GSM based Forest Fire Protection

Akash Shirture[1] Anjali Sangare[2] Lokesh Mahajan[3] Prof. Madhuri Sonwane[4]
[1,2,3,4]Department of Electrical Engineering
[1,2,3,4]Thakur Shivkumar Singh Memorial Engineering College (Affiliated to RGPV Bhopal), Burhanpur, M. P., India

Abstract—Natural disasters have always been mankind's constant companion since time immemorial. Forest fire is one such disaster which when occurs at large scale not only destroys the flora, fauna, vegetation of the forest but also puts the life of human being and animals at a very high risk. In the recent past years, managing this type of crisis, viz., a large scale fire has become a very difficult and challenging task. Security and automation is prime concern in our day to day life. The approach to home and industrial automation and security system design is almost standardized nowadays. In this paper, we have tried to increase this standard by combining new techniques and developed a low cost home and industrial automated security systems. Everyone wants to be as much as secure as possible. The design of simple hardware circuit enables every user to use this.

Keywords: Fire Sensor, Temperature Sensor, Gas Sensor, Flame Sensor

I. INTRODUCTION

Earth is an intrinsically flammable planet owing to its cover of carbon-rich vegetation, seasonally dry climates, atmospheric oxygen, and widespread lightning and volcano ignitions. The forest provides a home for wildlife, they support many types of flowers, they provide oxygen. As they are surrounded by oxygen, the combustion reaction takes place rapidly. Harmful forest fire can be strongly influenced by the amount and condition of fuel available to burn (leaf litter, bark, leaves and branches). When forest fire occurs, the spread of wildfires varies based on the flammable material present, its vertical arrangement and moisture content, and weather conditions.

Fig. 1: Regular Fire Affected Area of India

Fire Alarm Systems are very essential for security purpose. Whatever field we choose for our survey we can get a clear view of fire hazards in a system. Fire Alarm and protection system is a combination of Electrical and Electronics Instruments. Now by using power electronics switches we have increase the efficiency of this system a lot.

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II. LITERATURE REVIEW

Numerous solutions have been proposed and implemented for this problem. Most common systems used in field work are video surveillance systems. Video cameras are sensitive to smoke only in day time. Fire sensitive cameras at night, using IR thermal imaging cameras for heat flux detecting and using backscattering of laser light, detect the smoke particles. This fire alert system has a few limitations because of environmental conditions like dust particles, mist, shadows and so on. Another method is automated picture capturing of fires in forest. Capturing can be done by the cameras which are placed on top of towers. A motor was introduced to give a coverage view on the forest and for its movement (Basu et al., 2018). Captured pictures are processed using program or MATLAB simulation and matching with references taken at beginning stage. This alert system has limitation of false caution rate and visual cameras installed on towers are of high cost. Another method of fire detection is by using satellite systems. Base station collects the information sent by the satellite and runs an algorithm to recognize the facts (Basu et al., 2018). The raw data of satellites are processed and then Advanced Very High Resolution Radiometer instrument is utilized to recognize hotspots. In South Korea, forest fire surveillance system was proposed by using wireless sensor networks. Wireless sensor networks detect humidity and an application analyses the collected information (Hariyanwal et al., 2013; Kumar et al., 2017). In this methodology, there is some loss of information during communication. By using temperature sensor and GPS modem, forest fire detection can be possible (Basu et al., 2018). Here, temperature sensor collected data were sent to base station by both primary and main antennas (Alahi et al., 2017). Continuous power supply was difficult for too many antennas and sensors. In addition to the above limitations climatic changes may affect the system.

III. TYPES OF FOREST FIRES

Forest fires can usually be divided into three categories namely.

- Ground Fire
- Surface Fires
- Crown Fires

A. *Ground Fire*

This kind of fires is the most difficult to detect because they are undetectable until they blaze up. Generally by the time they are detected, the forest undergrowth is already reduced to ashes, killing all the animals that live underground. Ground fires as given in Fig. 1 occur basically on the floor of forest which will produce much heat but without flames.

