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DEVELOPMENT OF A MICROCONTROLLER BASED EMERGENCY LIGHTING SYSTEM WITH SMOKE DETECTION AND MOBILE COMMUNICATION FACILITIES

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ABSTRACT

This paper describes a microcontroller based emergency lighting system, which can early detect fire and send the alarm message through a mobile network. This is achieved via smoke and gas detector technology added with integrated microcontroller, mobile communication and a LED emergency light. First five Minutes of fire is more important than last five hours [1]. Hence, it is important to have early detection of fire and start fire fighting in its inception. In many hazardous areas where flammable materials are handled, any leak or spillage may give rise to an explosive atmosphere. In this situation, early detection of leaking gas or smoke plays an important role in reducing fire deaths and injuries. In fact, immediately after detection of fire, fire fighting should be started by means of portable fire extinguishers or by informing the fire brigade. This developed system can initiate these functions by detecting the fire hazard, establishing the communication to dwellers and turning on the emergency light to show the exit route.

Keywords: emergency light, **e**scape route, gas and smoke sensor, hazardous area, mobile communication

1. INTRODUCTION

The combined smoke detector system with emergency lighting and communication system can save lives if there is a fire at home or any official building or cinema hall. Smoke spreads very fast and power cuts out immediately; this needs a smoke alarm, and an emergency light to show the exit route. Primary purpose of detection system is to respond as quickly as possible and transform the responses into an automatic alarm, SMS alert and immediately turn on the emergency light to evacuate the premises, moving people to a place safely or allowing important documents to be moved to a safety zone [2]. Installation of a battery backed emergency light with relay technology is used here to switch on the emergency light. This system can detect smoke and different gas leakage like LPG, methane, butane or any such petroleum based gaseous substance. It sends the SMS alert in hazardous situation, so that people can evacuate easily with the help of emergency light. This system is easy to install and very simple to operation. Its longer life makes the system relatively more reliable and compact. This system has been developed in Illumination Engineering Laboratory of Jadavpur University.

2. HARDWARE COMPONENTS REQUIRED

In this system, the following components are mainly required:

a) Gas and smoke sensor (MQ2) is used for detection of smoke and gas; b) Microcontroller board is used for controlling the whole system; c) GSM

Module is used for mobile communication; d) 5V Relay is used for switching the emergency light;

e) LED Emergency light is used to show the exit route;

f) DC power Supply is used to turn on the emergency light in emergency situation;

g) LCD Module is used to display whether the gas or smoke is present or not;

h) Transistor is used for switching purpose;

i) Adapter 12 V is used to supply the GSM Module;

j) Buzzer is used to alert;

k) Small LED is used to check the relay circuit is properly working or not.

3. WORKING PRINCIPLE OF GAS AND SMOKE SENSOR MODULE

Fig. 1 shows the block diagram of functioning of gas and smoke sensor module. In this system, mainly semiconductor type smoke & gas sensor module is used. Sensitive material of smoke & gas sensor is SnO_2. Initially, when the air is clean, the conductivity between the electrodes of sensor is less as the resistance is in order of 50 kΩ and electrodes are keeping at constant distance. The inverting terminal input of comparator is higher than the non-inverting terminal input. The indicator Buzzer and LED is off. In the event of fire, when the sensor gets filled with smoke, the resistance of the sensor falls to 5 kΩ and the conductivity between the electrodes increases [3]. This provides a higher input at the non-inverting terminal of comparator than the inverting terminal and the output of the comparator becomes high. The alarming LED and Buzzer are turned on as indication of presence of smoke. The sensitivity of the gas & smoke sensor can be adjusted by the potentiometer.

4. MICROCONTROLLER USED IN THE SYSTEM

In this system ARDUINO UNO is used, which is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins of which 6 can be used as PWM outputs, input voltage (7–12) V of direct current (DC), 5V DC operating voltage, 40 mA on input or output pin and 50 mA on 3.3 V-pin, 6 analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button [4].

5. BRIEF DESCRIPTION HOW GAS & SMOKE SENSOR COMMUNICATE WITH MICROCONTROLLER & EMERGENCY LIGHTING

In this system, a smoke detector with emergency lighting for safety purpose in any indoor area is introduced. This is achieved via smoke and gas detector technology and added intelligence utilizing integrated microcontroller, mobile communication and a LED emergency light. Here a LED emergency light is used, this light is operated at 3V DC, 0.25A battery source. Fig. 2 shows the circuit diagram of using Microcontroller to interface of Gas and smoke sensor with emergency light.

