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Smart Fire Security System Using Arduino UNO and GSM

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ABSTRACT: The fire is a kind of disaster threatening social wealth and humanity's safety. They cause threats to the residential community and may result in deaths and property damage. In present days, people construct buildings without any proper safety measures and Fire usually occurs in homes because of carelessness and changes in the environmental conditions. So, we need a system that can detect fire accidents. The fire alarm system is needed in different places like buildings, hospitals, libraries, schools, and banks, etc. So, in this paper, we proposed a fire alarm system using Arduino. The primary purpose of the system is to provide early warning of fire. So, that the people can be evacuated & immediate action can be taken to eliminate or reduce the fire in this system, an alarm can be triggered by using detectors or by manual cell points.

KEYWORDS: Fire Detection, Arduino UNO, GSM Module, DC Motor, Sensors, Camera Module.

I. INTRODUCTION

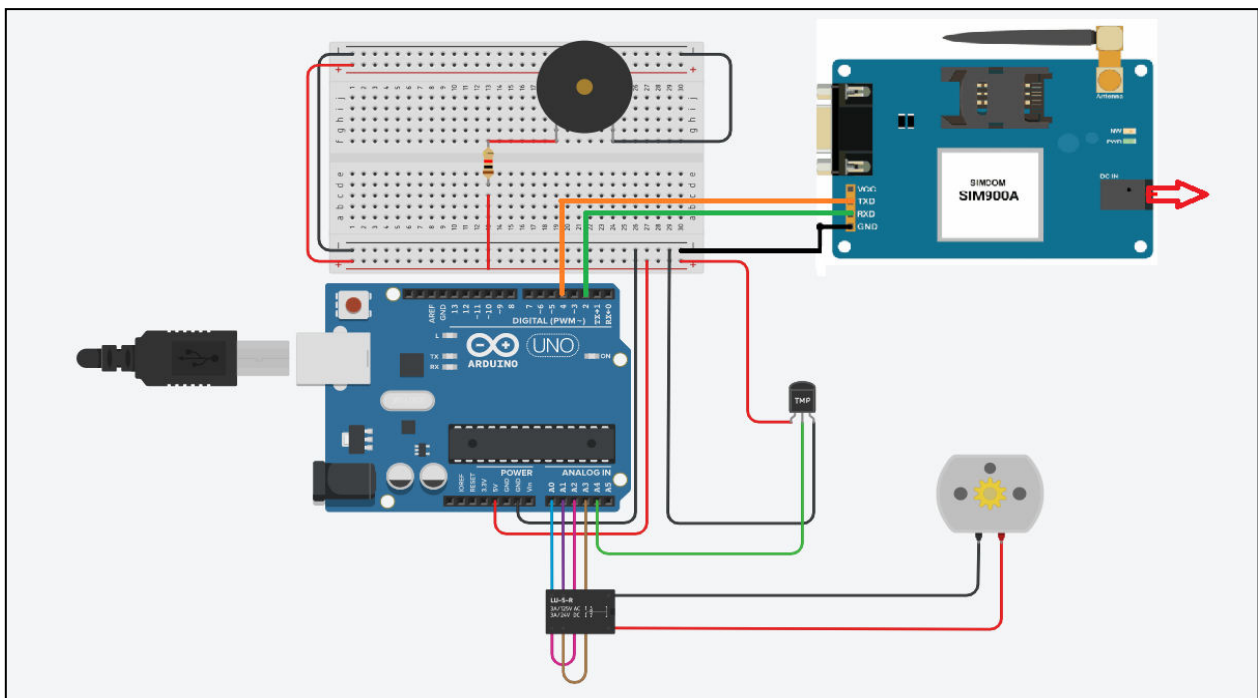
A fire alarm system is one of the basic systems that is required to be installed in every household and building in many countries. Having the system installed helps alert people of a possible fire, give them early warnings; automatically call the emergency services and contacts, minimize the time it takes for the fire department to come; lower the risks of a false fire alarm; in the event of a fault, it can tell the exact problem, it also can have reduced fire damage to property. Alarm Systems are fundamental for security reasons. In this project, we have taken a temperature sensor where the sensor will sense the fire. All Fire Alarm Systems essentially operate on the same principle. If a detector detects smoke or heat, or someone operates a break glass unit, then alarm sounders operate to warn others in the building that there may be a fire and to evacuate. For the system protecting property, it is additionally likely that the Fire Alarm will incorporate remote signalling equipment which would alert the fire brigade via a central station. Fire alarm systems include: Conventional fire alarm system, Addressable fire alarm system, Analogue addressable fire alarm system, and Wireless fire alarm system. In a Conventional fire alarm system, several call points and detectors are wired to the Fire Alarm Control Panel in Zones. A zone is a circuit and typically one which wires a circuit per floor or fire compartment. The Fire Alarm Control Panel would have several Zone Lamps. The reason for having Zones is to give a rough idea as to where a fire has occurred. The accuracy of knowing where a fire has started is controlled by the number of Zones a Control Panel has, and consequently, the number of circuits that have been wired within the building. The Control Panel would then be wired to a minimum of two sounder circuits which could contain bells, electronic sounders, or other audible devices. Sounder Circuits and Detection Zones are wired in a star configuration. Each circuit would have an end of line device which is used for monitoring purposes. Wireless fire alarm systems are an effective alternative to traditional wired fire alarm systems for all applications. They utilize license-free radio communications to interconnect the sensors and devices (smoke detectors, call points, etc.) with the controllers. It is a simple concept, which provides many unique benefits and is a full analog addressable fire detection system without the need for cable.