Ground type of fires is rarest of the three and has been rarely recorded because they normally occur at forests which are situated at very high altitudes such as Himalayan forests.

B. *Surface Fire*

Surface fires, occurring on or near the ground in the litter, ground cover, scrub and regeneration, are the most common type in all fire-prone forests of the Mediterranean countries. In this type, the spread of fire is regular and usually depends on wind speed. Surface fires burn only surface litter and duff. These are the easiest fires to put out and cause the least damage to the forest Surface fires are the most tame fire and can be put out relatively easily, these fires only occur at the surface and are generally no taller than the average human. Surface fires create the least amount of destruction. Surface fires occur on the ground and the spread of this type will always take a regular shape and will usually depend on the speed of wind.

To detect this type of fire which will not only produce flames but will also generate smoke one can go for smoke sensor.

C. *Crown Fire*

Crown fires the most dangerous fires for a forest, spread rapidly and widely this type of fires will give much more flame then smoke. To detect these fires one needs a very robust sensor that can withstand a very high temperature. Crown fires pose the highest risk by far due to their fast spreading behavior, they develop on top of trees and in some cases can jump from one tree to another making these the most aggressive form of fire.

Fig. 2: Types of forest fire

IV. CAUSES OF FOREST FIRE

- Less moisture content in the fuel
- Wind movement
- Topography
- Forest cover
- Debris burning
- Camp fire or fire used for cooking
- Incendiary
- Lighting of match sticks negligently
- The most common cause of wildfires varies throughout the world. In Canada and northwest China, for example, lightening operates as the ma-jor source of ignition. In other parts of the world, human involvement is a major contributor.

V. EFFECT OF FOREST FIRE CLIMATE

- Heat waves, droughts, cyclical climate changes such as El Niño, and regional weather patterns such as high pressure ridges can increase the risk and alter the behavior of wildfires dramatically.
- Years of precipitation followed by warm periods can encourage more widespread fires and longer fire seasons.
- Since the mid-1980s, earlier snowmelt and associated warming has also been associated with an in-crease in length and severity of the wildfire season in the Western United States. Global warming may increase the intensity and frequency of droughts in many areas, creating more intense and frequent wildfires.
- A 2015 study indicates that the increase in fire risk in California may be attributable to human-induced climate change.
- A study of alluvial sediment deposits going back over 8,000 years found warmer climate periods experienced severe droughts and stand replacing fires and concluded climate was such a powerful influence on wildfire that trying to recreate presettlement forest structure is likely impossible in a warmer future
- Intensity also increases during daytime hours. Burn rates of smoldering logs are up to five times greater during the day due to lower humidity, in-creased temperatures, and increased wind speeds.

VI. TYPES OF TEMPERATURE DETECTOR

(1) Resistance Temperature Detector
(2) Thermistors
(3) Thermocouples

The main concern of this report are Resistance Temperature Detector (RTD) and Thermistors, so they will be discuss in detail, which both falls into the category of ELECTRICAL RESISTANCE SENSOR. Whereas the working principle of a thermocouple is related with change in EMF generated due to the use of two dissimilar wires.

VII. SENSING DEVICES FOR DETECTOR

There are two sensing devices mainly used for this report which are discuss in details.

A. Resistance Temperature Detector

Resistance Thermometers, also called Resistance Temperature Detectors or Resistive thermal devices (RTDs), are temperature sensor that exploits the predictable change in electrical resistance of some materials with changing temperature. As they are almost invariably made of platinum, they are often called platinum resistance thermometers (PRTs). They are slowly replacing the use of thermocouples in many that governs resistance thermometry.