When developing a smoke and gas detector system, there is a need to monitor the gas and smoke sensor parameters continuously. This combined smoke detector system with emergency lighting and communication system can monitor the smoke from the fire or gas leakage continuously. This is achieved by scanning the digital output (D_0) of the sensor continuously. When the air is clean that is there is no smoke or gas leakage, the D_0 of the sensor is high as well as the conductivity between the electrodes of the sensor is less. If there occurs a smoke or gas leakage at any time, the conductivity between the electrode of the sensor is high as well as the digital output D_0 of the sensor will change to low status and that time SMS alert, buzzer and emergency light will be activated [5].

When the emergency situation arises, SMS is sent by using AT commands. The SMS alert set in the programme and the base of the transistor *Q1* gets the high pulse due to detection of smoke or gas, the transistor is turned on or forward biased and turns on the buzzer, which is connected to the specified pin of the microcontroller. Once smoke or gas

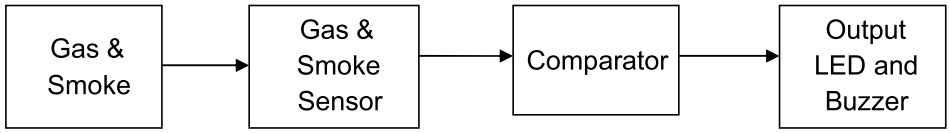

Fig. 1. Block diagram of gas & smoke sensor module

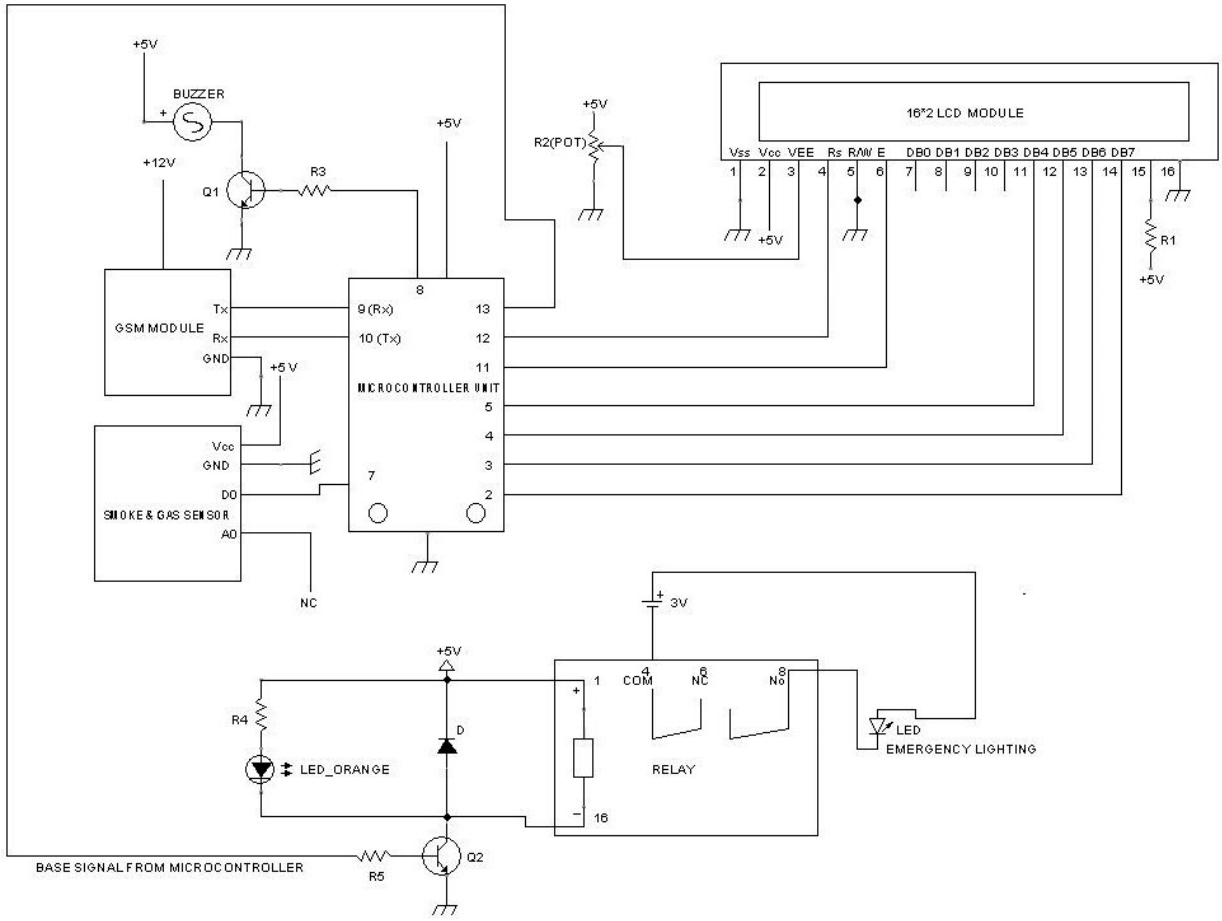

Fig. 2. Circuit diagram of using microcontroller to interface gas and smoke sensor with emergency light