II. RELATED WORK

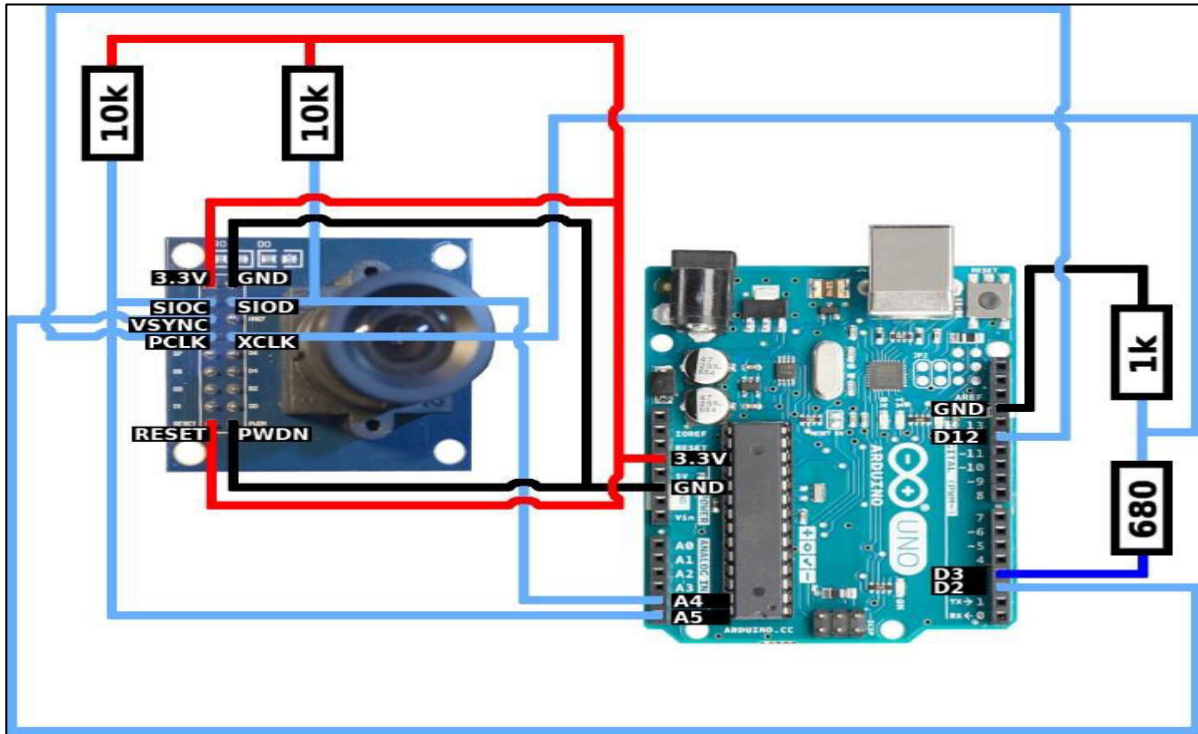
Already many solutions have been proposed and implemented for this problem. These systems make use of one of the following techniques: video surveillance system, video camera sensitive to smoke in the day time, cameras sensitive to fire flame at night, detection of heat flux using IR thermal imaging cameras and LIDAR system which detects the smoke particles by backscattering of laser light. All this system has some limitations due to atmospheric conditions such as dust particles, fog, shadows, etc. Another method is the use of Visual Cameras that take snapshots of the forest to detect the fire. These cameras were mounted on the top of communication towers [2, 3]. A rotating motor is installed to provide a full round view of the forest. The images obtained from the camera are processed using a program or MATLAB code and are compared with the reference images taken at the initial stage. This system also had the limitation of a high false alarm rate. Also, the cost of the installation of visual cameras on communication towers was very high. Another method is the use of a satellite system to detect forest fire. The main components of the system are satellite(s) and the base station that collects the data send by satellite(s) and runs the analyzing algorithm. The raw data from the satellite(s) is processed and then Advanced Very High-Resolution Radiometer (AVHRR) instrument is used to detect the presence of Hot Spots. However, the clouds greatly affect the system [4, 5]. Forest Fire Surveillance System which consists of WSN was also proposed for the detection of forest fires in South Korea. The WSN determines the temperature and humidity after which the middleware program and web application analyze the collected data. However, in this approach of detection of forest fire, there was some loss of data during communication [6]. WSN consisting of temperature sensor setup and GPS module was also proposed for detection of a forest fire. In this temperature data was transmitted to the base station via primary and main antenna using satellite. One of the limitations of the system was the installation of too many antennas; continuous power was required to both temperature sensor setup and antennas. In addition to this climatic/seasonal change can affect the system [7].

