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SMART FIRE DETECTOR AND SMOKE EXTRACTOR SYSTEM WITH GSM TECHNOLOGY

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ABSTRACT: Fire outage is one of the phenomena that still pose a serious challenge to the security of lives and properties. Fire, being an important process that affects ecological systems across the globe has both positive and negative effects. It has been used by humans for cooking, generating heat, signaling [7] and propulsion purposes. However soil erosion, atmospheric pollution and hazard to life and property are majorly the negative effects. This paper presents a special and efficient system for detecting the fire and reducing the casualties. In this paper we present the implementation of two sensors. One is Thermistor [9] as a temperature sensor and second is TGS gas sensor as a gas leakage detector circuit. Thermistor has the property of decreasing resistance when the temperature increases which leads to detection of fire. Now when the fire is detected using the detector circuit the system will give response to extractor circuit to start the extraction of smoke so that visibility can be increased and people does not suffer from suffocation. During this process system will also send a message to the fire department regarding number of men and vehicles needed on the spot. At this point GSM system comes to the rescue and message is sent through it. Along with that, message will be displayed on LCD screen in the building to evacuate the building as soon as possible. This paper presents a cost effective system that detects fire and extracts smoke saving lives and properties.

KEYWORDS: Fire detection, smoke extraction, GSM technology, messaging system, LCD display, thermistor, Cost effective.

I. INTRODUCTION

A typical fire alarm control system shall be capable of detecting fire and transmitting it to central monitoring station. Fire points (detectors or sensors) communicate with fire alarm control unit. As part of compliance in case of any fire related event information need to be communicated to monitoring station for just in time response.

Nigeria, like any developing country, is witnessing an era of rapid economic and social development. This development brings with it, new technologies, new materials, power sources and telecommunication equipment. Modern industries [8] are springing up housing volatile materials and highly sophisticated equipment that increase the menace of fire. Concern for safety of lives and properties calls for an efficient and dependable fire protection system. This has enhanced the application of new technologies in the fire field. .According to the National Fire Protection Association (NFPA) website, "In 2010, there were 1,331,500 fires reported in the United States. These fires caused 3,120 civilian deaths, 17,720 civilian injuries, and $11.6 billion in property damage. It is also estimated that in the United States a fire department responds to a fire every 24 seconds ". Looking at these statistics we see that fires in homes and buildings are a part of our daily lives.

Although we cannot stop the fire always, we can do a lot in terms of detecting it, at its early stage. The resulting damage can be minimized and lives can be saved if fire gets detected at its early stage and fire station can send the rescue team on time.

II. MOTIVATION

Fire can be deadly dangerous and can destroy homes, take hundreds of lives, burn the whole building down as well as pollute the air with emissions harmful to human health. Fire impact [5] on people, property and the environment in all countries around the world. In some cases, the resulting losses are extraordinary, causing hundreds of deaths, widespread damage to property and contents and significant impacts on the environment. More often, fires may cause a single casualty or affect a single home, though the effects are still highly significant to those affected and collectively are substantial. Looking at all these statistics we thought of a system that will be cost effective and will help developing countries like India to reduce the causalities caused by fire.

