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Smoke Indicator Alarm and Gas Sensors

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Abstract: This paper describes the design of a smoke indicator alarm and gas sensors with Arduino-based system by means of GSM module. However, depending on the features available on the safety system, smoke indicator alarms and gas sensors systems may not be inexpensive, and most safety systems can only provide local alarm, which means that property owners may not be aware of what is going on when an emergency occurs. The project's goal is to increase safety, with the main goal being to prevent fires from destroying resident homes and other property. The ATmega328p chip is used in conjunction with an Arduino Nano board. The ATmega328p is the main controller, and it controls the smoke indicator alarm and gas sensors that are affected by the flame sensor and gas sensor. The smoke was detected using a MQ2 gas sensor. While flames were detected using a flame sensor. A short messaging service SMS and a call to the registered number through GSM module will be sent to the user as an alarm message and call. When the gas sensor detects a smoke level of 200 or more, an alert signal is displayed on the LCD display immediately and it will send an SMS alert to the users, and if the flame sensor detects a fire, it will display an alarm on the LCD and users phone. The test result is reported and analyzed when there is a lot of smoke in the house. This technology can assist users in improving their safety standards by providing a quick response in the event of an accident. Users will be able to protect their lives and property from disasters as a result of this.

Keywords: GSM module, MQ2 gas sensor, LCD, Arduino Nano

1. Introduction

The term "fire hazard" or "fire risk" is no longer widely used. Fires can be caused by a variety of reasons, including the emergence of smoke, an increase in temperature in the surrounding region, conditions fire or open flames, and carbon dioxide and carbon monoxide emissions. As a first step in preventing fire, smoke detectors are installed in high positions or high-risk regions [1-2].

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A smoke detector detects smoke only and must be connected to the control panel of a fire alarm system. Smoke detectors that connected to alarms system can detect fires and do not serve as an alarm system. When a smoke alarm detects smoke, an alert is sounded. Smoke detectors usually used for large structures such as tall buildings or factory and also commercial region, but for small buildings and residential houses are usually employed smoke alarms.

Fire detection technology still faces challenges related to reducing false alarms, increasing sensitivity and dynamic response, as well as providing protections for highly expensive and complex installations to better safeguard the public and meet evolving regulations [3-4]. The objectives of this project are to build a Smoke Indicator Warning and Gas Sensor project with an MQ-2 sensor. Then, by using a siren to offer consumers and the general public early warning to save themselves and to make it easier for users to keep track of smoke and gas leaks via the SMS short message system.

2. Materials and Methods

This project is microcontroller-based smoke alarm that will continuously monitor and sound an alarm when there is a considerable amount of smoke present. This smoke alarm also has a visual alert LCD monitor as well as a GSM (Global System for Mobile) module for mobile monitoring. The GSM Modules is used to enhance the project, and this module can be accessed using a connected device such as a mobile phone, tablet, or PC. Arduino, GSM module, MQ-2 gas sensor, LED light, sound alarm, and other electronic components and microcontrollers were used in the project. The Global System for Mobile Communication (GSM) module is used as part of the component to complete this project. After various sources were used to find ideas about the systematics of this alarm, the project implementation process was carried out. Table 1 shows all the component use in this project.

Table 1 : List of components that used in the project

Hardware Simulation	Software Simulation
• Maker UNO • SIM900A (GSM module) • Flame Sensor • MQ2 gas sensor • LCD I2C • Red and Yellow LEDs • Buzzer • Resistor 220Ω • Breadboard • Jumper wires	• Arduino Nano • Virtual Terminal • Flame Sensor • Variable Resistor 1kΩ (potentiometer) • LCD display • Red and Yellow LEDs • Buzzer • Resistor 220Ω

Figure 1 and Figure 2 shows the Arduino Nano board and Maker UNO board. The Maker Uno and Arduino Nano are the main component in this project. The microcontroller on this boards which is ATmega328 is used as the microcontroller to control the circuit properly. The Arduino Nano is small, flexibility and breadboard-friendly board. It has 22 input or output pins which 14 of these pins is digital pins and the rest 8 pins is analogue pins. Next, Maker Uno is specially designed to simplify building projects and usually for educational use. Its 12 LEDs, 1 buzzer and 1 button make it easy for user to build simple projects related to electronics and programming. It has 6 analogue pins and 14 digital pins. The Maker Uno works with micro-USB while Arduino Nano works with mini-USB which is use to upload the programming codes.

Figure 1: Arduino Nano Board

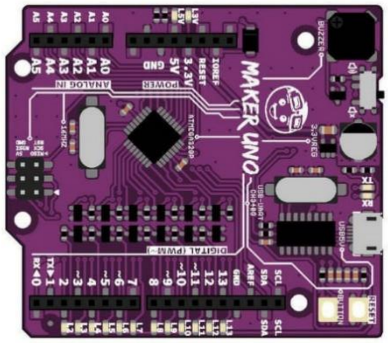

Figure 2: Maker Uno board

Figure 3 shows the SIM900A module used in the project. For communication part, SIM900A has been selected as the GSM module. The SIM900A module is used in many mobile phones and PDAs. It operates with EGSM900 and DCS1800 frequencies. The module is the best application for designing project for Voice call and SMS applications, IoT (Internet of Things), location search system and mobile communications. The SIM900A uses little energy in its operation and is a module that can communicate with a microcontroller with low power consumption.

