HOME BASED FIRE MONITORING AND WARNING SYSTEM

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Abstract— **Fire is a very dangerous situation and it is very much necessary to monitor and give warning before anything untoward happens. In many developing countries, houses do not come fitted with fire alarm system as seen in developed countries like Singapore, USA etc. This results in fire being unattended and leading to lot of losses like property, human and so. Also in developing countries like India, we do not have any strict laws pertaining to installation of Fire Alarm system in all homes for alerting Fire Service personnel for action.**

So there is an urgent need towards developing an automated Fire monitoring and warning system which plays an important role in maintaining and monitoring the safe environments and situations. However the usability of many existing fire alarm system is well known using Vision based Camera but could only be produced with high cost. Also currently these high cost system cannot be deployed in all average income homes in developing countries.

So taking these above mentioned aspects into consideration, we here have developed a Home based Fire monitoring and Warning System using Arduino Uno R3 which is economical and affordable by all. The system here detects fire during the existence of smoke or flame at a particular level and also towards alerting the property owner efficiently and quickly via GSM.. All these activities are controlled by AtMega microcontroller of Arduino. This system would help all the users at any level of income to have one at their home and it also saves from the great losses and damage which might happen due to fire.

Keywords—GSM, ATMega, Arduino

I. INTRODUCTION

Fire hazards can be very dangerous and cause human loss. The only solution to mitigate these losses is responding to such emergency situation quickly. In developed countries like USA, Singapore etc, it is government rule to install fire alarm in all homes towards alerting home owner's and Fire service personnel in time for action. Such kind of Fire Alarm system doesn't exist in developing countries like India which result in lot of losses and damage.

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In such situations, detecting the fire well in advance and alerting would reduce losses of property and life. A fire or smoke alarm system can be monitored locally or remotely as appropriate.

Remote alarm system [1] provides the benefit of monitoring the premise from a distant location and taking immediate action based on message received unlike manual system. These Remote monitoring systems [2-4] can be developed in various ways using technologies like wireless sensor networks, Ethernet, image processing and other digital communication technologies. Though these systems are reliable and have lot of advantages, there are still lots of concern being complex, incompact, non-standalone, expensive and having redundant appurtenances. So there is need for developing a system that is reliable and responsive as well as simple, easily implementable and cost effective from point of view of household in developing countries.

Fire hazards cause woebegone incidents throughout the world, especially in the developing countries where the fire-safety measures are precarious and often inadequate. Although a number of advanced systems are used in practical scenarios [5-7], a reliable, easy implementable and cost-effective automated fire-alarm system is not available. The existing fire alarm system in market nowadays, is too complex in term of its design and structure. Since the system is too complex, it needs regular preventive maintenance to be carried out to make sure that the system operates well. Meanwhile, when the maintenance is being done to the existing system, it could raise the cost of using the system. Therefore, the developed FAS are designed with a low cost microcontroller and all level users can have one for a safety purpose. So there comes the need for an standalone and autonomous fire detection system which could quickly detect the fire, raise an alarm and also at times initiate fire extinguishing too.
The systems equipped with LM35 Flame sensor that can detect unfavorable accidental situations, as it happens, and with the help of a processing unit can alert instantly via GSM and buzzer for undertaking cautious measures at the premises.

The entire system been developed using Arduino Uno Microcontroller, LM35 Flame Sensor and GSM SIM 900. The rest of the paper is organized as follows. Section 2 talks on Literature Review pertaining to research work. Section 3 talks on hardware and software design pertaining to Fire Monitoring and Warning System. Section 4 gives the implementation of Fire Monitoring and Warning System using Arduino and GSM. Section 5 is the conclusion and Future Work

II. Literature Survey

In this section, review on fire detection technologies and prevention system been discussed. Most of the fire detection technologies are categorized into two groups which are Vision based and Sensor based. These are all discussed in detail in this section

A. Automatic Fire Detection System

With the increase in number of surveillance cameras for fire detection, vision based fire detection [5-7] become with the equipment sets became highly popular. The reason being these vision based system does not incorporate additional hardware budget. The challenge in video frame detection based approach is that it is not suited for early stage fire detection for the fact that there might be only smoke or minimal fire flames only. So accordingly these video frame detection [5-7] based approach can be misled in detecting fire correctly and alerting.

