nor astable connection because no timing or frequencies is required, The LM555 is configured to deliver a logic output any time the PIN 2 and 6 is HIGH or LOW, the IN4148 diode is to prevent back flow of current to PIN 7, The variable resistor was connected to set the sensitivity of the printed circuit board (PCB). The PCB has two terminals one connected to the VCC while the other terminal is connected to the LM555 timer, whenever water touches the board it bridges and that will send an output signal to the LM555 timer which is connected to the microcontroller (Motion Sensor, 2010). Figure 5 is the circuit diagram of the moisture sensing unit.

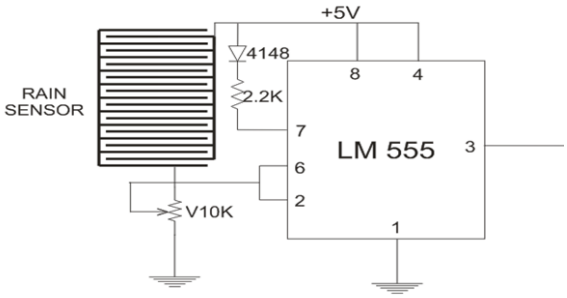

Fig.5:Circuit Diagram of the Moisture (rainfall) Sensor

Design of Output Drivers

Three 12 volts DC relays were used to control the three basic buttons of the mobile phone (NOKIA1209) used; these are the power button, the select button and the scroll down button. The relay is an electromechanical device that deals with electronic and mechanical devices, it has 5 terminals, and terminals 1 and 2 are the coil of the relay while terminals 3, 4, and 5 are Normally Closed (NC), Common (C) and Normally Opened (NC) respectively. If current flows through the coil, the Common will disconnect from the Normally closed (NC) to the Normally opened (NC) and if the current should stops flowing the Common (C) will go back to the Normally closed (NC).

Figure 6 is the circuit diagram of the relay switching circuit used in this design, for this work also, two terminals of the mobile phone were used, one terminal was connected to the Common while the second terminal was connected to the Normally Open (NO) of the relay, when current flows through the coil from the microcontroller, the Common (C) will disconnect from the Normally closed (NC) to the Normally Opened (NO) thereby pressing the required button of the mobile phone (Mehta and Mehta, 2006).

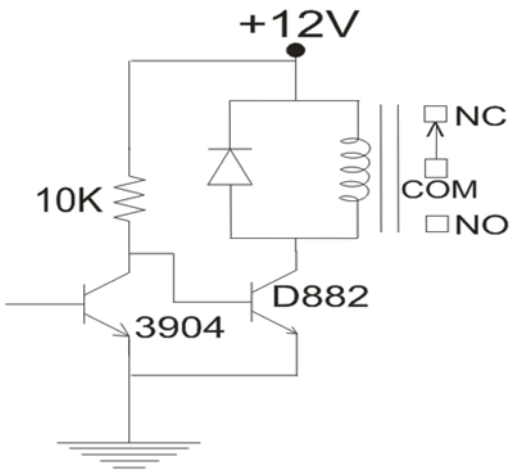

Fig.6: Relay Switching Circuit For The mobile phone

Microcontroller Unit

A microcontroller is a single chip that contains the processor (the CPU), non-volatile memory for the program (ROM or flash), volatile memory for input and output (RAM), a clock and an I/O control unit. This unit acts as the control or brain of the entire system and is responsible for interpreting the messages sent from the sensing unit and sending the appropriate message to the mobile phone. The microprocessor used for this work is **AT89S52** and it belongs to the **8051** family.

89S52 Microcontroller

The **AT89S52** is a low-power, high-performance **CMOS 8-bit** microcontroller with **8K** bytes of in-system programmable flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard **8051** instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile **8-bit** CPU with in-system programmable Flash on a monolithic chip, the Atmel **AT89S52** is a powerful microcontroller, which provides a highly flexible and cost-effective solution to many, embedded control applications.

The **AT89S52**shown in figure 7 provides the following standard features: **8K bytes** of Flash, **256** bytes of RAM, **32 I/O** lines, Watchdog timer, two data pointers, three **16-bit** timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the **AT89S52** is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt (Muhammad *et al*, 2005).

For this work, the **AT89S52** microcontroller was interfaced with Nokia (1209) GSM mobile phone to decode the received message and do the required action. The protocol used for the communication between the two is Assembly Language. The microcontroller pulls the SMS received by phone, decodes it, recognizes the Mobile number and then sends a message to the Mobile number.