leakage is detected by the system, the set numbers of SMS alert are sent. When this situation arises, humans should take proper action to stop the gas or smoke problem.

After sending the SMS alerts, the system will activate the emergency light. When the smoke or gas leakage has been stopped and system will automatically reactivate its SMS alert setting by resetting SMS counting variable back to zero. Fig. 3 shows the flow chart to interface gas and smoke sensor with emergency light.

When the base of the transistor *Q2* gets the high pulse due to detection of smoke or gas, the transistor is turned on or forward biased. The relay also gets energized and 'NC' (Normally Closed) terminal of the relay changes to 'NO' (Normally Open) terminal, the relay circuit is completed. The emergency light is turned on.

In this circuit an orange colour small LED is used. This LED is used to check the relay circuit is properly working or not that is relay circuit is properly energized during the presence of smoke or gas or not. When there is no gas leakage or smoke, the

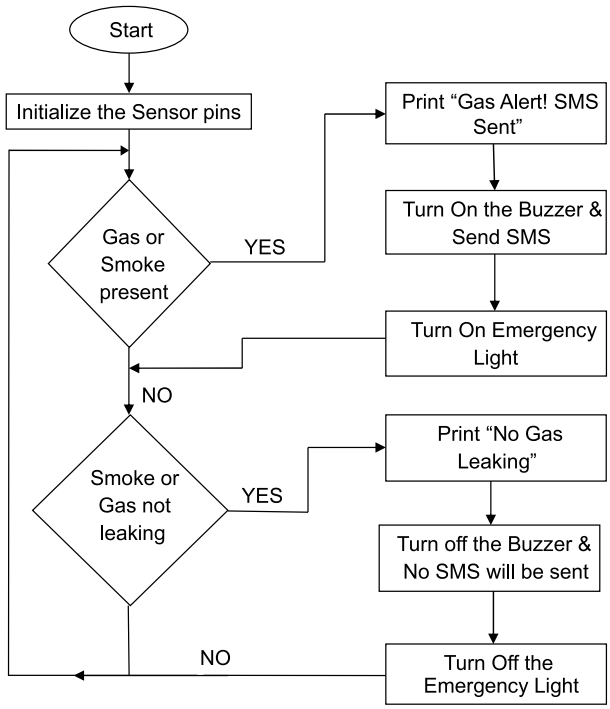

Fig 3. Flow chart to interface gas and smoke sensor with emergency light

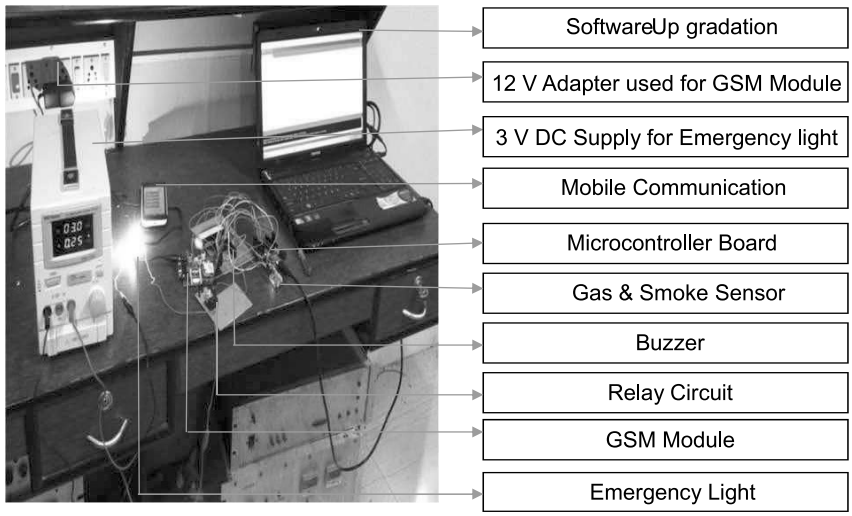

Fig. 4. Experimental setup using microcontroller to interface gas and smoke sensor with emergency light

