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DESIGN AND SIMULATION OF GAS AND FIRE DETECTOR AND ALARM SYSTEM WITH WATER SPRINKLE

R.O.Okeke, M.Ehikhamenle,

Department of Electronic and Computer Engineering,

University of Port Harcourt, Choba, Rivers State, Nigeria

Email: mattinite4u@yahoo.com, remyokeke@yahoo.co.uk

Abstract- This work is to design and implement a Fire and Gas Detection System with water sprinkler using SMS Feedback. This system makes use of a microcontroller along with sensing circuit which will detect gas leakage and fire and with the help of an alarm system the system gives alert about fire or gas leakage and with the installation of a GSM modem SMS can be sent to notify the user if there is fire or gas leakage and if the fire occurs the water sprinkler sprinkles water on the affected area to reduce the effect of the fire. A Liquid Crystal Display (LCD) displays the status of the system

Key words: Gas Detection, sprinkler, Liquid Crystal Display (LCD)

I. INTRODUCTION

Fire and Gas systems (FGS) are important tools for safeguarding our residence home and other facilities that handle flammable and toxic materials. All such facilities have inherent fire risk that cannot be fully mitigated with instrumented protective function, in some cases these facilities require the installation of fire and gas systems to mitigate these hazards. Proper design of fire and gas systems begins with the selection of a performance target for functions employed by the fire and gas system. Performance of a fire and gas System is primarily characterized by the system's ability to detect hazards (detector coverage) and the system's ability to mitigate hazards. Determination of the necessary coverage, mitigation effectiveness requirements for a FGS is an exercise in risk analysis. A well designed fire and gas system is intended to detect and in some cases automatically mitigate fire, combustible gas and toxic gas hazards. Proper placement of detectors is critical in the design of a fire and gas system to ensure that coverage is adequate to detect hazards at their incipient stage, in order to avert escalation. The gas detection system can detect a leakage of combustible or toxic gas and take action to mitigate or prevent it from escalating into a fire or explosion. If a fire should result, systems can be attached to extinguish the fire and protect other areas from the actions of the fire. The same system, usually with different detectors and principles, can be used to detect toxic gases, give warning to personnel and provide the possibility of taking automatic actions. Fires in process plants may be either like any other industrial fires, for example electrical fires in utility or an ignited leak of a product from the process. Some facilities use separate gas and fire detection systems. Generally, the fire detection system and gas detection system is combined into one fire and gas system. A separation that may be made is to have one fire and gas system for the 'process' areas and another sub-system for the utility or office/accommodation areas. Systems can be single, duplicated or triplicate. Redundant systems are not new. Systems in the early 1980's were being delivered with dual, diversely located controllers, dual detectors, and dual control outputs. Kenexis,(2014).

2. RELATED WORK

A. Intelligent Residential Security Alarm and Remote Control System Based on Single Chip Computer: LIU zhen-ya et al,(2008) the paper focuses on, Intelligent residential burglar alarm, emergency alarm, fire alarm, toxic gas leakage remote automatic sound alarm and remote control system, which is based on 89c51 single chip computer. The system can perform an automatic alarm, which calls the police hotline number automatically. It can also be a voice alarm and shows alarm occurred address. This intelligent security system can be used control the electrical power remotely through telephone (Forzani et al, 2009).

B. Design and implementation of Remote

Monitoring System Based on GSM: Chen et al, (2008) this paper focuses on the wireless monitoring system, because the wireless remote monitoring system has more and more application, a remote monitoring system based on SMS through GSM. Based on the overall architecture of the system, the hardware and software architecture of the system is designed. In this system, the remote signal is transmitted through GSM network. The system includes two parts which are the monitoring center and the remote monitoring station. The monitoring center consists of a computer and a TC35 communication module for GSM. The computer and the TC35 are connected by RS232. The remote monitoring station consist of a TC35 communication module for GSM, a MSP430F149 MCU, a display unit, sensors and a data gathering and processing unit. The software for the monitoring center and the remote monitoring station were designed using VB (Geng et al, 2007).