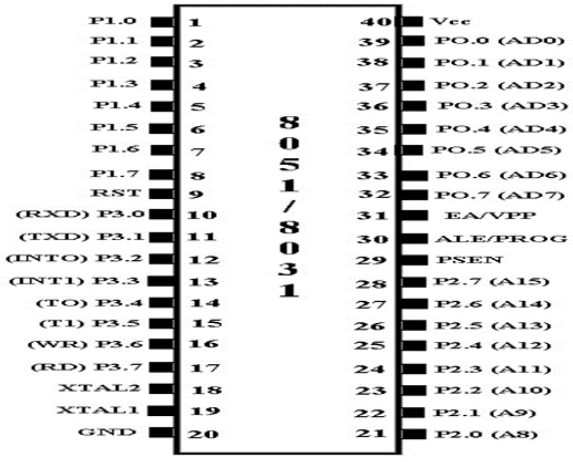

Fig. 7:Pin diagram of the 8051 Microcontroller

The Microcontroller was programmed with the use of assembly language and simulated by the use of edsim51

software before finally burning it on the chip. Figures 8 and figure 9 are the diagrams of the flow chart of the program and the complete circuit diagram of the design respectively.

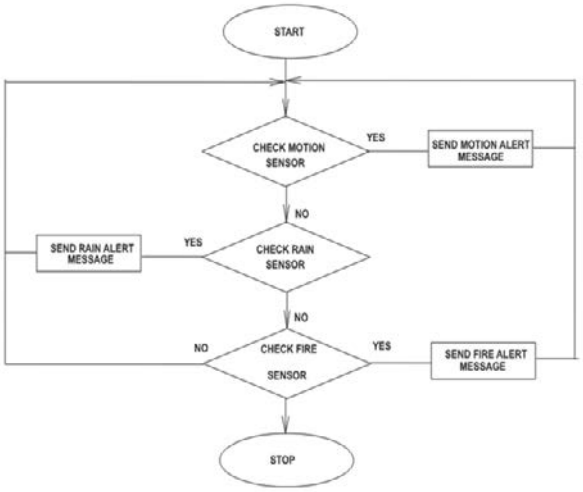

Fig. 8: Program Flowchart

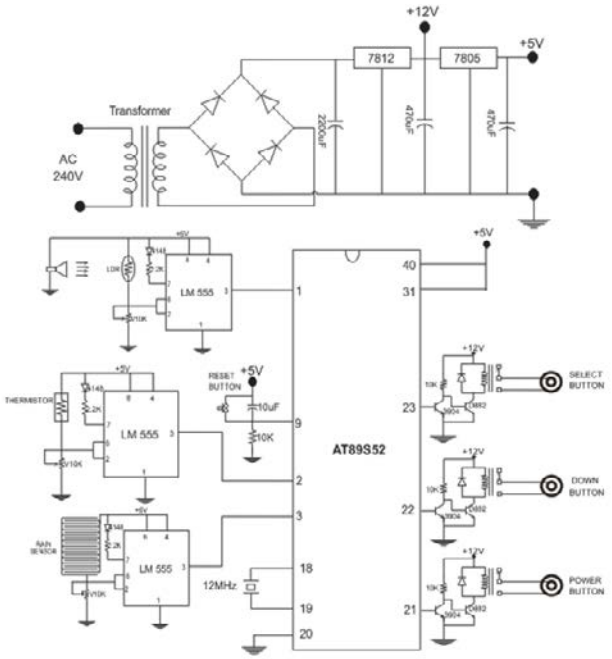

Fig.9:Circuit Diagram

3. RESULTS AND DISCUSSIONS

Performance test was conducted between the system interfaced with the NOKIA (1209) phone and the phone of the owner of the house after connecting the circuit appropriately to check if the circuit will be able to send a message to its appropriate destination if there was to be intrusion, fire accident and rainfall to the owner's home.

3.1. Fire Sensor Test

Heat was put very close to the thermistor and temperatures monitored by a thermometer are recorded and the responses of the system were recorded. Table 3.1 present the results of the test carried out on the fire sensor.

Table 1: Fire sensor results

Test	Temperature (degree Celsius)	Message sent
1	0	No
2	10	No
3	20	No
4	30	No
5	40	No
6	50	Yes
7	60	Yes
8	70	Yes
9	80	Yes
10	90	yes

3.2. Rainfall Sensor Test

The printed circuit board of the rainfall sensor was left without moisture **(0)** and no message was sent. Then water was dropped on it **(1)** and it triggered the LM555 time which sent a message to the microcontroller, then the microcontroller with the help of the relays pressed the mobile phone that now sent a rainfall alert message to the owner of the house. Result is presented in Table 2.

Table 2: Rainfall sensor test

Test	Rainfall senor	Message sent
1	0	No
2	1	Yes

3.3. Motion Sensor Test

The laser-light dependent resistor was faced in the direction of light without obstruction **(0)** and no message was sent. Then an obstruction was put over it **(1)** and it triggered the LM555 timer which sent a message to the microcontroller. The microcontroller with the help of the relays pressed the mobile phone and an intruder message was sent to the owner of the house. Table 3 shows results obtained.

Table 3: Motion sensor result.

Test	Motion senor	Message sent
1	0	No
2	1	Yes

4. CONCLUSION

An improved GSM technology-based microcontroller multi-sensor home security and monitoring system has been developed. Test were performed and the system showed a capability of informing a remote owner through an SMS message of an intruder break in, a fire outbreak and rainfall (water) entering an apartment. The SMS sent highlight which of the eventualities have occurred. Extensive test confirms that the system performs accurately and can prevent colossal damage to live and properties.

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