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Design and Development of ARM-7 based Home Security System with GSM Technology

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ABSTRACT: Wireless communication is often require in the filed of telemedicine, household security and industrial safety. Applications of latest technologies in the field of wireless embedded systems have proved very remarkable results. House hold security is one of major concern topic. The paper proposes the design & development of ARM-7 based system which facilitates the information about household safety parameters like Fire/Smoke, LPG gas leakage and intruder sensing etc through SMS or voice call alert information through GSM technique. The developed system uses Fire/Smoke sensor, LPG gas leakage sensor and infrared based intruder sensing mechanism. The system automatically sends SMS or Voice call alert information to concerned person's cell phone if any one of the sensor enables. Thus the developed system can be readily used for a household safety and security application.

Key words: GSM modem, Fire/Smoke Sensor, LPG gas leakage sensor, Infrared intruder sensor etc.

I. INTRODUCTION

The word automation or automatic control is used for controlling of various systems or operating equipment like control of machinery, process control in factories, monitoring of temperature in boilers and heat treating ovens, switching systems in telephone networks and other applications with less human intervention. The advantage of automation is lies in saving of labor cost, energy and materials which will also improve quality, accuracy and precision. Automation can be achieved by including various components like mechanical systems, hydraulic & pneumatic systems, electrical & electronic systems etc. The dedicated Embedded Systems or standalone embedded systems suffers with a drawback that they are rigid, such systems puts restriction on movement of the operator and needs physical presence to control and monitor the processes or parameters [1, 2, 3]. For short distance wireless communication such automated systems for monitoring and controlling of various processes & parameters reported by researchers [4, 5]. The constraint of such systems is distance between transmitting & remote terminal. Other method of very short distance communication method adopted by some researcher by using Bluetooth technology [6]. Then people have started to work on unlimited range of communication technologies by making use of GSM & GPS for various applications [7,8]. The wireless communication techniques have given better results as compared to the wired systems. The home security & safety are two main major concerns. There are many applications & embedded devices to monitor the security and safety of the home. This proposed system is developed on ARM-7 TDMI core processor which has the GSM connectivity. Varieties of sensors have been used as far as home safety & security is concerned like LPG gas leakage which is one of the dangerous safety parameter which also causes heavy damages to the house if not monitored. Fire/Smoke sensor which is used to sense the fire or smoke arises due to electrical or burning of any other inflammable material which is also to be monitored. The third one is intruder sensor or entry of unauthorized persons entry in the house has to be sensed. The system senses any abnormalities in theses sensor values by enabling a particular sensor and sends appropriate SMS or Voice call alert to the owner of the house by using the wireless GSM connectivity.

II. THE SYSTEM OUTLINE

The home automation and its security system is also one of the major challenging area. Security of the home is at most concern subject.

Today's latest technologies have been in use for pool proof security. The home security involves some critical parameters like LPG gas leakage system, fire/smoke alarming system, theft & intruders monitoring system. Many sophisticated techniques and systems are now available for this purpose. Latest Controllers, sensors, video cameras and loud buzzers are used to address these issues. Recently, very comprehensive and error free systems are available, which are both accurate and cost effective. Further, they are highly reliable and compact. Such a system essentially makes use of a Microprocessor or Microcontroller. We have used ARM-7 Microcontroller which is the most advanced processor of today's technology. In this project an attempt is made for the "Design & Development of an ARM-7 based embedded system for home security". The developed system uses a Philips LPC -2148 flash programmable 16/32-bit ARM-7 based microcontroller for the precision control of various sensors. This is automatic, compact, reliable and low cost system. The scheme used in this project can be implemented to a home security which involves LPG gas leakage alarming, fire/smoke alarming and intruders alarming system.

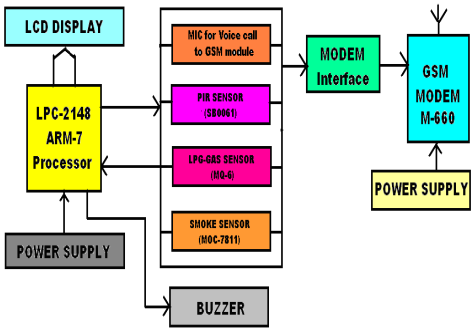

Fig.1. Block diagram of the proposed system.

The system also uses the GSM technology for communicating any unwanted incident to the owner of the house through SMS and voice calling technique.