Also as smoke is grayish and semi-transparent, the edges of high frequency images can lose their sharpness and hence give a wrong indication of fire. In addition smoke is distinguished by checking the variations of background color tones, segmentation of smoke colored pixels, blur background, illumination etc. But the challenge in this system is that it is not possible to distinguish between foggy weather and smoke. So towards overcoming this issue, motion analysis employed which include vision based technique to detect smoke accurately.

But with the deployment of sensors like gas sensor where fire can be easily detected even before inflammation based on type of gas being leaked. These sensor based fire detection techniques are easy to install, cheap and can be deployed easily too.

Now computer based fire detection are combined with sensor network giving more attractive approach. However it could increase the expense, complexity of the system towards installation and deployment.

B. Fire Detector's Review

Heat or Thermal detectors are most primitive one's which works based on fixed temperature only. These detectors get activated based on a predefined temperature or in some case if there is an abnormal rise in temperature. These detectors are quite reliable, inexpensive, easy to maintain and have lower false alarm rate. The challenge with these detectors is that they are quite slow that by the time information reaches the damage could already been underway. So these detectors have limited usage only.

The other detector is the smoke or gas detector which is relatively newer invention and been used during 1970s and 80's. These detectors detect the fire during the early stages which is flaming or smoldering stage. These detectors come with different operational principles which are optical or photoelectric detectors, ionization detectors, air sampling detectors etc. Each of these types has specific applications in specific circumstances.

Photoelectric or optical smoke detectors consist of various components which are a light source usually an infrared LED and also a lens towards converging light rays into a beam and a photodiode. In normal circumstances, the light beam passes straight. But in case smoke intercepts the path of light, the fraction of lights gets scattered into photodiode accordingly the smoke detector gets activated. This method detect fires that begin with long duration of smoldering.

Lastly Ionization smoke detectors are based on radioactive element like americium-241. In this the radioactive isotope emits alpha particles into an ionization chamber which consist of electrodes.

III. System Design

Fig.1 shows the developed Fire alarm where temperature sensor unit placed inside the arena or premise. These sensors are connected to the control un it by means of a data input line. So when the sensor detects any anomaly which is smoke or fire, the control unit activates the local siren and GSM module. The alarm message is sent in the form of short message as SMS trough the GSM module to concerned personnel and fire station nearby for action.

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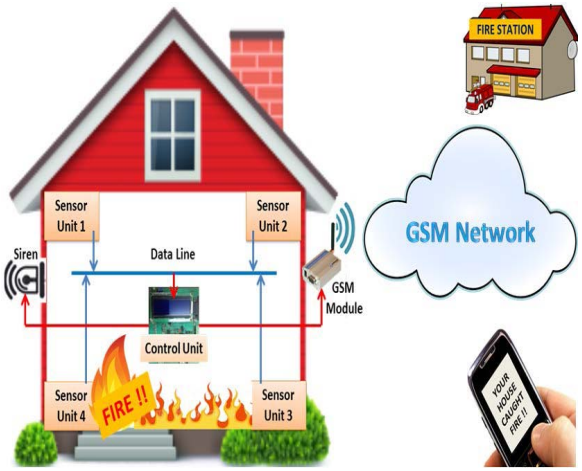

Fig.1. Home based Fire Alarm System Design

A. *Hardware Design*

The hardware of the system mainly comprises sensor section, control unit, network module, and power supply.

