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Development of System for Early Fire Detection using Arduino UNO

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Abstract:
The fire alarm system proposed in this paper integrates the use of affordable instruments, connectivity and wireless communication. The proposed Fire alarm systems are a real-time monitoring system that detects the presence of fire and captures images via a camera and display it on a screen. Using an automatic triggering by connecting one more arduino along with relay the screen switching would be automated. As soon as the output of the sensors viz temperature, humidity, CO2 & fire is increased above the threshold value the controller 1 would send the signals to GSM and controller 2. Now the second controller will turn ON the screen with a help of relay. In the mean time the live surveillance of the area would be captured in the wireless camera being used the embedded systems used to develop this fire alarm system is Arduino UNO. The key feature of the system is the ability to remotely send an alert whenever a fire is detected. The system will also alert the user by using a GSM module. When the presence of smoke is detected, the system will display the live feed of the area under surveillance. The advantage of using this system is that it can detect early fire. The system is also power efficient as the screen will only be ON when fire is detected.

Keywords: GSM (Global System for Mobile Communication), Arduino UNO, LIDAR (Light Detection and Ranging), AVHRR (Advanced Very High Resolution Radiometer)

1. INTRODUCTION

Fire is an undesirable event. Forest fire also known as bush fire or hill fire is an uncontrolled fire occurring wild or forest areas. It is very important to detect these kinds of fire as early as possible so as to prevent the damage from it to ecological system. Every year millions of acres of forest are burnt down. The land where forest is burnt it becomes impossible to grow vegetation over there. This is because soil becomes water repellant and accepts no more water, leading to reduction in ground water level. The global warming report 2008 mention forest fire as one of the major cause behind increase in global warming. In recent year 2016 more than 4000 hectares of forest were burnt in the hills of Uttarakhand. This shows that these fires cause a great loss to social wealth as well as human life. So there is an urgent need of the hour to develop a system that could detect and alert the concerned authorities about the fire as early as possible. The fire alarm system proposed in this paper integrates the use of affordable instruments, connectivity and wireless communication. The system has lower power consumption and faster processing ability at a lower cost.

2. LITERATURE SURVEY

Already many solutions has 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 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 program or MATLAB code and are compared with the reference images taken at initial stage. This system also had limitation of high false alarm rate. Also the cost of installation of visual cameras on communication towers was very high. Another method is the use of satellite system to detect the forest fire. The main components of the system are satellite(s) and the base station that collects the data send by the 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 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 detection of forest fires in South Korea. The WSN determines the temperature and humidity after which middleware program and web application analyzes 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 forest fire. In this temperature data was transmitted to base station via primary and main antenna using satellite. Some of the limitation of system was installation of too many antennas; continuous power was required to both temperature sensor setup and antennas. In addition to this climatic/seasonal changes can affect the system [7].

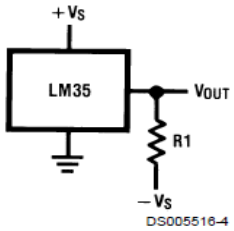
3. PROPOSED SOLUTION

Our proposed solution presents a prototype for early forest fire detection. In this system the alert is send to the main headquarter module via SMS whenever the value of any sensors exceeds its threshold value. Another SMS is also send

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 next section in this section we have explained all the basic components used in our prototype including sensors and microcontroller. The components used for our project are as follows:

3.1 Temperature Sensor

The most important phenomenon that occurs during a forest fire is the rise in the temperature. In our prototype we have used the LM35 as the temperature sensor. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy).



Choose $R_1 = -V_S/50\ \mu A$
V_{OUT}=+1,500 mV at +150°C
= +250 mV at +25°C
= −550 mV at −55°C

Figure.1. LM35 Temperature sensor

3.2 Humidity Sensor

Humidity is a very important feature in detecting a fire. In case fire the air will be dry thus decreasing the humidity. This decrease in humidity can give us indication of forest fire. The DHT-11 sensor can be used to detect humidity in the range of 20-90% RH with the accuracy of ±5% RH. DHT-11 uses resistive type humidity measurement component.

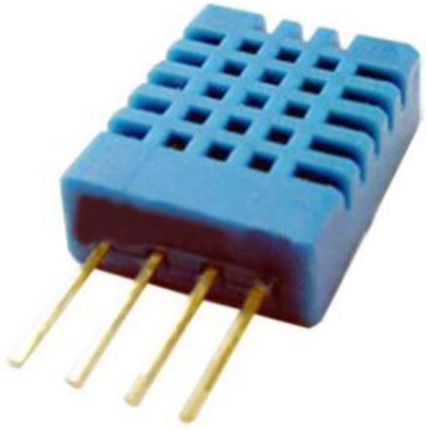


Figure.2. DHT-11 sensor

3.3 Smoke Sensor

One of the main characteristics of fire is the smoke. Thus smoke sensors can play a vital role in detecting fire in the forest. We have used MQ-2 sensor for detecting smoke depending upon its availability and cost. MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application. Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising. Please use simple electro circuit, Convert change of conductivity to correspond output signal of gas concentration.