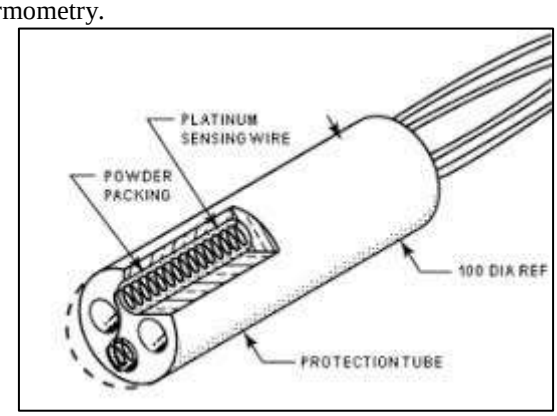

Fig. 3: Resistance Temperature detector

B. Thermistor

A thermistor is an electrical device made of a solid semi-conductor with a high temperature coefficient of resistivity which would exhibit a linear voltage current characteristic if its temperature were held constant. When a thermistor is use as a sensing element, the relationship between resistance and temperature is primary concern.

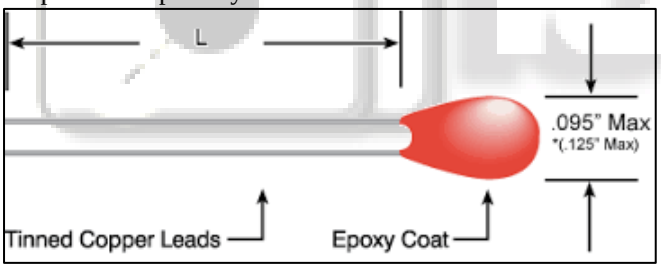

Fig. 4: Thermistor

VIII. METHODOLOGY

Basically, the design and development of this project are divided into two main parts which are hardware architecture and software details. In the hardware architecture, the design of the circuit was constructed and the prototype of the project was built. While in the software development, the whole complete prototype was operated via programming codes.

A. Hardware Architecture

1) Arduino Uno ATMega328

Since Arduino is the main board, microcontroller on it which is ATmega328 is used as the main controller to manage the circuit accordingly. It is a well-known open source microcontroller-based kit for creating digital devices and interactive tool that can interact with LEDs, LCD display, switches, buttons, motors, speakers and many more. The Arduino system offers a set of analog and digital pins that can be integrated to many other boards and circuits which absolutely have different functions in a design. Arduino board provides a USB serial communication interfaces for loading the codes from computer. To do the codes, Arduino has prepared its own software called integrated development environment (IDE) which completely supports C and C++ programming languages. Figure 1 shows the Arduino UNO board that is used throughout the project.

Fig. 5: Arduino Uno ATMega328

2) GSM SIM900A

GSM (global system for mobile communication) is a cellular network. GSM network operate in four different frequency ranges. Most GSM network operates on 900 MHz or 1800MHz bands. The transmission power limited to a maximum of 2 watts GSM 850/900/300 and 1 watt in 1800 /1900. The longest the GSM specification support in practical use is 3.5km (2mi). In this project we have use a SIM 900a based GSM modem to receive and send short message to user and system.

Fig. 6: GSM SIM900A

SIM900A GSM Module is the smallest and cheapest module for GPRS/GSM communication. It is common with Arduino and microcontroller in most of embedded application. The module offers GPRS/GSM technology for communication with the uses of a mobile sim. It uses a 900 and 1800MHz frequency band and allows users to receive/send mobile calls and SMS.

3) LM35 sensor

LM35 is chosen for measuring the temperature since it is an analog and linear temperature sensor which has a linear relationship between output voltage and temperature changes (°C). Besides, the LM35 does not require external calibration to deliver the accuracy of ±(1/4) °C at room temperature or ±(8/4) °C at the temperature range of -55 °C

to +150 ºC [10]. Due to its low-input impedance, linear output, and accurate inherent calibration of LM35, it does make the sensor's readout and control circuitry interfacing become easy [10], [11]. The device is usually used with single power supply or with plus or minus supplies. It can receive an input range of -2V up to 35V and result the output voltage range of -1V to 6V. Figure 3 displays the LM35 sensor which is used to measure the temperature for this project.