II. METHODOLOGY

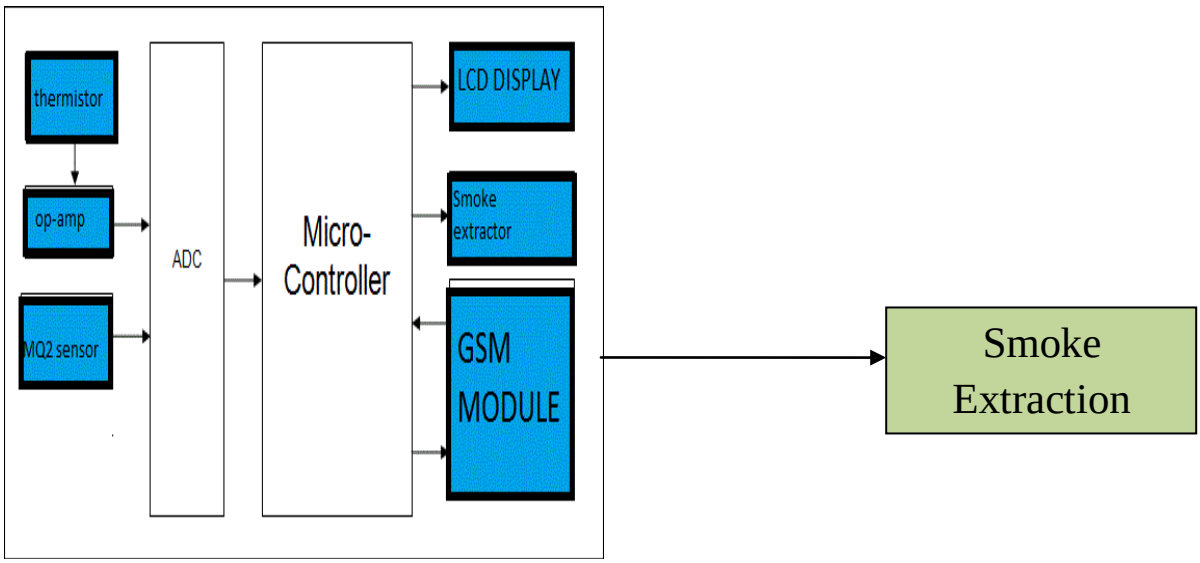
The fire alert design has been built around techniques for digitalizing analogue signals obtained from transducers [4] used to monitor (i.e. sense) temperature of the room and the smoke intensity in the room. The room temperature to be monitored, being analogue, is measured through the use of a thermistor, while the smoke intensity in the room is detected using MQ2 Smoke sensor [9]. The thermistor resistance decrease with increase in temperature and this would cause a decrease in the voltage input to the non-inverting input of the comparator thereby causing the voltage reference set at the inverting input to be greater. In this state the comparator outputs a LOW, to indicate high temperature (i.e. fire). While in gas sensor the gas diffuses into the sensor, through the back of the porous membrane to the working electrode where it is oxidized or reduced. This electrochemical reaction [1] results in an electric current that passes through the external circuit. In addition to measuring, amplifying and performing other signal processing functions, the external circuit maintains the voltage across the sensor between the working and counter electrodes for a two electrode sensor or between the working and reference electrodes for a three electrode cell. At the counter electrode an equal and opposite reaction occurs, such that if the working electrode is an oxidation, then the counter electrode is a reduction.

IV. LITERATURE REVIEW

According to the National Fire Protection Association (NFPA) website, "In 2010, there were 1,331,500 fires reported in the United States. These fires caused 3,120 civilian deaths, 17,720 civilian injuries, and $11.6 billion in property damage. It is also estimated that in the United States a fire department responds to a fire every 24 seconds ". Looking at these statistics [6] we see that fires in homes and buildings are a part of our daily lives. To solve the problems caused by the fires, several safety measures have been put in to place to reduce the number of fatalities and losses. Some of the commonly used safety devices today are fire alert systems and smoke detectors. Many homes and buildings today have a fire alarm system or smoke detectors that alert the occupants when there is fire. The fire alarms systems [9] alert the occupants of building by sounding an alarm which is loud enough for everyone in the building to hear in order to evacuate. These alarm systems are effective only if the fire alarm can be heard; otherwise if no one is near the home or building, the fire or smoke in the building would go unnoticed. The other major problem created by fire is that it takes the fire department a long time to determine which rooms are occupied and which rooms to extinguish the fire first. Our paper differs from the existing systems by being able to send data to the fire department through messaging (GSM), showing live update of the number of fireman and vehicles to be sent before they get to the scene of fire. It will help the firestation to determine the number of fireman to be sent on the spot. Meanwhile, system will start extraction process of smoke on its own in the building so that fire can be controlled upto a level. When the fire is caught the thermistor's resistance will decrease by

heating leading to detection of fire. Once fire gets detected the extraction process starts to reduce the smoke in the building. And at the same time system will send message to the firestation regarding the fire and number of men to be sent.

SYSTEM OVERVIEW



The system has two sensors for detection of fire and smoke [3]. The thermistor detects the rise in room temperature and tells the system of fire. The smoke is detected by MQ2 Smoke sensor. The extraction of smoke is done by extractor fans attached to the system. The GSM Module sends the message to the nearest fire station regarding the number of men needed on the spot. A text is displayed on the LSD display to evacuate the building as soon as possible. 8051 Microcontroller is the heart of the system.

