



# SOLAR POWERED WIRELESS FOREST FIRE DETECTION

**1Aparna Gosavi, 2Aniket Pawar, 3Supriya Bhosale, 4Vaibhav Pokharkar**

**1Student, 2Student, 3Student, 4Student**

**1Zeal College of Engineering And Research ,Pune,**

**2Zeal College of Engineering And Research ,Pune,**

**3Zeal College of Engineering And Research ,Pune,**

**4Zeal College of Engineering And Research ,Pune,**

## **ABSTRACT:**

This project proposes an effective viable solution for detecting forest fires, in this paper the system incorporates. GSM network, so that the signal could be sent any far distance, where the centralized control centre is located. The proposed system consists of smart sensor which uses solar power for its operation and a GSM module which is connected to the GSM network for transmitting the detected fire alarm signal. When fire is detected, the sensor produces a signal of approximate level which triggers GSM module to transmit the alarm signal to far end control centre. The centre in turn processes the signal and takes necessary action to counteract the situation. Since the sensors in the system powered by the GSM module is powered by solar energy there is no need for conventional electrical energy. It is expected that the system could be a cost effective one and a viable one for detecting fires. The aim of our project is to continuously monitoring forest condition, detect ion of forest fire and its position and to inform the forest authority. So that necessary action can be taken immediately in case of fire. The two main modules present in the project are the GSM Module and the GPS Module. This paper gives an importance of wireless sensor technology. The sensors collect the data and transmit to the central unit as well as alert is sent via call or message using GSM.

Keywords: GSM, GPS, Flame Sensor, Temperature sensor, Smoke Sensor, Wireless Sensor Technology.

## 1.INTRODUCTION:

Forests are part of the important and indispensable resources for human survival and social development that protect the balance of the earth ecology. However, because of some uncontrolled anthropogenic activities and abnormal natural conditions, Forest Fires occur frequently [1]. Frequency of forest fires has increased considerably due to climate changes, human activities and other factors. The prevention and monitoring of Forest Fires has become a global concern in Forest Fire prevention organizations.

In order to simplify and reduce the costs of fire monitoring, the concept of Wireless sensor Networks (WSNs) [2] has been recently proposed. Cheap and compact wireless sensor devices deployed over a large territory and operating both jointly and autonomously may be effectively used to detect hazardous gases and monitor wild-fires [3]. Forests Fires is the most universal and most immediate destructive agency. This is usually caused due to carelessness and negligence but exceptionally because of matchsticks, friction of rocks etc.

In this project, an automatic early warning system integrating multiple sensors to remotely monitor areas of forest for the risk of fire and extreme weather conditions is developed. The system integrates various sensors including temperature sensor, smoke sensor, carbon monoxide sensor, flame sensor. The signals and measurements collected from these sensors are transmitted to the control centre using GSM module to automatically analyse and combine sensor information and detect the presence of fire or smoke.

### 1.1 THE CAUSES FOR FORESTS FIRES ARE:

1. Less moisture content in the fuel
2. Wind movement
3. Topography
4. Forest cover
5. Debris burning
6. Camp fire or fire used for cooking
7. Incendiary
8. Lighting of match stick

### 1.2 OBJECTIVE:

Continuously monitoring forest condition, detection of forest fire and its position and inform the forest authority so necessary action can be taken immediately in case of fire

1. Study the working of Arduino with different sensors.
2. To understand the operation of GSM module with the Arduino uno for fire detection system.
3. To study causes of fire and find solution to it.
4. To study function of different sensors like flame sensor, temperature sensor, smoke sensor.
5. To establish the behavioural characteristics of fire including causes and interventions.
6. To investigate the challenges associated with fire-fighting and response services.
7. To review existing techniques applied in the detection of fire at residential level and review their challenges.

8. To develop a prototype that incorporates multiple sensors to detect residential fire outbreaks.
9. To test the developed prototype.