C .A New Approach of Automatic Localization System Using GPS and GSM/GPRS Transmission: Lita et al, 2006 this paper focuses on, a low cost automotive localization system using GPS and GSM-SMS services, which provides the position of the vehicle on the driver's or owner's mobile phone as a short message (SMS) on his request. The system can be interconnected with the car alarm system which alerts the owner, on his mobile phone, about the events that occurs with his car when it is parked. The system is composed by a GPS receiver, a microcontroller and a GSM phone. In additional the system can be settled for acquiring and transmitting the information, whenever requested about automobile status and alerts the user about the vehicle started engine. The system can be used as a low cost solution for automobile position localizing as well as in car tracking system application.

D. Investigation of gas sensors for vehicle cabin air quality monitoring: Galatsis et al, (2002) this paper focuses on, car cabin air quality monitoring can be effectively analyzed using Metal Oxide Semiconducting (MOS) gas sensors. In this paper, commercially available gas sensors are compared with Fabricated Moo3 based sensors possessed comparable gas sensing properties. The sensor has response 74% higher relative to the host commercial sensor tested

3. METHODOLOGY

The Operation of the Fire and Gas Detection System is presented in the block diagram as shown in figure 3.1. It consists of a Power Supply Unit PSU which supplies the needed power to the PIC16F877A microcontroller, MAX232, GSM module SIM900, Gas sensor MQ-2, Temperature sensor LM35 and the Liquid Crystal Display LCD. The microcontroller is connected to the Power Supply Unit, LCD, Gas sensor, Temperature sensor and MAX232. The LCD shows the status of the system when there is a presence of gas or smoke which may lead to fire outbreak in the environment. A detailed analysis of the various units in the system is shown in the block diagram given in fig 1 below

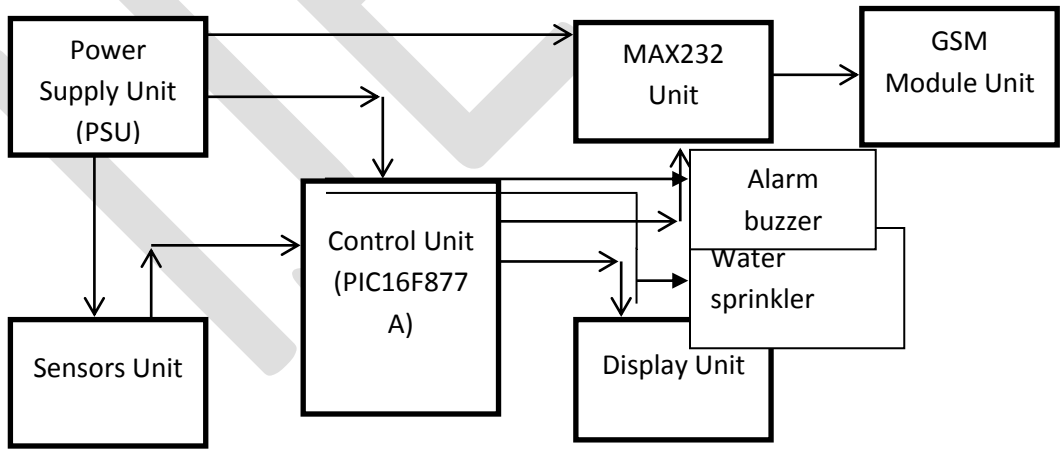


Fig1: Block Diagram of Fire and Gas Detection System

A. Power supply unit (psu)

The power supply unit is necessary for the provision of regulated (step-down rectified) Dc power supply from AC mains to circuit components i.e. microcontroller, GSM Module, sensors, LCD's and MAX232. The power supply unit consists of a step down transformer (240/24v), the diode Rectifier, voltage regulator and capacitors for filtering.

Sensors Unit

The sensor unit consists of the various sensors used in the sensing of the presence of gas or flame which may lead to fire outbreak in an environment. The sensors used in this system are the MQ-6 and LM35 for Liquefied Petroleum Gas (LPG) and Temperature detection of the environment respectively.

1. Gas Sensor (MQ-6)

The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses and are used indoors at room temperature. The output is an analog signal and can be read with an analog input of a PIC microcontroller. The MQ-6 Gas Sensor module is useful for gas leakage detecting in home and industry. It is highly sensitive in the detection of the presence LPG, butane, propane, methane, alcohol, hydrogen and smoke. Some modules have a built-in variable resistor to adjust the sensitivity of the sensor. It was used in this research work for the detection of LPG and smoke in the building. The sensor and it configuration is shown in the fig below.