B. *Arduino Processing Unit*

Arduino is a microcontroller board providing a platform for controlling the signal/input from various sensors and other modules. It provides an open source platform independent IDE that allows the programmer to process the electronic signals from attached components and control them. One of the most popular Arduino is Arduino Uno which is an 8 bit Atmel AVR Microcontroller with a clock speed of 16 Mhz. Last but not the least, these boards are not expensive and have a very active developer's community. These are shown in Fig.2

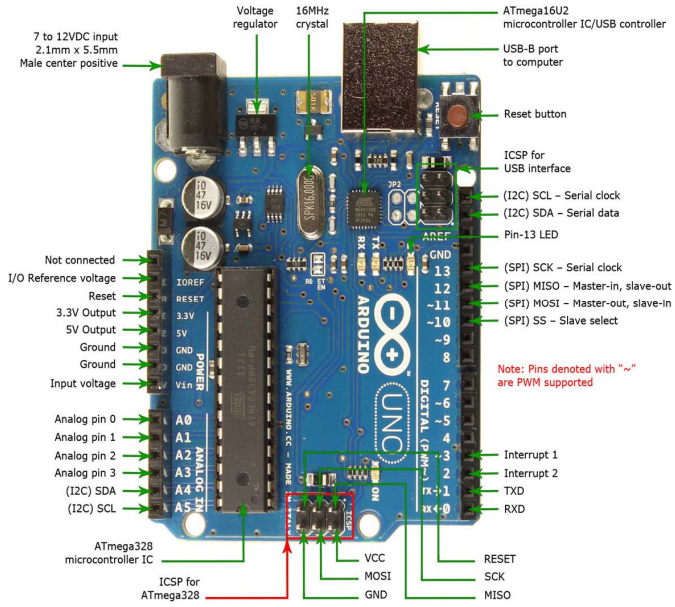

Fig.2. Physical outlook of Arduino Uno R3

C. *Flame Detection Modules*

In this sensor, the output voltage is linearly proportional to temperature measured in centigrade. The output of LM35 sensor produces an analog voltage as shown in Fig.3. LM35 sensor module increases the output by 10 mV/˚C. So once the temperature goes beyond the pre-set temperature (50˚C), the module will produce an high output.

Now towards detecting fire, flame sensor module been used which is highly sensitive to fire and flame spectrum. The module here detects the light wavelength between 760-1100 nm which is range of IR light. However the detection range is normally 3 feet and detection angle is 60 which is not that large to monitor a single room.

D. *Control Unit*

ATMega 8L is a low power 8-bit AVR RISC-based general purpose computer which is our control units heart. Tha major advantage of this microcontroller is optimized power consumption, good processing speed, small physical dimension and low cost for this purpose. One digital I/O pin is sued towards getting the status of sensor unit using common data line. The GSM module been controlled using RS-232 serial communication protocol and AT commands as shown in Table I.

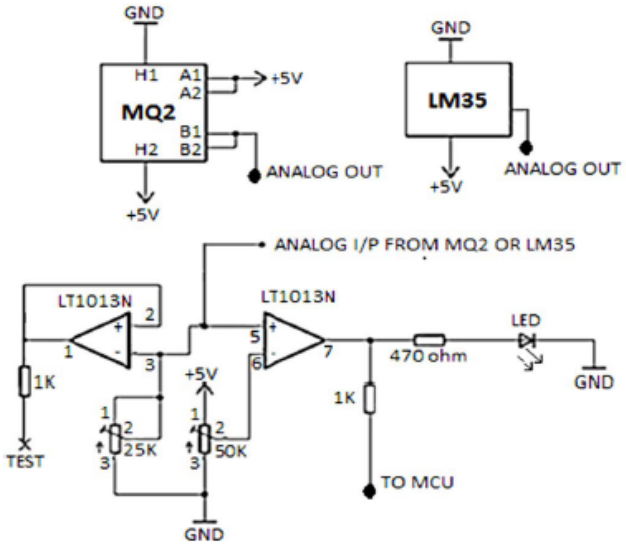

Fig.3 Circuit diagram of the sensor module.