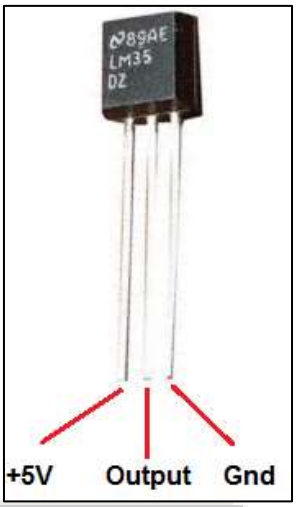

Fig. 7: LM35 sensor by Texas Instrument

4) Flame Sensor

Flame sensor is the most sensitive to ordinary light that is why its reaction is generally used as flame alarm purposes. This module can detect flame or wavelength in 760 nm to 1100 nm range of light source.

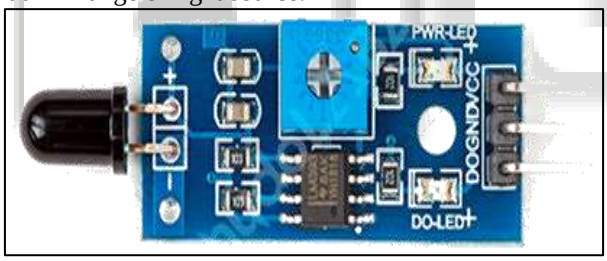

Fig. 8: flame sensor

5) LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of application. A 16×2 LCD display is very basic module and very commonly used in various device and circuits.

Fig. 9: LCD Display

6) Alert Buzzers

Audio signaling device such as Alert buzzer or beeper which may be mechanical, electromechanical or piezoelectric (piece for short). The uses of buzzers and beepers which includes timers, alarm devices mouse click and keystroke.

Fig. 10: Alert buzzers

IX. BLOCK DIAGRAM

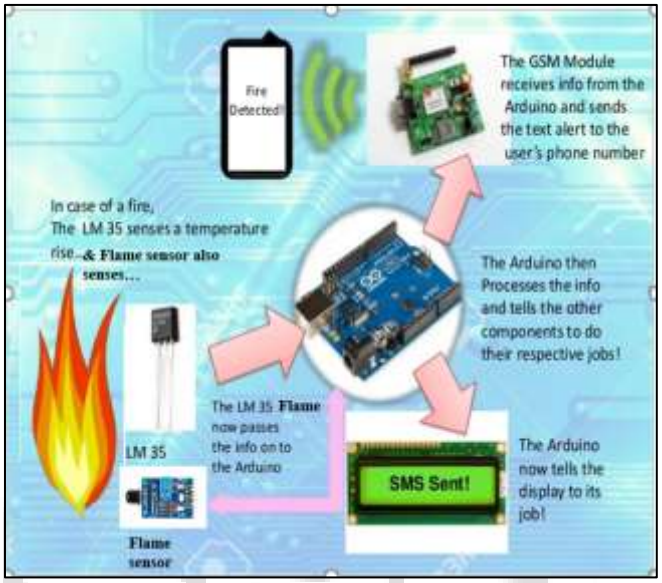

Fig. 11: Block Diagram

X. WORKING OF FOREST FIRE PROTECTION

For developing this forest fire detection system[7] only a few components are needed, namely, flame sensor, LM-35 temperature sensor, Arduino UNO development board, GSM module.