base of the transistor gets low pulse, the transistor is reverse biased, and the relay also gets de-energized, and in such case the 'NO' terminal of the relay changes to 'NC' terminal. Fig. 4 shows the experimental setup using microcontroller to interface gas and smoke sensor with emergency light.

6. ADVANTAGE OF THE SYSTEM

The developed combined smoke detector with emergency lighting system has the following specifications:

– The LED emergency light has long life, small size, good efficacy and good visibility having monochromatic yellow LED light. The whole system requires proper maintenance and can be sustained for a long period of time.

– This system is easy to install and very simple to operation.

– This system is more reliable in domestic, industrial and commercial interiors.

– This system detects the different gas leakage like LPG leak, methane leak, butane leak, or any such petroleum based gaseous substance and smoke that can be detected using smoke and gas sensor.

7. DISADVANTAGE OF THE SYSTEM

The developed combined smoke detector with emergency lighting system has the following disadvantages:

– The smoke and gas sensor with emergency light is driven by battery power. So, regular checking, maintenance and replacement of the battery system is necessary. A smoke detector and emergency light with dead battery saves no live.

– Water steam is very harmful for smoke and gas sensor. Smoke detector should not be installed in bathroom, steam rooms or over ovens of kitchens. If sensors are installed in such a place, this will be get damaged or create malfunctioning.

– The smoke and gas sensor should not install near gas ovens, stoves. If sensors are installed in such a place, this will give the false alarm. But this areas are the most important areas where need of careful monitoring for fire hazards, installation of the system in a proper wall or ceiling is very much necessary [6].

8. CONCLUSION

In this system, the gas and smoke detector system with an emergency light is provided with a microcontroller system. In this troublesome world, risks are increasing due to human faults and failure. Automation and security is the most important factor in our day to day life. This system approaches to home and industrial automation and security system design which is almost standardized now to day. Everyone wants to be as much as secured as possible. This developed system, if installed in large scale, may save lives of many people by giving early warning and showing the escape route.

In case of emergency situation in future, laser light may be used to get more sensitivity in the smoky and hazardous situation than LED. Laser achieves the goals of high sensitivity and high stability by its monochromatic nature.

This combined smoke detector system with emergency lighting and communication system may be used outside of official building or heritage building etc. At night, when the density of people of any area is very low, if fire hazard occurs outside, the fire may spread rapidly and may affect the inside of the building and damage various important documents, instruments or artefacts. This developed smoke detector system with emergency lighting and communication system may protect this hazardous situation.

This combined smoke detector system may be effective in wildfire. Wildfire may occur all over the world except Antarctica continent. The wildfire spreads very fast and come to the local premises what may cause extensive damage to property, human life, wild life etc. This developed smoke detector with SMS alarm system may save extensive damage of property, human life, wildlife, forest etc. from the wildfire.

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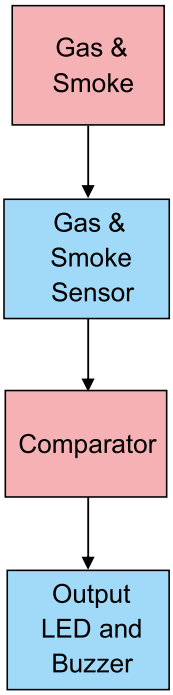