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Table I. List of AT commands

Commands	Description
AT	Status
AT + CREG?	Network registration
AT + CIMI	Request international mobile subscriber identity
AT + CPBF	Find phonebook entries
AT + CMGF	Select SMS message format
AT + CMGS	Send SMS message

E. *Network Modle*

Alert message sent to user's in remote location using Radio Frequency Transmission, Ethernet, GSM. Among these, GSM based mobile network is the most appropriate one and available all through the globe and cost effective.

GSM module mainly requires a subscriber Identification Module called SIM card from the wireless carrier towards operating. Now towards controlling the module and processing the short messages, AT commands are needed which are been defined in the GSM standards. For our work, a SIM300CZ GSM kit has been used . This has been shown in the Fig.4. The GSM module for our work operates on the

850/1900 MHz and 900/1900 MHz frequency bands, which is available throughout the globe.

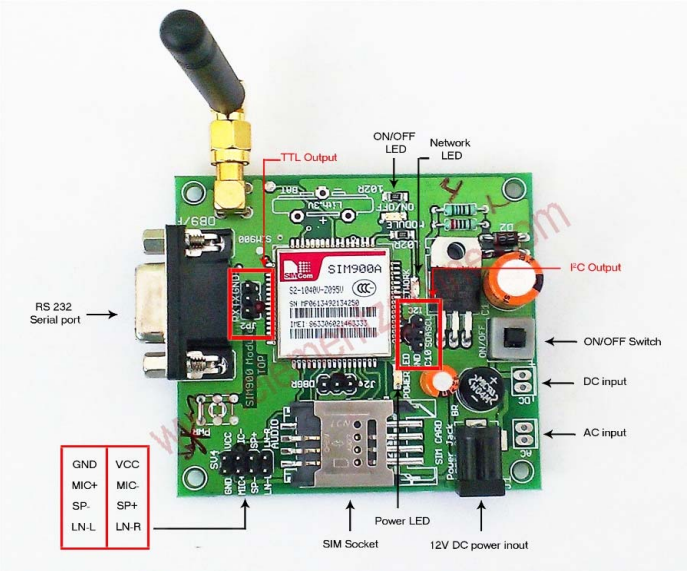

Fig.4 Physical overview of GSM module

E. Software Design

The entire system is been controlled by firmware that is implemented using embedded C and built in micro C Compiler. The software code is downloaded into an 8 bit *Atmega8L microcontroller. Fig.5 shows the Program Flowchart of the system*

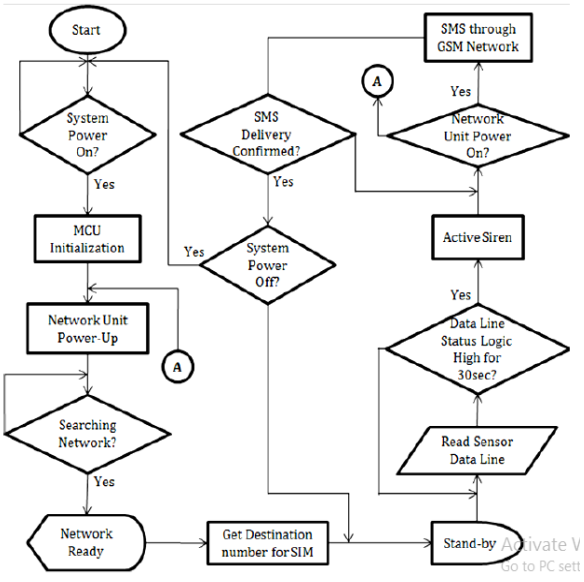

Fig.5 Flow code of the system program

IV. Implementation Using Arduino And GSM

The implementation of Home based Fire monitoring and Warning system been implemented in Arduino Uno. LM35 Temperature Sensor used to detect fire in the premise towards sending warning message via GSM to owner's mobile and ring the buzzer for action. The complete hardware unit of the system is shown in Fig. 6 showing LM35 Sensor, Buzzer, GSM and Arduino board