FIRE DETECTION SYSTEM

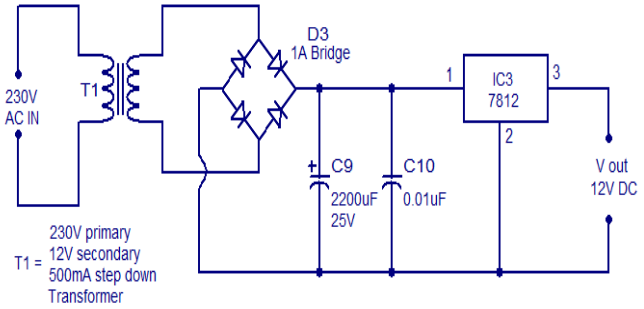
Here two sensors are used to detect the fireone is Thermistor as a temperature sensor and second is MQ2 Smoke sensor as a Gas leakage detector circuit. Thermistor works on the principle of NTC [7] that is, Negative Temperature Coefficient and PTC Positive Temperature Coefficient. Here NTC thermistor is used. It works on the principle of resistance variation. When the temperature increases due to fire the resistance of the thermistor decreases changing output voltage. Gas sensor resistance is to be change when Toxic gas reacts with the gas sensor. Output of the gas sensor and Thermistor is connected to the ADC for digital conversion. ADC 0809 converts the analogue value into digital value and this value is connected to the microcontroller directly. Microcontroller gets the value from ADC in hex value and after converting hex to ASCII code, data is transfer to the LCD directly. LCD shows the current value of gas and temperature on the first line of LCD.

FIRE CONTROLLING SYSTEM

When the fire has been detected and displayed on LCD screen the system switch on the fan connected to it so that smoke can be extracted from the building and visibility can be increased. when gas sensor measurement is cross over the limit then GSM modem send a SMS to the fire station to send the rescue team. The message will contain the intensity of fire and number of rescue teams needed on the spot. For GSM modem connection, we use IC MAX232 [9] with the microcontroller to send a SMS via GSM modem. For GSM modem, we use AT command's.

POWER SUPPLY STAGE

The power supply [7] employed in this design is a linear power supply that provides a regulated dc voltage (12V) used to power the whole circuit. A step down transformer was used to step down the input voltage of 220VAC to 18VAC. The 18VAC was rectified into direct current through the bridge rectifier. But for this system we require a logic voltage level not more than 12.25Vdc. Hence, a voltage regulator IC, 7812, was used to regulate the dc voltage supply to the required 12V.



THERMISTOR

The fire detector stage uses a thermistor [2] to monitor the room temperature. The thermistor is a solid state device that has its resistance changing with temperature. The resistance change with temperature is nonlinear, and therefore temperature must be calibrated with respect to resistance. The thermistor resistance decrease with increase in temperature and this would cause a decrease in the voltage input to the non-inverting input of the comparator thereby causing the voltage reference set at the inverting input to be greater. In this state the comparator outputs a LOW, to indicate high temperature (i.e. fire). But when the temperature in the room is normal, the input voltage at the non-inverting input of the comparator is greater than the voltage at the inverting input and thus, the comparator outputs a HIGH.

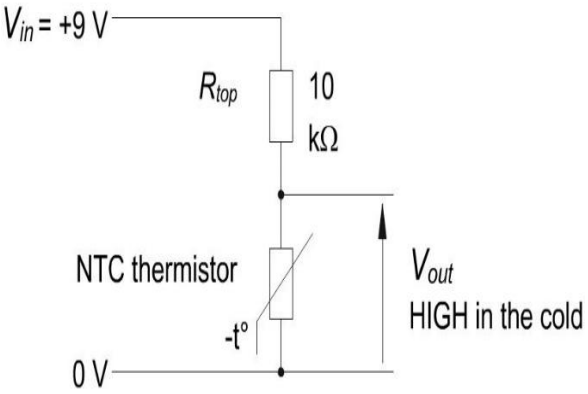


Fig. basic circuit using thermistor

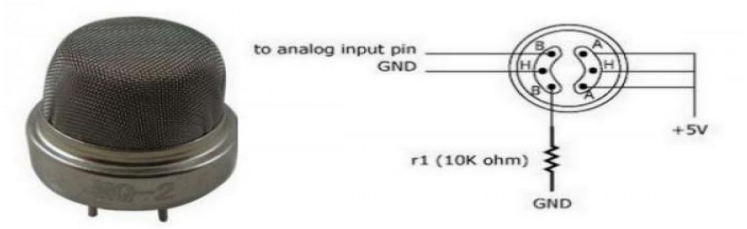
The resistance of thermistor is given by:

$R = R_o e^k$

$K = \beta(1/T - 1/T_o)$

MQ2 SMOKE SENSOR

In this system MQ2 smoke sensor [3] is used to detect the smoke in the room so that extraction process can be started. The MQ-2 gas sensor is sensitive to LPG, i-butane, propane, methane, alcohol, Hydrogen and smoke. It could be used in gas leakage detecting equipments in family and industry.