Fig 2: MQ-6 Sensors

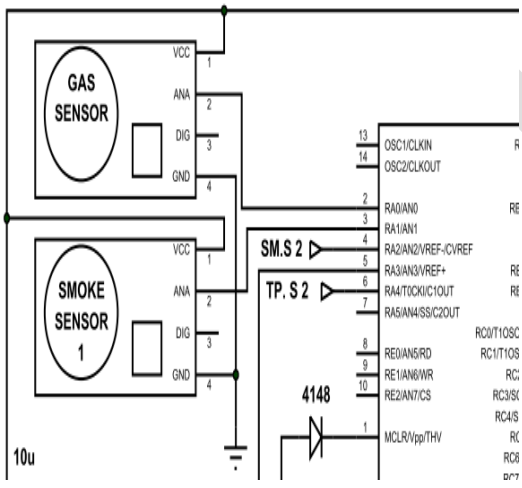


Fig 3: circuit of interfacing mq-6 as an lpg and smoke detector

2. Temperature sensor (LM35)

Temperature sensor LM35 is chosen, it's used to sense the temperature of the environment and when the temperature goes above a certain level say 45º a certain voltage corresponding to the said degree will be read by the microcontroller indicating the occurrence of a possible fire outbreak. The sensor and it configuration is shown in the fig below.

Fig 4: Lm35 Sensor

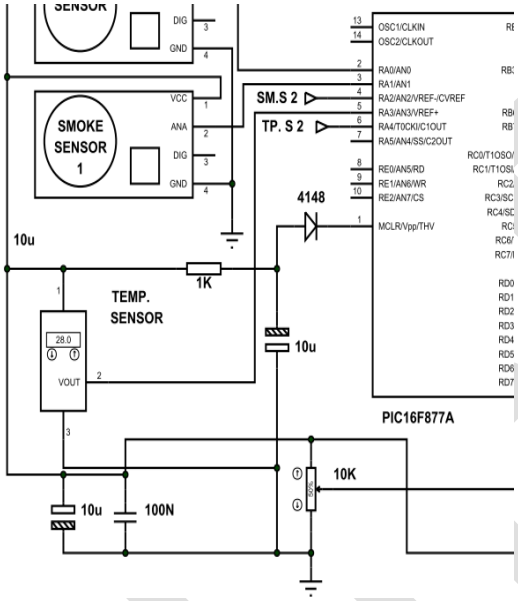


Fig 5: circuit of interfacing lm35 sensor

C. Control Unit (Pic16f877a Microcontroller)

The control unit is the brain of this section and its main components is the PIC16F877A microcontroller.

1. PIC16f877A Microcontroller Architecture

PIC 16F877A is a 40-pin 8-Bit CMOS FLASH Microcontroller from Microchip. The core architecture is high-performance RISC CPU with only 35 single word instructions. Since it follows the RISC architecture, all single cycle instructions take only one instruction cycle except for program branches which take two cycles. 16F877A comes with 3 operating speeds with 4, 8, or20 MHz clock input. Since each instruction cycle takes four operating clock cycles, each instruction takes 0.2µs when 20MHz oscillator is used. It has two types of internal memories; program memory and data memory. Program memory is provided by 8K words (or 8K*14 bits) of FLASH Memory, and data memory has two sources. One type of data memory is a 368-byte Random Access Memory (RAM)

and the other is256-byte EEPROM (Electrically erasable programmable ROM).The core feature includes interrupt capability up to 14 sources, power saving SLEEP mode, and a single 5V In-Circuit Serial Programming (ICSP) capability. The sink/source current, which indicates a driving power from I/O port, is high with 25mA. Power consumption is less than 2mA in 5V operating condition.PIC16F877A is show in fig 6.