Figure.3. MQ-2 Sensor

3.5 Gas Sensor

A gas sensor is a device which 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. 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 on 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.

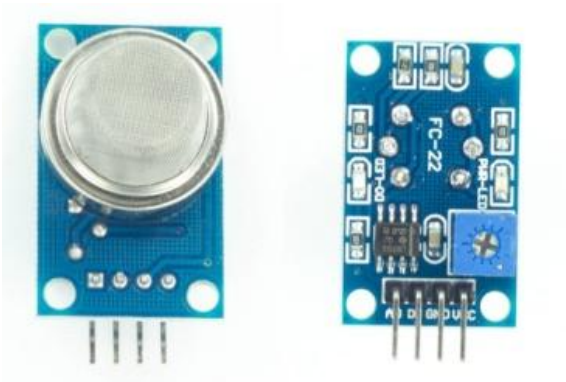


Figure.4. MQ-5 Gas Sensor

3.4 GSM Module

GSM (global System for Mobile Communication) is a digital mobile telephony syatem that is widely used in all parts of the world. It uses a variation of time division multiple access(TDMA) and is most widely used of the three digitakl

wireless telephony technologies (TDMA, GSM and CDMA).The GSM used in our project is SIM-900A GSM module. SIM- 900A is a dual band GSM/GPRS engine. It works on frequencies 900/1800 MHz. The Modem is coming with RS232 interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The onboard Regulated Power supply allows you to connect wide range unregulated power supply. Using this modem, you can make audio calls, SMS, Read SMS; attend the incoming calls and internet through simple AT commands

3.5 Arduino

Arduino is a tool for the design and development of embedded computer system, consisting of a simple open hardware design for single board microcontroller. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

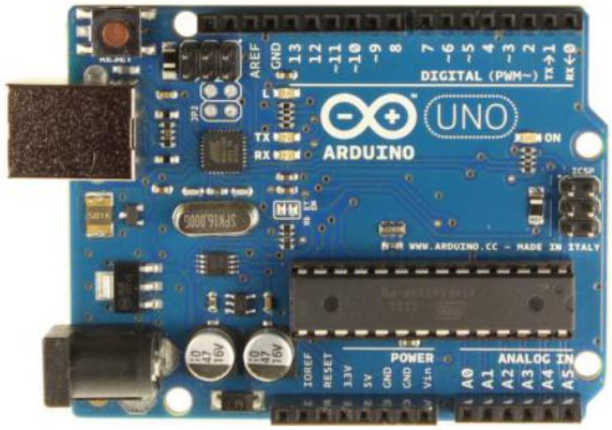


Figure 5: Arduino UNO

3.6 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. A solid state contactor is a heavy-duty solid state relay, including the necessary heat sink, used where frequent on/off cycles are required, such as with electric heaters, small electric motors, and lighting loads. There are no moving parts to wear out and there is no contact bounce due to vibration. They are activated by AC control signals or DC control signals from Programmable logic controller (PLCs), PCs, Transistor-transistor logic (TTL) sources, or other microprocessor and microcontroller controls.

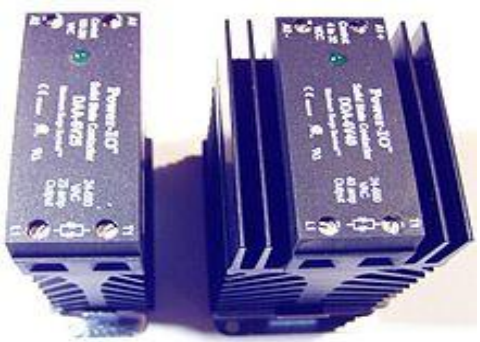


Figure 6: Solid State Contactor Relay

4. SYSTEM ARCHITECTURE AND WORKING

Figure 4 below shows the architecture of the proposed fire alarm system. The structure of this fire alarm system is composed of four sensors viz gas, temperature, smoke and humidity. The sensors will sense the various factors that are changed during a fire. Threshold values for these factors are feed in the microcontroller board Arduino UNO. The main function of the Arduino UNO is to process the analog inputs from the various sensors and send SMS using the GSM module. Second microcontroller is used to process the message from the GSM and based on that control the screen.