GSM MODULE

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem [5] looks just like a mobile phone. A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it may be a mobile phone that provides GSM modem capabilities.

In this system we are sending message through GSM module (IC MAX 232) to the nearest firestation to send the required number of rescue teams on the spot. This process of interfacing the microcontroller through USB [3] to communicate with the mobile phone is carried out in order to receive a message from installed mobile phone in the system to another phone numbers processed during the programming. There are various different protocols [7] that can be used for USB communication, and it is important that the mobile phone and the microcontroller use the same settings.

LCD DISPLAY

When fire is caught or emergency of fire occurs the system displays a message on the LCD screen installed in building to evacuate the building as soon as possible. For this purpose here we are using 8-bit LCD display [6]. A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector.

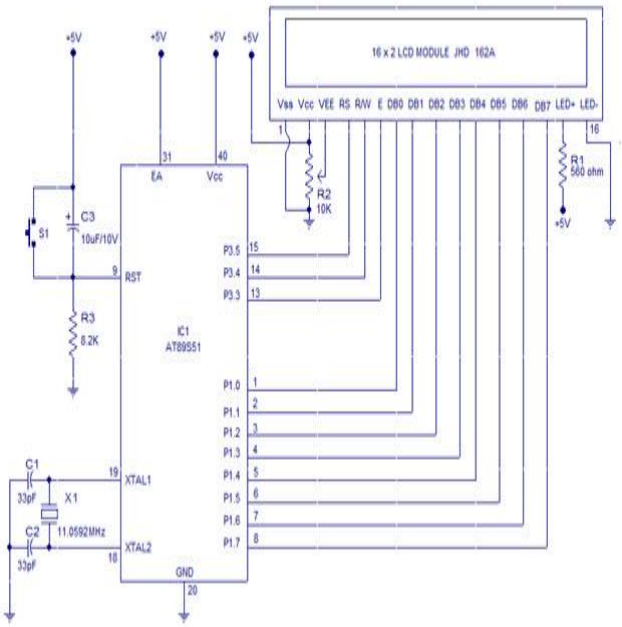
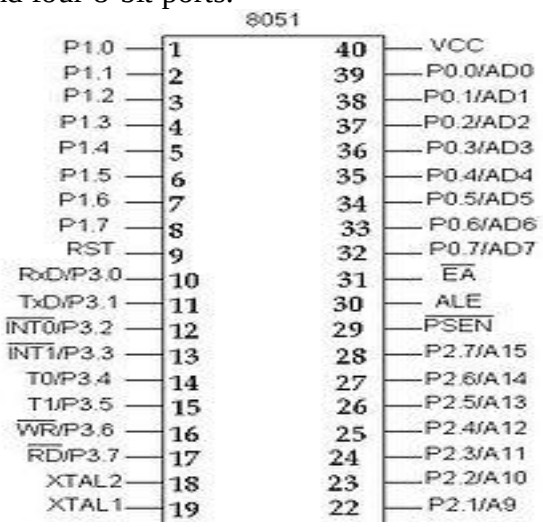


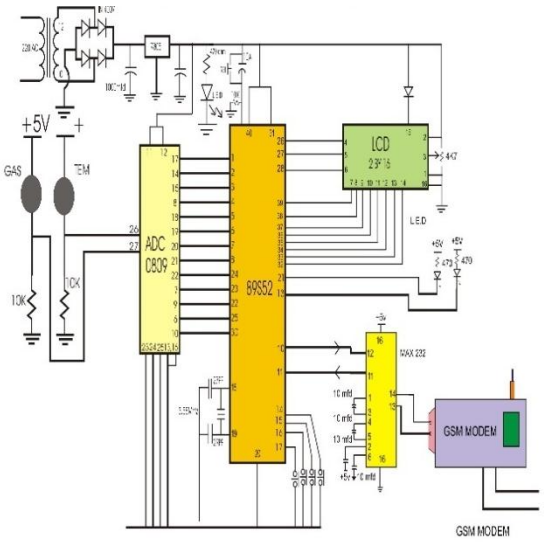
Fig. LCD interfaced with 8051

8051 MICROCONTROLLER

8051 microcontroller [8] is the heart of this system. The Intel 8051 is an 8-bit microcontroller which means that most available operations are limited to 8 bits and it can be programmed using 8051 assembly language. It has 4KB on chip program memory, 128 bytes on chip data memory, 4 reg. banks, 8-bit data bus, 16-bit address bus, 16-bit timers and four 8-bit ports.