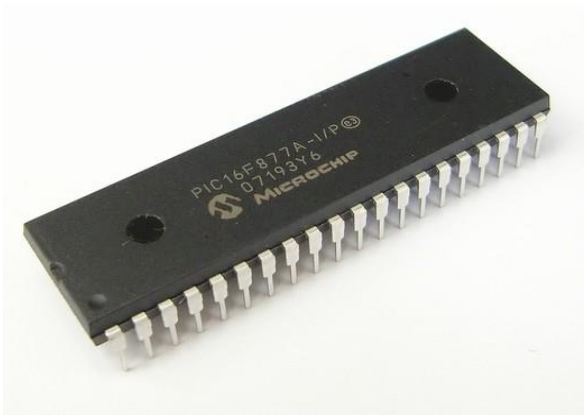
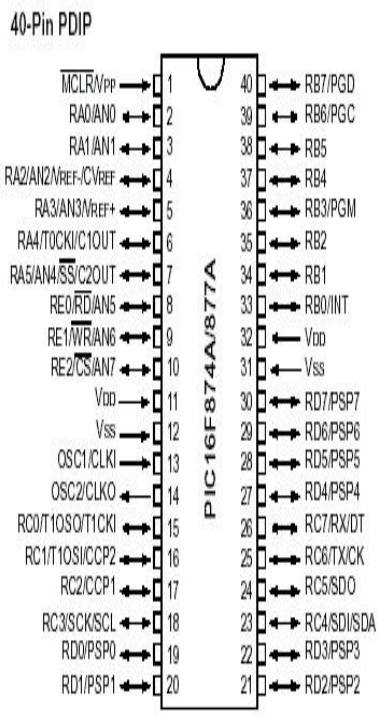


Fig 6: PIC16F877A Microcontroller

3. PIC16F7F877A Pin Description



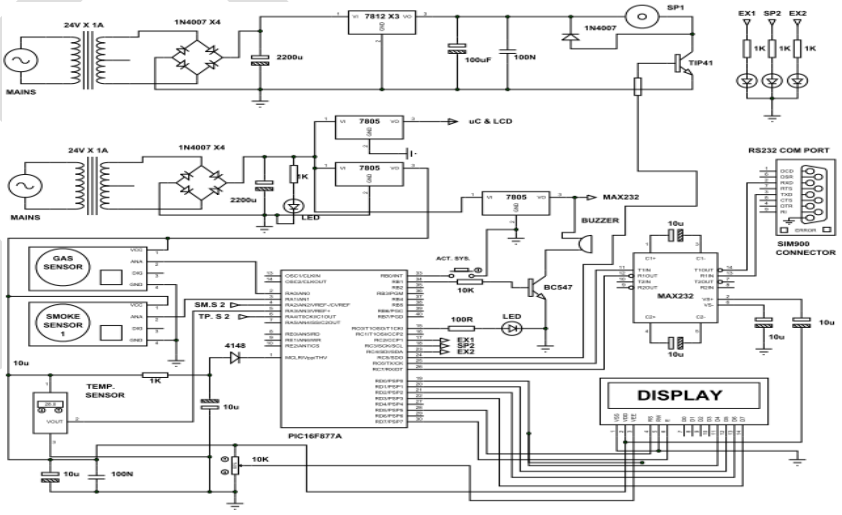


Fig 7: PIC16F877A Pin Descriptions Fig 8: The complete circuit diagram of the Fire and Gas Detection System

D. Fire And Gas Detection System

The Fire and Gas Detection system makes use of two sensors the MQ-2 and the LM35; the MQ-2 is used to detect the presence of Liquefied Petroleum Gas (LPG) and the LM35 is used to detect the temperature of the surrounding and as well detect the presence of flame in the surrounding and the signal gotten from the two sensors are sent to the microcontroller and the status of the system is displayed on an LCD. With the help of the GSM module, the system sends SMS to the user's phone number telling the user the status of the environment whether a gas is detected or flame is detected in the surrounding.

E. MAX232

The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pump sand external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5V. It is helpful to understand what occurs to the voltage levels. When a MAX232 IC receives a TTL level to convert, it changes TTL logic 0 to between +3 and +15 V, and changes TTL logic 1 to between -3 to -15 V, and vice versa for converting from RS232 to TTL. This can be confusing when you realize that the RS232 data transmission voltages at a certain logic state are opposite from the RS232 control line voltages at the same logic state. The MAX232has two receivers that convert from RS-232 to TTL voltage levels and two drivers that converts from TTL logic to RS-232 voltage levels. As a result, only two out of all RS-232 signals can be converted in each direction. Typically, the first driver/receiver pair of the MAX232 is used for TX and RX signals, and the second one for CTS and RTS signals.