III. METHODOLOGY

Our proposed solution presents a prototype for early fire detection. In this system, the alert is sent to the main headquarter module via SMS whenever the value of any sensors exceeds its threshold value. Another SMS is also sent to the registered mobile number so that he/she can take necessary action for preventing the fire from spreading. The block diagram of our proposed solution is explained in the next section in this section we have explained all the basic components used in our prototype including sensors and microcontroller.



(A)



(B)

The components used for our project are as follows:

3.3.1 Arduino Uno

- An Arduino Uno is an open-source microcontroller board based on the microchip ATmega328p microcontroller.
- The Board has 4 digital I/O pins six analog I/O pins and is a programmable environment via a type B USB cable.
- Arduino boards are a button, or a Twitter message and turn it into an output activating a motor turning an output.



(C)

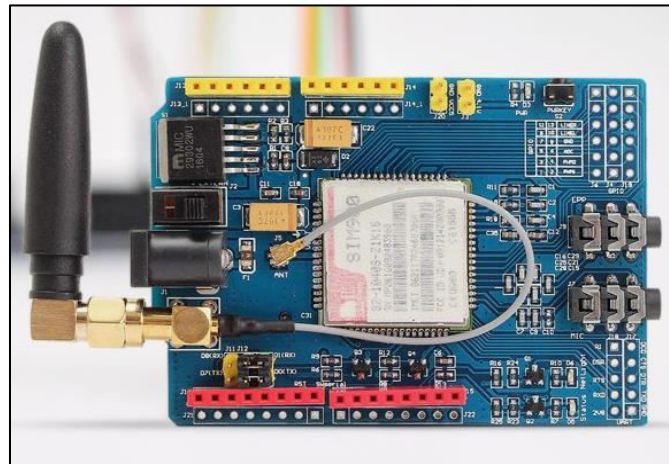
Arduino function	Pin	Arduino function	Pin
reset	(PCINT14/RESET) PC6	PC5 (ADC5/SCL/PCINT13)	analog input 5
digital pin 0 (RX)	(PCINT16/RXD) PD0	PC4 (ADC4/SDA/PCINT12)	analog input 4
digital pin 1 (TX)	(PCINT17/TXD) PD1	PC3 (ADC3/PCINT11)	analog input 3
digital pin 2	(PCINT18/INT0) PD2	PC2 (ADC2/PCINT10)	analog input 2
digital pin 3 (PWM)	(PCINT19/OC2B/INT1) PD3	PC1 (ADC1/PCINT9)	analog input 1
digital pin 4	(PCINT20/XCK/T0) PD4	PC0 (ADC0/PCINT8)	analog input 0
VCC	VCC	GND	GND
GND	GND	AREF	analog reference
crystal	(PCINT6/XTAL1/TOSC1) PB6	AVCC	VCC
crystal	(PCINT7/XTAL2/TOSC2) PB7	PB5 (SCK/PCINT5)	digital pin 13
digital pin 5 (PWM)	(PCINT21/OC0B/T1) PD5	PB4 (MISO/PCINT4)	digital pin 12
digital pin 6 (PWM)	(PCINT22/OC0A/AIN0) PD6	PB3 (MOSI/OC2A/PCINT3)	digital pin 11 (PWM)
digital pin 7	(PCINT23/AIN1) PD7	PB2 (SS/OC1B/PCINT2)	digital pin 10 (PWM)
digital pin 8	(PCINT0/CLKO/ICP1) PB0	PB1 (OC1A/PCINT1)	digital pin 9 (PWM)

Digital Pins 11, 12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17, 18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

(D)