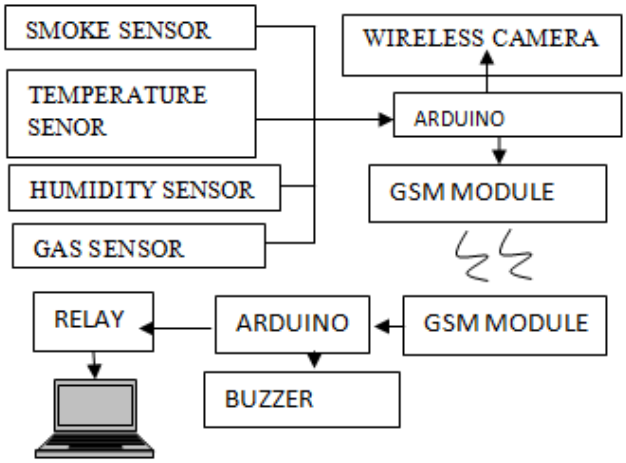


Figure.7. Block Diagram of fire Surveillance System

The system will take the input from the four sensors namely temperature sensor, Gas sensor, Humidity Sensor and smoke sensor. The input of these sensors will be given to the microcontroller board which in our case is the Arduino UNO. The microcontroller will compare the input from the sensor with the predefined threshold values. These threshold values are such that under normal conditions the output of these sensors will never cross these values. These values are only attained if there is a fire in the surrounding. If the input has surpassed these threshold values the microcontroller will give a signal to the GSM module and the relay which will be controlling the wireless camera. As the relay receives a high input from the microcontroller it will switch on the camera and live feed will be given. The GSM module after receiving a input signal from the microcontroller will send a message to the registered user and receiver GSM module. This here is the work of the transmitter section now we will proceed to the receiver section. The receiver section consists of a GSM module, screen, relay and a buzzer. The receiver GSM module

after receiving a signal from the transmitter GSM module will send a signal to the receiver microcontroller (Arduino UNO). The microcontroller will in turn control the relay and the buzzer. The relay in the receiver side is used to control the screen. If the screen is kept on for a long time it will consume energy and power will be wasted. The working of the transmitter side is shown in figure 5 with the help of a flowchart.

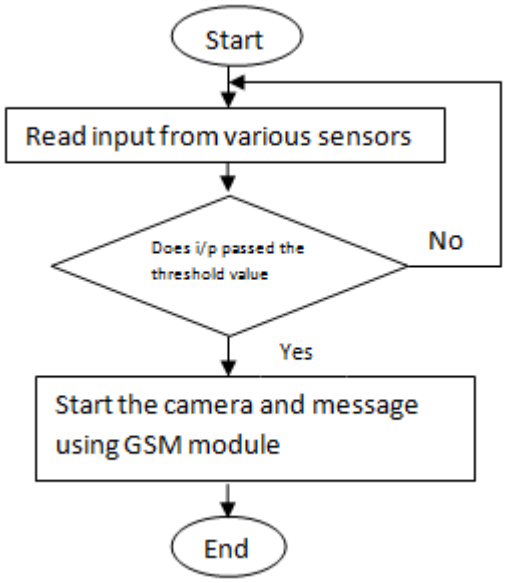


Figure.8. Flowchart of the Transmitter Section

5. CONCLUSION AND FUTURE WORK

This system presented the development of a fire alarm system using the Arduino UNO. This system undoes the need of 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 a low cost, power efficient and based on the instruments that reliable as well as durable. Many future works are also possible in this system design. We can use the multiple nodes for a single receiver node. GPS module could also be used to pin point the exact position of the fire. We can use the wind sensor to determine the rate of fire flow and its direction. Automated fire extinguishing system could be used along with the system. This system is developed to implement the knowledge gained during the engineering program.

6. REFERENCES

[1]. Stipanicev D., Vuko T., Krstinic D., Stula M., Bodrozic L., " Forest Fire Protection by Advanced Video Detection System-Croatian Experiences", Split, Croatia, 2006

[2]. Losso A., Corgnati L., Perona G., "Early Forest Fire Detection: Smoke Identification through innovative Image Processing using Commercial Sensors", Environment Including Global Change, Palermo, Italy, 2009

[3]. Kovacs R., Kiss B., Nagy A., Vamos R., "Early Forest Fire Detection System For Vegetable Fire in the Aggtelek National Park", Budpest, Hungary,2004

[4]. Kelha V., Rauste Y., Buongiorno A., "Forest Fire Detection by Satellites for Fire Control", European Space Agency, Finland, 2000

[5]. Manyangadze T., "Forest Fire Detection for Near Real Time Monitoring using Geostationary Satellite", International Institute for Geo-information Science and Earth Observation, Enschede, Netherland, 2009

[6]. Son B., Her Y., Kim J., "A Design and Implementation of Forest Fire Surveillance System based on Wireless Sensor Network for South Korea", International Journal of Computer Science and Network Security, Vol 6 No. 9B, September 2006

[7]. P.J. Vivek, G. Raju, S. Akarsh, "Forest Fire Detection System", International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319-8753, Vol 3, Issue 6, June 2014