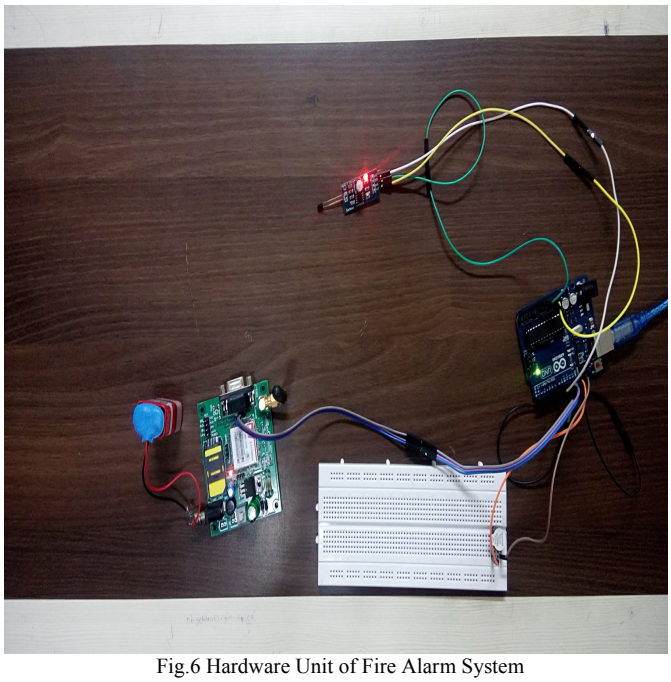

Fig.6 Hardware Unit of Fire Alarm System

To do the experiments, cigarette lighter used as a fire source. Once lighter is lighted, signals sent to microcontroller and trigger the fire incident. The fire detection module can transmit the decision results to mobile phone through the GSM module. The experimental results are shown in various screenshots.

When the flame is brought near the sensor (LM-35), the flame is detected as a physical input. The Flame Sensor acts as a transducer and it converts the physical input to a digital signal. When the physical input has been converted to the digital signal, it is fed into the digital Arduino pin. Further to the digital input which the Arduino receives, it detects the flame and according to the temperature which the sensor detects, the buzzer produces the buzzing sound and immediately the message is sent to the registered mobile number to prevent further damage and loss of property.
Fig.7 shows where the flame is given as a physical input to sensor which converts to digital signal. Based on sensor input, the data is fed to the microcontroller of Arduino which is programmed to signal the buzzer connected to one of the digital output pin of Arduino to activate the buzzer as shown in Fig.8 and accordingly alert sent as SMS to the registered mobile through GSM connected to Arduino as shown in Fig.9

Tests have been conducted towards computing the time taken from Fire module towards sending alert message (SMS) via GSM network by the system. These time responses been plotted and shown in Fig.10. It is seen from the graph that maximum time taken by the system towards delivering

SMS was 10.5 seconds (test no. 9), and the minimum time was 7 seconds (test no. 1 and 6) approximately. It is seen that on an average, our developed system took 7-10 seconds to deliver alert SMS to the concerned authority which is quick to take necessary action to avert the fire hazard.