III. DESIGN OF PROPOSED SYSTEM

The hardware components of this proposed system consists of general components of a standard embedded system & few of which are as follow:

3.1. LPC-2148-ARM-7 Microcontrollers
3.2. GSM Modem (M-660)
3.3. Smoke Sensor (MOC-7811)
3.4. Passive Infra-red Sensor
3.5. Liquid Crystal Display (LCD)
3.6. LPG-Gas Sensor (MQ-6)
3.7. Buzzer
3.8. RS232 Interface
3.9. Power supply unit

3.1:Microcontroller LPC2148: The LPC2148 microcontroller is a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. 128-bit wide memory interfaces and also enables 32-bit code execution at the maximum clock rate. Because of small size and low power consumption, the LPC-2148 is best suited where compactness is an essential requirement. It has a USB 2.0 full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB upto 40 kB. It also includes inbuilt 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC etc.

Dual band GSM modem: This MODEM is a wireless modem which can send and receive data through the GSM network. It needs a subscriber identity module (SIM) card and connectivity to the GSM network. It has built in TCP/I. The communication between this modem & embedded system is done by suing AT commands. This modem works on two frequencies i.e. 900 MHz and 1800 MHz for up-linking and down-linking. Therefore it is also called as Dual band GSM MODEM. It works with RS232 standard with the help of TTL level converter.

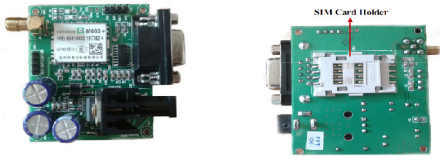

Fig. 2. Image of GSM Modem.

Subscriber Identity Module: The Subscriber Identity Module (SIM), popularly known as a SIM card. It is a detachable smart card having the user's subscription information and phonebook.

Short Message Service (SMS) Short Message Service or (SMS) is one of the most commonly GSM facility for text information transmission. Because this facility of GSM is a cheap, convenient and flexible way of conveying data.

3.3: Smoke Sensor (MOC7811): - It is a smoke detector sensor. It consists of an infrared emitting diode facing a photo detector. There is a slot in between the emitter and the detector for interrupting the signal. This sensor operates when smoke is produced by a fire affects the intensity of a light beam passing through air which can block/obscure the beam. It will also cause the light to scatter due to reflection off the smoke particles. They are designed to sense smoke by utilizing these effects of smoke on light.

Fig.3. Image of Smoke sensor

3.4: Passive Infrared Sensor (PIR): - Passive Infra-Red Sensor is a pyro-electric sensor that identifies motion by measuring changes in the infrared levels emitted by surrounding objects. These motions can be detected by checking for a high signal on a single I/O pin. The sensor has the following features.

1. It has single bit output
2. The size of sensor is very samll

* it is compatible with all types of micro controllers.
* It works on 5V to 20V DC with less than 100uA current.

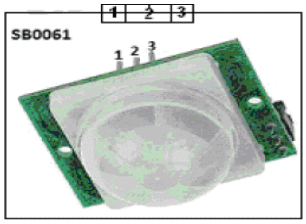

Fig. 4. Image of PIR Sensor.

This type of sensor, have crystalline material inside which generates an electric charge when exposed to infrared radiation. The changes in the amount of infrared striking the element change the voltages generated, which are measured by an on-board amplifier. It includes a special filter called a Fresnel lens, which focuses the infrared signals onto the element.

3.5: LCD Display Unit:- It is a low-cost, low-power display device capable of displaying text and messages. It is a 16x2 character display unit. It is very commonly used in many embedded systems for display purpose

3.6: LPG Gas Sensor MO-6:- MQ-6 sensor is used as LPG gas leakage detecting sensor in this proposed system. It also detects the other gases like iso-butane, propane, LNG. Thus prevents the nuisance of alcohol and cooking fumes and cigarette smoke. It consists of micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. This sensor has 6 pins, 4 are used to fetch signals, and other 2 are used for providing heating.

3.7: Buzzer & Buzzer driver circuit:- A buzzer is incorporated with its driver circuit to indicate time out situation in the voting process, the timing is drawn from I2C Real Time Clock.