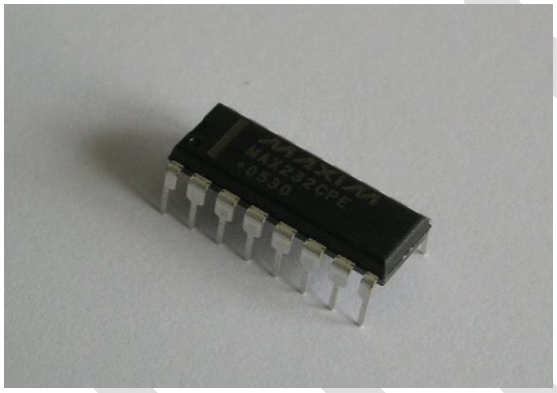


Fig 9: MAX232

F. Liquid crystal display unit

This unit consists of a 16× 2 Character LCD. The liquid crystal display is connected through a variable resistor; the variable resistor (10kΩ) is used to adjust the brightness of the LCD.

The LCD displays the status of the system when gas detected or when a flame is detected through the various sensors installed the system; this is shown in fig 10 below.

Fig 10: Liquid Crystal Display

G. Gsm Module (Sim900)

This is a GSM/GPRS-compatible Quad-band cell phone, which works on a frequency of 850/900/1800/1900MHz and which can be used not only to access the Internet, but also for oral communication (provided that it is connected to a microphone and a small loud speaker) and for SMSs. The module is managed by an AMR926EJ-S processor, which controls phone communication, data communication (through an integrated TCP/IP stack), and (through an UART and a TTL serial interface) the communication with the circuit interfaced with the cell phone itself. The processor is also in charge of a SIM card (3 or 1,8V) which needs to be attached to the outer wall of the module. In addition, the GSM modem (Sim900) device integrates an analog interface, an A/D converter, an RTC, an SPI bus, an IC, and a PWM module. The radio section is GSM phase 2/2+ compatible and is either class 4 (2 W) at 850/ 900 MHz or class 1 (1 W) at 1800/1900MHz. The TTL serial interface is in charge not only of communicating all the data relative to the SMS already received and those that come in during TCP/IP sessions in GPRS (the data-rate is determined by GPRS class 10: max. 85.6 kbps), but also of receiving the circuit commands (in our case, coming from the PIC governing the remote control) that can be either AT standard or AT-enhanced SIMCom type. The module is supplied with continuous energy (between 3.4 and 4.5 V) and absorbs a maximum of 0.8 A during transmission. The fig 3.12 shows the SIM900 GSM Module.

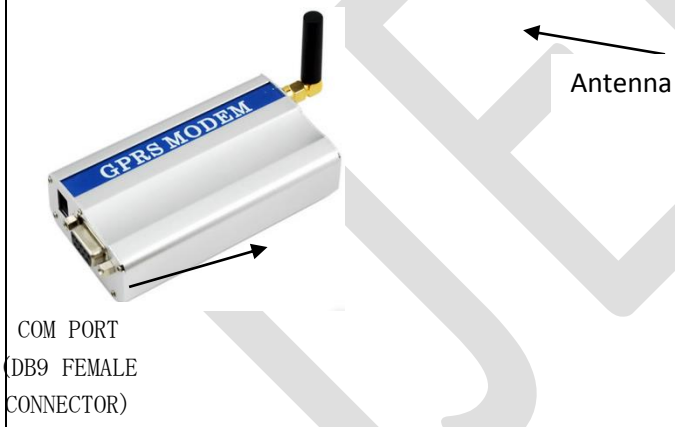


Fig 11: SIM900 GSM Modules

H. Software Design

The system software was programmed to read the sensors (mq-6 and lm35) and produce an output when the preset value and sensor analog signal is matched. All logic decisions by which all other control actions like scanning of available parking space in the park are written using the micro C compiler and simulated for test purpose before burning the compiler generated hex file using proteus simulation wizard.