Figure 3: SIM900A module

Figure 4 and Figure 5 shows the flame sensor and MQ2 gas sensor. Another component that also required in this project is the sensors. MQ2 gas sensor is chosen as component to detect the smoke level while flame sensor is for sense the presence of fire. MQ2 gas sensor is gas leakage detection that usually use for home and industry. It is suitable for detecting hydrogen, liquefied petroleum gas, methane, carbon monoxide, alcohol, smoke or propane. This sensor has high sensitivity and fast response, that is why the result can be taken as soon as possible. The second sensor is known as flame sensor. This sensor has high photosensitivity that suitable used in fire alarm to detect the existence of fire. The response of the flame sensor is faster and more accurate than smoke detector because of its mechanism while detecting the fire. The sensitivity of both sensors can be adjusted by variable resistor (potentiometer).

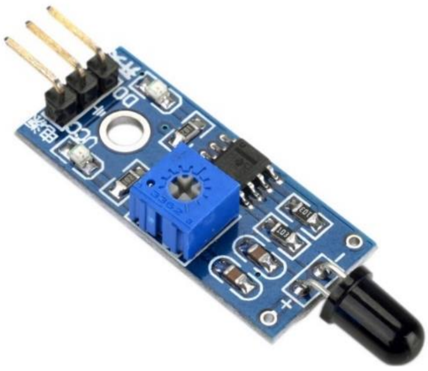

Figure 4: Flame sensor

Figure 5: MQ2 gas sensor

The configuration and development of this project are divided into two parts which are hardware simulation and software simulation. In the hardware simulation, the configuration of the circuit was constructed, and the real prototype of the project was built. While in the software simulation, the whole complete wiring was operated via software and programming codes.

The Figure 6 shows the block diagram of the smoke indicator alarm and gas sensors. The flame sensor and MQ2 Gas Sensor are used as input devices while red LED, yellow LED, SIM900A, LCD I2C and buzzer are used as output devices. Then, the input is given to Maker UNO, the processing device with microcontroller ATmega328 that will provides output to output devices in form of warning that are to be performed by them such as the red LED and buzzer will turn ON if the sensors detected smoke level greater than 200 and the presence of fire, while yellow LED will turn ON if the smoke level and status of flame is normal. LCD I2C display the smoke level and the status of flame either low or high on the screen. The Maker UNO will send a signal to the GSM module which is SIM900A, then send a warning to the registered phone number via SMS if smoke level greater than 200 is detected and make a voice call when there is presence of fire.

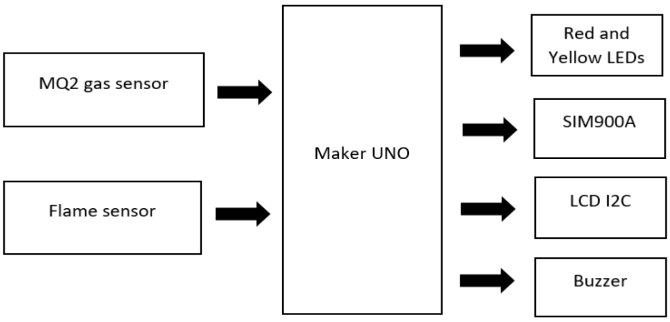

Figure 6: Block Diagram of Smoke Indicator Alarm and Gas Sensors

Figure 7 display the flow chart of the smoke indicator alarm and gas sensors for software simulation. Before that, MQ2 gas sensor has been replaced to a variable resistor (potentiometer) because the smoke level does not change when using the MQ2 gas sensor in Proteus 8 Professional software. When the system is run, variable resistor (potentiometer) is adjustable for smoke level, while flame sensor, LCD display, red LED, yellow LED, buzzer and virtual terminal will turn ON according to their respective functions conducted by programming codes. The LCD display shows the smoke level and the status of the flame either low or high. Since the Proteus 8 Professional software does not have the GSM module component, it is exchanged with the virtual terminal. Then, signal is sent to virtual terminal that will show the smoke level and the predefined message by programming codes if the variable resistor reading is greater than 200 and flame sensor is high.