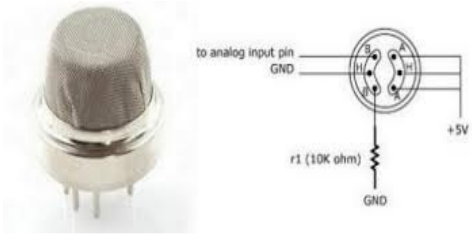

Fig. 5. Image of MQ-6 LPG sensor (Top view & Bottom view).

3.8: RS 232 Interface: - RS 232 is an essential interface between a GSM modem and a developed embedded system. To make use of this RS 232, a TTL level converter MAX-232 is necessary. It is a 9 pin D type male and female connectors.

3.9: Power supply unit: - The power supply consists of a step down transformer, rectifier, filter & a regulator. A well designed power supply unit certainly improves the system performance.

IV. SYSTEM OPERATION

As soon as the system is powered ON, the processor automatically executes the system program stored in EPROM. The LCD displays welcome message, initializes the GSM, indicates the signal strength and scans the output of the sensors. All three sensors 1) Smoke sensor 2) LPG gas sensor and 3) intruder sensor produces analog signal and hence they are connected to the ADC which is inbuilt with ARM processor. The ADC starts receiving the analog signals from the sensors and reads these signals by successive approximation method and converts them into digital data in real time mode. The processor sends the current status of the sensor in the form of digital information to LCD for local display. In case of any abnormality in the sensors like ignition of fire/smoke, leakage of LPG gas & unknown person's entry in the house will enables the sensors due to which the corresponding status will be displayed on the LCD. As the designed system is incorporated with GSM technology, which facilitates an alert SMS will be sent to the owner's cell phone. As soon as the SMS is received by the owner, a voice call connection will be established between the system and owner's cell phone so that, any body present in the vicinity of the system can talk and give information about the status of the sensor.

V. SOFTWARE IMPLIMENTATION

The system software is written by by using C and embedded C in micro vision Keil-4 software. Then the hex is downloaded in the ARM core by using Flashmagic software. The system software does not uses any generalized operating system program, as the developed system is a dedicated embedded system.

VI. EXPERIMENTATL RESULTS AND DISCUSSION

The developed system was very rigorously tested in the laboratory by enabling various sensors. Firstly a fire/smoke is created near the smoke sensor MOC7811. The system immediately gave buzzer alarm and sent SMS message to a test SIM card of a cell phone apart from making a voice call to that number. Similarly we have tested the LPG gas leakage sensor MQ-6 for this, we have used electronics lighter to sense the leakage of LPG. Lastly infrared intruder sensor, for this, if you create an obstacle in between infrared transmitter & receiver, it will be sensed. The large sized embedded systems certainly create the space problem and is tried to solve in the proposed system by implementing very compact, low power consumption ARM-7 processor. It was proposed to reduce the size of the embedded system by implementing compact high performance ARM7 and to reduce the power consumption and also allow the system to automatically take the status of sensor output & inform to the concern person without distance limitation between transmitter & receiver with the use of GSM mobile technology for wireless communication. From the above discussions it is clear that the system is automatic, wireless, portable and communicates the status of sensors to the authorized person's cell phone thus provides security & safety of the home.

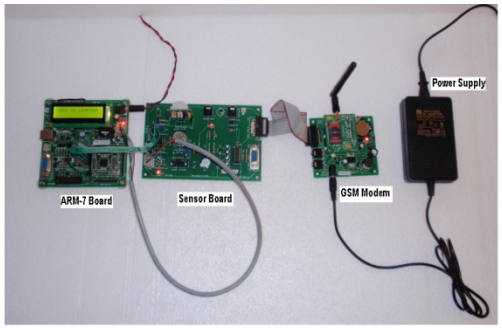

Fig. 6. Photograph of experiment.

vii. CONCLUSIONS

In this project an attempt is made to design & develop an ARM-7 based home security system with SMS and voice call alert. In this system the home security is equipped with three sensors that is a LPG gas leakage sensor, a fire/smoke detection sensor and a intruder sensor.

As and when any sensor is activated, like fire, smoke and unauthorized entry of a person (intruder), the system displays the results on the display and also sends SMS to the authorized cell phone. It also automatically makes a voice call to that number. The necessary hardware & software is developed for interfacing. The developed software is stored in the flash memory of the ARM microcontroller which reduces the hardware of the system. The three parameters have been monitored with simple circuits. Hence, the developed system is very compact, reliable & low cost.

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