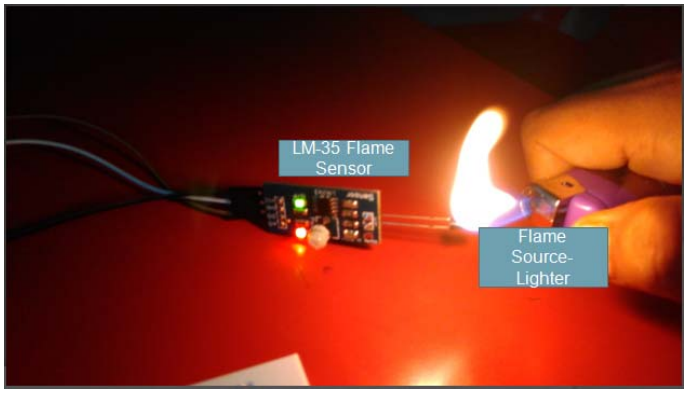

Fig.7 Flame Source to LM35 Sensor

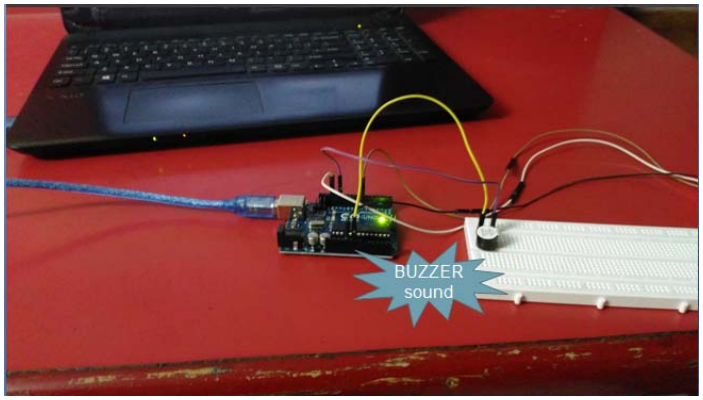

Fig.8 Buzzer Sound Activation

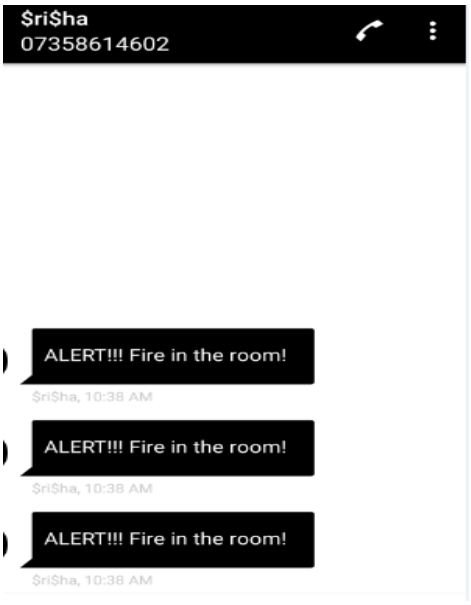

Fig.9 Alert SMS Message

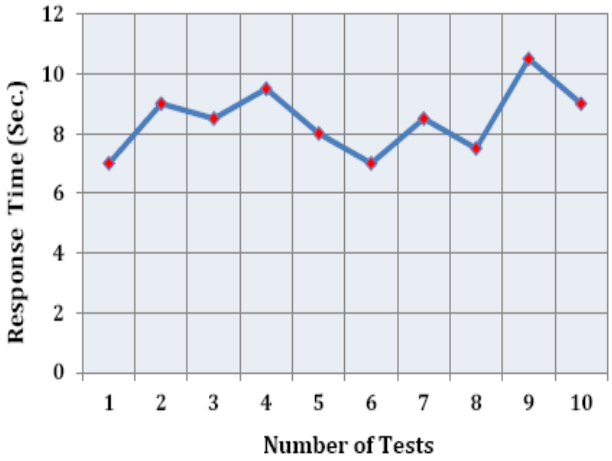

Fig.10 System response time

V. Conclusion & Future Work

Fire warning system is important system towards securing homes and organization. Lot of research work and system developed towards Fire warning system which includes vision, image processing and so. But all these systems are not economical and affordable by every home owner in developing countries. So accordingly we here have developed an Arduino based Fire monitoring and alarm system for home owner's primarily as to protect homes from any property loss , human loss from fire incident. This system driven by Arduino is economical and cheaper which can be deployed in all homes. The system implemented in Arduino allows the LM35 sensor to sense the temperature and send alert message via GSM to home owner which are shown as screenshots. Also the performance of the system been tested too. The designed systems have coverage up to 100 square meter area. The system can be further developed with added features with intelligence towards analyzing the intensity of fire and accordingly communicating not only to home owner's but also nearest fire service personal for attention. In addition the system should be interface with web server interconnect, fire area tracking and fire extinguisher interfacing etc. Lastly the Government should impose rule that automatic fire extinguisher system must be installed in all homes to protect invaluable lives and assets from fire and assure safety

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