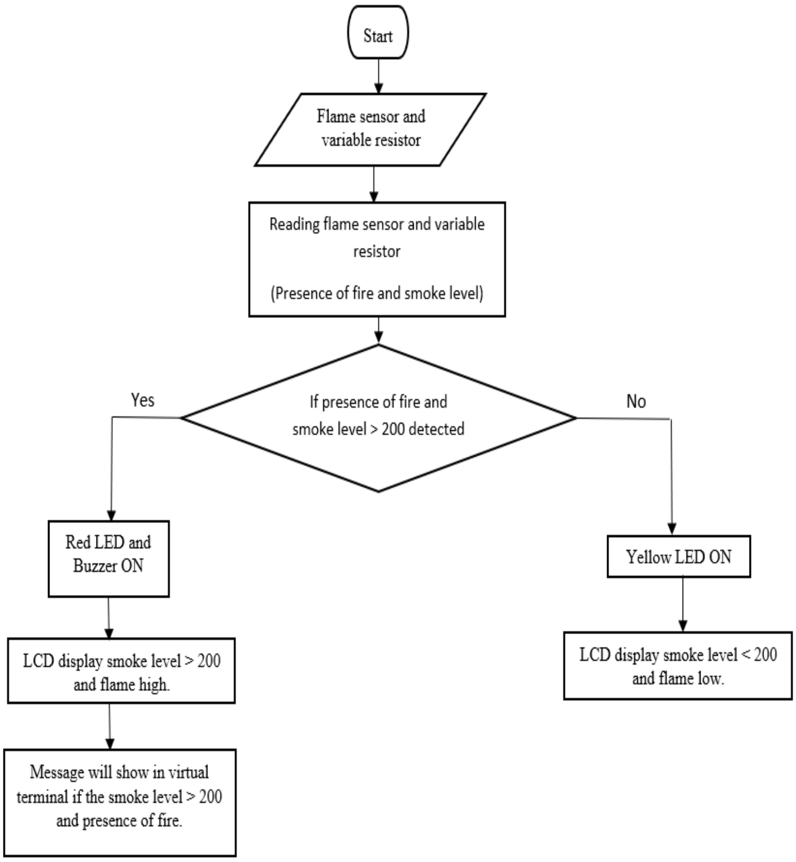

Figure 7: Flow Chart of Smoke Indicator Alarm and Gas Sensors

3.0 Results and Discussion

Several tests were performed to test and observe the effectiveness of system performance on this project. The test was performed by directing smoke at the MQ-2 sensor and directing fire at the Flame sensor. The test was performed using two methods, namely through prototype testing and simulation testing. **Figure 8** and **Figure 9** are the second methods used for this system project. Simulation in Proteus is a medium used to test the effectiveness of Smoke Indicator Alarms and Gas Sensor systems.

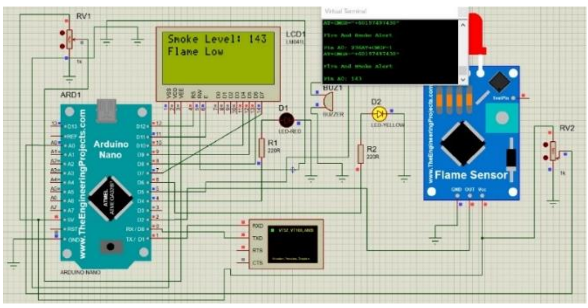

Figure 8: Simulation at normal conditions

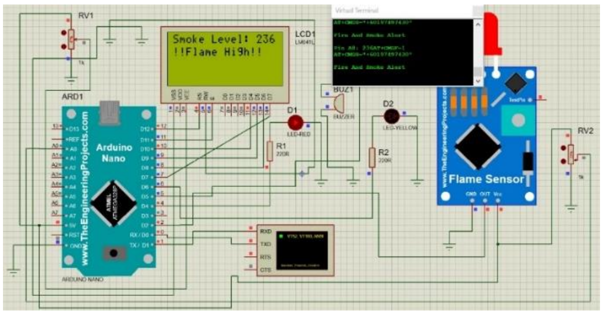

Figure 9: Simulation show after smoke and fire detected.

Table 2 shows the experimental analysis performed on the project system. When the sensor is not tested the yellow LED output will light up and the LCD display shows Smoke Level less than 200 and Flame Low. Once the MQ-2 sensor and Flame sensor detect smoke and flame, the red LED will light up and the LCD display will display a Smoke Level value of over 200 and Flame High. Next, the Buzzer will sound and an SMS is sent by the GSM Module to the user so that they can be aware of the fire. The LCD display will return to normal when smoke and flames are no longer detected.

Table 2: Results of project system analysis

Component Involved	The colour of the LED lights	LCD display for Smoke Level	LCD display for Flame Sensor	Virtual Terminal
The variable resistor reading is normal and flame sensor no detect fire	Yellow	Less than 200	Flame Low	No message
While the variable resistor reading is greater than 200 and flame sensor detect the fire	Red	More than 200	Flame High	Show the predefined message
The variable resistor reading is less than 200 and flame sensor no longer detect fire	Yellow	Less than 200	Flame Low	No message

4. Conclusion

The project was created to keep track of people who smoke in public places. Unpredictable or critical events frequently arise in crowded locations, such as shopping malls. In both smoking and non-smoking locations, the initiative will be implemented. This warning system can be implemented and operates to safeguard the community from threats that occur in public spaces, based on the findings. In fact, compared to other alarm systems on the market, this system is inexpensive to construct and simple to use. The MQ-2 and Flame Sensor components' capacity to detect smoke and fire as early warning signs in the system is obvious.

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