Fig. 1. Block diagram of gas & smoke sensor module

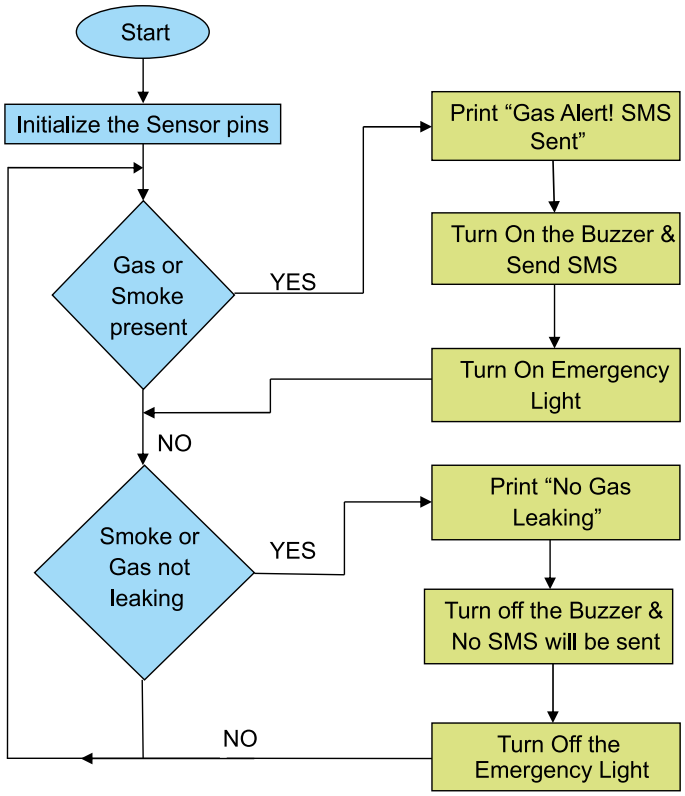

Fig 3. Flow chart to interface gas and smoke sensor with emergency light

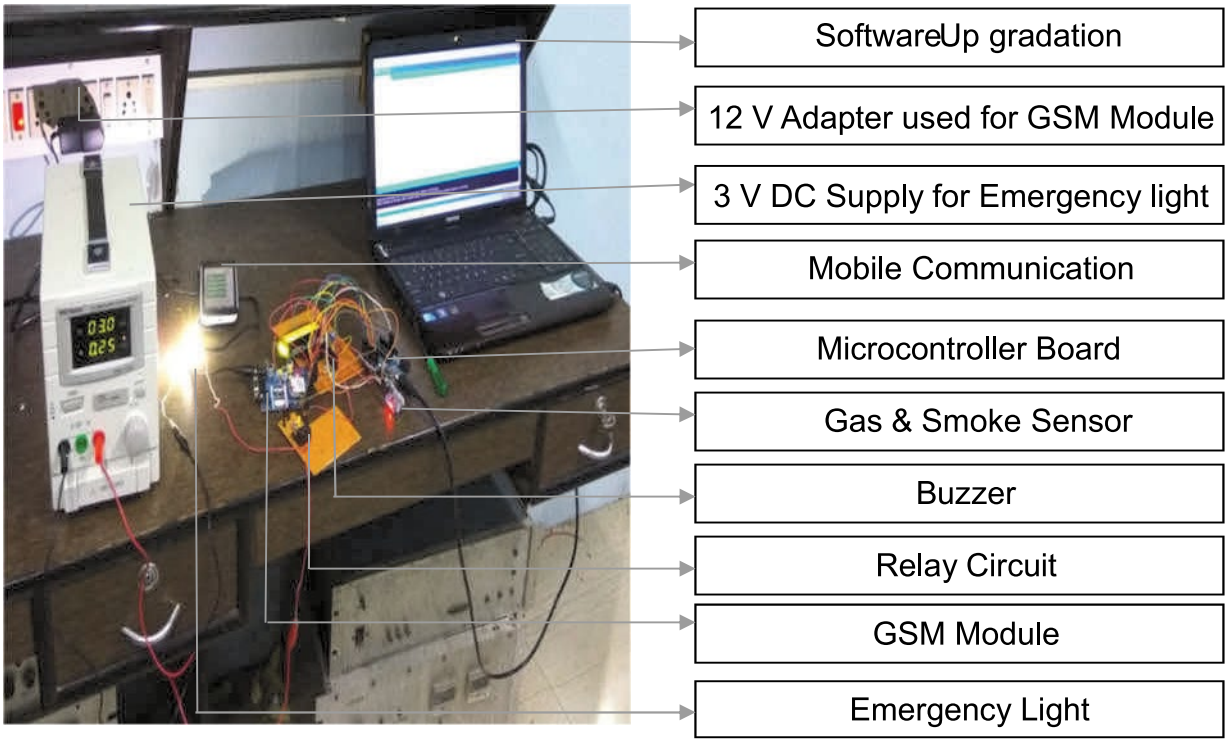

Fig. 4. Experimental setup using microcontroller to interface gas and smoke sensor with emergency light