I. System design flow chats

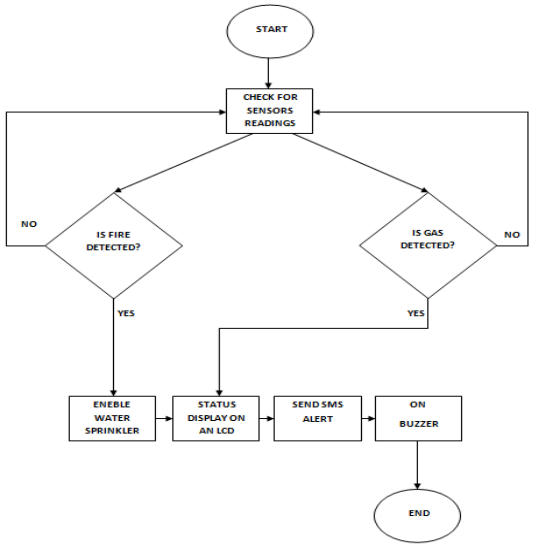


Fig 12: System flow chart

4. RESULT AND DISCUSSION

A. Power supply unit

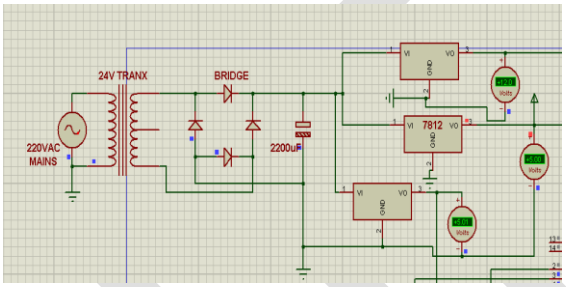


Fig 13 simulated result of the power supply

Table 1: Table of Voltage Regulator Testing results

Voltage regulator	Voltage (dc)
7812	11.89
7805	4.98

The table shows the dc voltage that was gotten from the power supply after the power supply unit was transferred to the board.

B. System simulation result of the controller unit is shown and explained as follows.

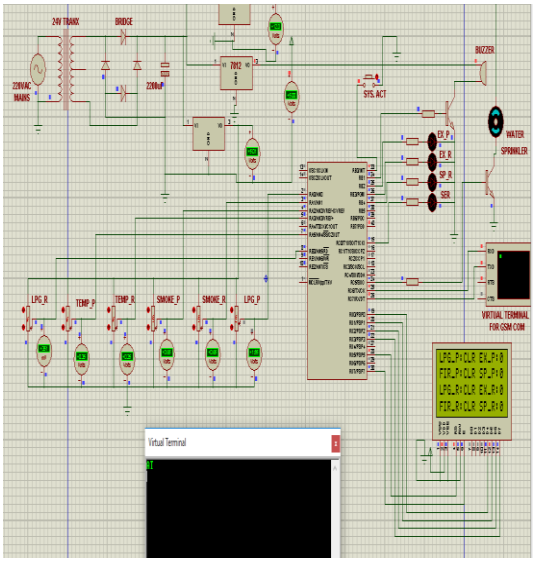


Fig14 simulated result when the environment is clear from fire and lpg licks

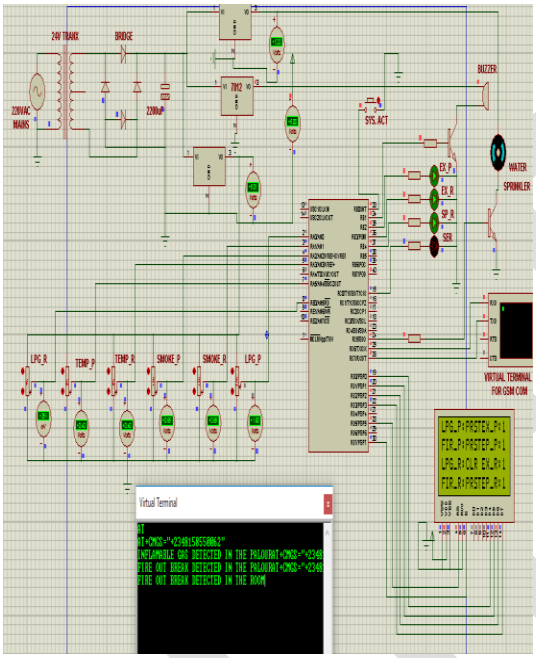


Fig 15: simulated result when there is presence of gas in the parlor, present of fire in the parlor and room.

From the result, the last column indicated with "1" on the second caption represent the status of the water sprinkling system and the fire extinguishing system where "1" represent on and "0" represent off.

5. CONCLUSIONS

A fire and gas hazard control has been designed, implemented and found working. This system has solved the problem caused by gas leakage in our surrounding which lead to fire outbreak that has caused the death of its victims. This system has been designed to carry out the detection and notify the presence of a Liquefied Petroleum Gas (LPG) in our surroundings. It also detect and notify the presence of fire in the environment then fight the fire outbreak itself using fire extinguisher and the water sprinkling system. The construction was made such that maintenance and repairs are done easily incase the system breaks down or if a fault occurs.

This system can be applied in residential places, offices and hotels. With this system safety is assured.

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