3.3.2 GSM Module

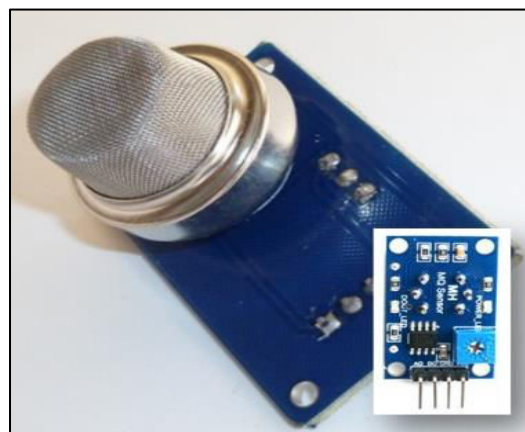
1. The acronym GSM is a presently understood global system for mobile communication. We chose the SIM900A because our country Ethiopia supports the SIM00 2G network. It requires a SIM card just like mobile phones to activate communication with the network. Also, they have IMEI (International mobile equipment identify module) number similar to mobile phones for their identification.
2. The MODEM needs AT commands for interacting with the processor or controller, which are communication serial communication. these commands are sent by the controller processor. The modern sends back a result after it receives a command. Different commands supported by the modem can be sent by the processor computer controller to interact with the GSM cellular network.



(E)

3.3.3 Gas Sensor

A gas sensor is a device that detects the presence of gas in an area. This sensor interacts with a gas to measure its concentration. Each gas has a unique breakdown voltage e . the electric field at which it is ionized. The sensor identifies gases by measuring these voltages. The concentration of the gas can be determined by measuring the current discharge in the device. The MQ-5 gas sensor detects the presence of various gases such as hydrogen, carbon monoxide, methane, and LPG ranging from 100ppm to 3000ppm. When a gas interacts with this sensor, it is first ionized into its constituents and is then absorbed by the sensing element. This absorption creates a potential difference in the element which is conveyed to the processor unit through output pins in form of current. This changes the resistance of the sensing element which alters the value of the current going out of it



(F)

3.3.6 10K Resistor

- 10k resistor color code is as shown in fig in the image it is brown, black, orange, gold color code of resistor does not depend on the power rating of the resistor on its physical size and comes under standard wattage rating of 1/4w, 1/2w, 1w, etc.
- This resistor controls the collector current passing in the transistor and affects the base point. So according to the specific amplification(gain)the designer wanted has chosen this resistor to be 10k using the basic transistor equations.
- The first band is brown as it stands for 1.
- The second band is black which means 0.
- The third band multiplier $\times 1\text{k}\Omega$ - is orange.
- The fourth band depends on the tolerance so any color is possible for the tolerance band.



(I)

3.3.7 Fire sensor

- Fire detectors sense one or more of the products or phenomena resulting from fire, such as smoke, heat, infrared, and/or ultraviolet light radiation, or gas. In dwellings, smoke detectors are often stand-alone devices.
- The IR flame sensor is used to detect the presence of fire or other infrared sources (Flame or a light source of a wavelength in the range of 760 nm to 1100 nm can be detected).



(J)



3.3.8 Camera Module

VGA CMOS CAMERA IMAGE SENSOR is a camera sensor that is small in size, low operating voltages, and provides all the features of the single-chip VGA camera and image processor. This camera sensor detects in this project for fire. VGA image of the product is up to 30 frames/ sec. Users can fully control the image quality.



(K)

3.3.9 Buzzer

A buzzer is an audio signaling device. Typical uses of buzzer include alarm device, timer, and configuration of user input.

The buzzer is used in this project is a 6V buzzer and has got enough alarm sound to be used in a fire alarm system. It is a very small and compact 2 pin structure hence can be easily used on a breadboard.

The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at the required time and require interval.



(L)

IV. RESULTS

This project successfully achieved fire detection. The fire is detected with the help of a fire sensor, gas sensor, and flame sensor. The system will send live footage of the affected area to the user. The system will immediately alert the owner and fire department. Also, after detection, the DC motor will run and the sprinkler will sprinkle water in the affected area which will extinguish fire thus reducing the fire damage.



(N)

V. CONCLUSION

The project has been made to help schools, colleges, hospitals, and places where the crowd is more. This system presented the development of a fire alarm system using the Arduino UNO. This system undoes the need for a person to continuously monitor the area. The monitoring will be done with the help of sensors. Buzzer and Message alerts are used to alert the required authorities. This system is low cost, power-efficient, and based on instruments that reliable as well as durable. The camera will give live footage of the scene thus helps the fire department to analyze the scene. An automated fire extinguishing system could be used along with the system. Many future works are also possible in this system design. We can use multiple nodes for a single receiver node. This system is developed to implement the knowledge gained during the engineering program.

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