CIRCUIT DIAGRAM



WORKING

Here we have taken two sensors MQ2 and thermistor to detect the smoke and fire simultaneously. The thermistor resistance decrease with increase in temperature and this would cause a decrease in the voltage input to the non-inverting input of the comparator thereby causing the voltage reference set at the inverting input to be greater. In this state the comparator outputs a LOW, to indicate high temperature (i.e. fire). But when the temperature in the room is normal, the input voltage at the non-inverting input of the comparator is greater than the voltage at the inverting input and thus, the comparator outputs a HIGH. The input of thermistor is sent to the non inverting input of op-amp. The input of gas sensor is sent to the ADC 0809. ADC is interfaced with 8051 and it sends the signals from the sensors to the microcontroller. LCD is

interfaced with 8051 too and when fire is detected it displays the message saved. GSM is connected to 8051 via IC MAX232 and it sends the message to the saved number when 8051 signals it to do so.

RESULT

The various components used in the design were locally sourced from local electronic stores. After gathering all the components [2] needed for this project, the components were assembled according to the circuit diagram on a Ferro-board and were soldered for firmness. After the assemblage, casing, and fixing the peripherals on the system, the testing was carried out to ascertain if proper and expected working condition was achieved. For the testing, A mobile phone, improvised fire scene with matches, paper, were the materials used.

The matches were lighted and applied to the paper, after some time, the light was blown and the smoke was allowed to pass to the sensor. On sensing the smoke by the sensor, the system enabled the extractor unit and the fan started to remove the smoke and also the signal [4] was sent to the server node. The server node received the signal and sent an intelligent signal to the user phone. The node was powered on battery. Message was sent to the fire station to send the number of teams required and also a message was displayed on the LCD screen to evacuate the building. The major challenge of this project was the room temperature and testing of thermistor.

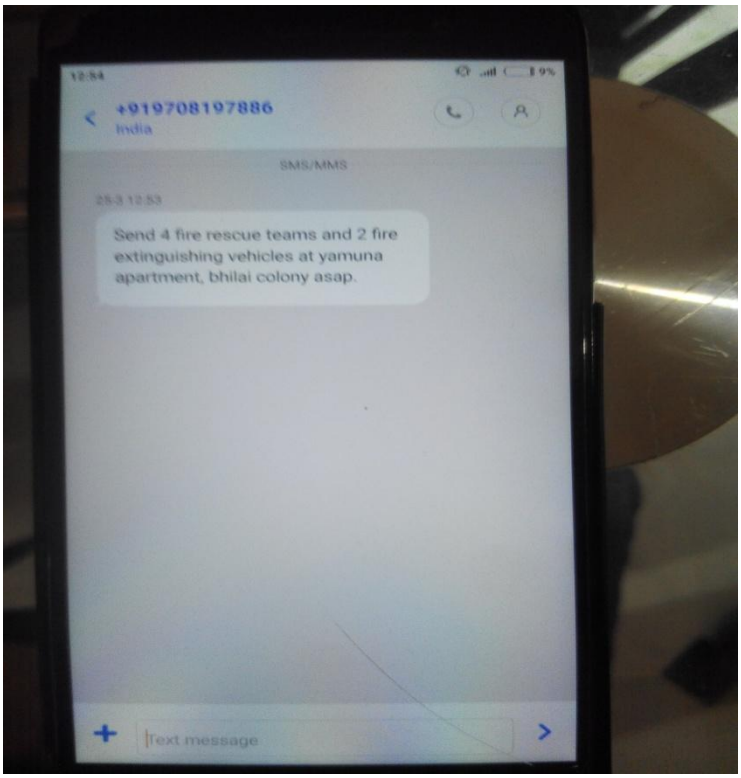


Fig. Mobile Receiver with Message

CONCLUSION

The design and construction of a GSM – based Fire Detector and Smoke Extractor System was successfully carried out and tested effectively. The system did not pose extra-ordinary constraint and the components and materials used conform to engineering standard. A close look at the circuit diagram of the smoke detector reveals that all the components used were all locally sourced and available. Also, consideration has been made in the area of cost and size (packaging) compared to other similar designs.

In this paper, thermistor's and MQ2 gas sensor has been proposed to detect the fire in a building. The detection of fire can give sufficient time to the people to leave the building as soon as possible avoiding loss

of lives. Once the fire is detected the smoke is removed using extractor fan. The system detects the intensity of fire and sends the message to the fire station to send the rescue team according to the intensity of fire. This is a very efficient system to reduce the casualties caused by fire.

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