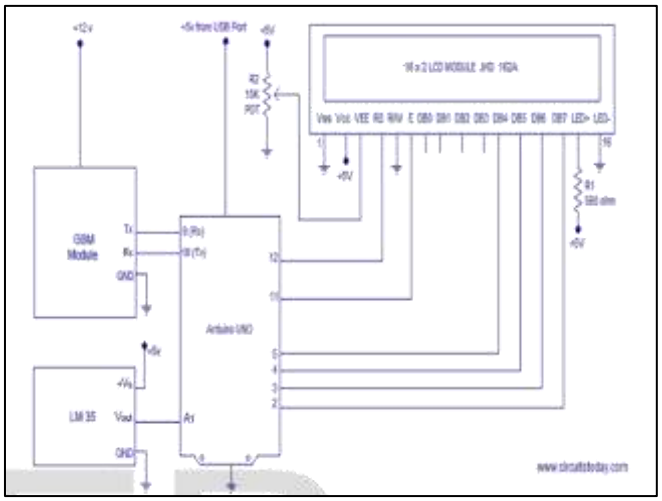

Fig. 12: Circuit diagram of GSM based fire detection system using Arduino Uno

The woodland fire recognition module works in three distinct stages. The principal stage comprises of perusing out-side ecological boundaries for example temperature and smoke focus utilizing temperature sensor LM-35 and flame sensor .The sensors read boundaries like temperature and air

quality and transmit this data to the following closest hub. This procedure goes on until the data arrives at the last node (multi-bounce transmission). This is the second phase of the general procedure. The third stage comprises of transmission of the data to the woodland fire observing unit or base station where the sensor readings are contrasted and the pre-characterized edge esteems to see if there is fire or no fire.

The figure shown below demonstrates the work flow of the fire detection system.

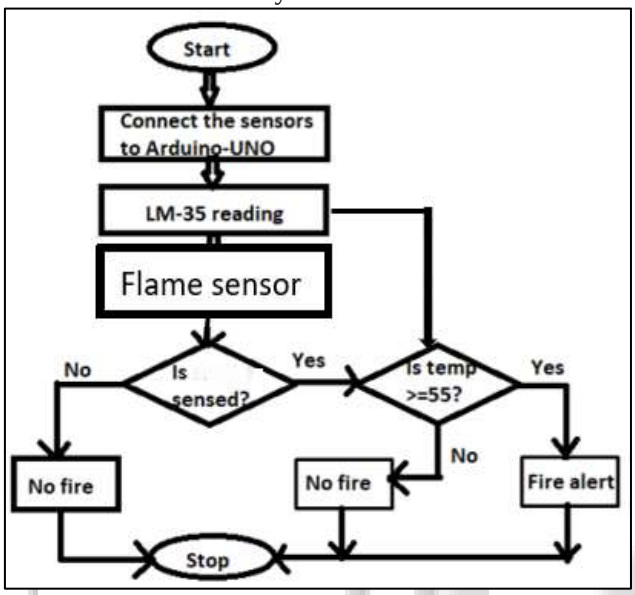

Fig. 13: Flow diagram of the fire detection system

Two sensors, temperature sensor LM35 and flame sensor are interfaced with Arduino UNO. The sensors pass on the readings to the Arduino board that has Atmega16 microcontroller, which will compare the readings with the threshold values. When the threshold limits [9] are exceeded, information goes to the receiver on mobile phone through GSM module. Then, the necessary actions to avoid spreading of fire are initiated.

XI. Results

Few tests were done to observe the system's performance. The tests were completed by applying heat near to the LM35. the condition which the LM35 is in ready mode (ready to detect fire but detect none) displays when the LM35 detected fire and alert message will appear on the LCD display. While exhibits the condition after the fire has been put out reveals the SMS received by the user when fire alert is notified by the system .The paper present user friendly and Low cost home and industrial security systems. It's a real time security purpose system developed with simple hardware which simplifies the possibility of error free security system. The system can be easily implemented with maximum reliability and the high security with the low cost is a special enhancement from the existing systems for home security. If this type of project is implemented by the Government then many lives can be saved including humans and animals as well as valuable trees. It can also save capitals, time and manpower. Implementation of this project can solve many of the environmental issues.

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