### 1.3 COMPONENTS USED ARE:

1. Flame sensor
2. Smoke Sensor
3. Toxic Gases Sensor
4. Temperature Sensor
5. LM35 Arduino UNO
6. SIM900A GSM Module
7. Charging kit 12 v
8. Solar panel 12v
9. LCD Display
10. 12v Li-Ion battery

#### I. FLAME SENSOR:

A flame-sensor is one kind of detectors which is mainly designed for detecting as well as responding to the occurrence of a fire or flame. The response of these sensors is faster as well as more accurate compare with a heat/smoke detector because of its mechanism while detecting the flame. Flame sensors are classified into four types

- IR single frequency
- IR multi-spectrum
- UV flame detectors
- UV/ IR flame detectors

#### FEATURES OF FLAME SENSORS ARE

1. Photosensitivity is high
2. Response time is fast
3. Simple to use
4. Sensitivity is adjustable
5. It is responsive to the flame range.
6. Accuracy can be adjustable.



FIG 1 Flame sensor

## ii. SMOKE SENSOR:

A smoke detector is a device that senses smoke, typically as an indicator of fire. Commercial smoke detectors issue a signal to a fire alarm control panel as part of a fire alarm system, while household smoke detectors, also known as smoke alarms, generally issue an audible or visual alarm from the detector itself or several detectors if there are multiple smoke detectors interlinked. There are two basic types of passive smoke detectors photoelectric and ionization.

The ionization smoke detector consists of an alpha particle producing a radioactive source, a smoke chamber, and charged detector plates. Ionization smoke alarms work by detecting the presence of large quantities of very small particles entering the ionization chamber, which when in sufficient quantity will cause an alarm to sound.

Photoelectric technology is generally more sensitive to the large smoke particles that tend to be produced by smouldering fires. "Smoke produced by a fire affects the intensity of a light beam passing through air. The smoke can block or obscure the beam. It can also cause the light to scatter due to reflection off the smoke particles. Photoelectric smoke detectors are designed to sense smoke by utilizing these effects of smoke on light.



FIG 2 Smoke sensor

### III. TOXIC GAS SENSOR:

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. Toxic gas detectors are used in work places that use toxic gas in order to secure worker safety, detect the location of any leakage, and measure gas concentrations. Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion They may be used in fire fighting.



FIG 3 Toxic gas sensor

### IV. TEMPERATURE SENSOR:

These are the most common type of sensors and detect temperature or heat. temperature sensors can be broadly classified into two categories namely contact and non-contact sensors.

- *Contact Sensor:*

The first category which is contact temperature sensors require physical contact with the objects to be measures such as solids and liquids.

- *Non-Contact Sensor:*

Noncontact sensors use radiation and convection to monitor temperature changes.

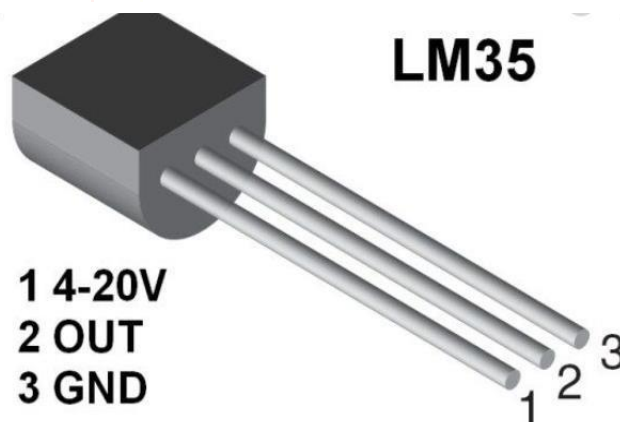


FIG 4 Temperature sensor

#### v. **SIM900A GSM MODULE:**

The SIM900A is a readily available GSM/GPRS module, used in many mobile phones and PDA. The module can also be used for developing IOT (Internet of Things) and Embedded Applications. The G.S.M refers to global system for mobile. It acts as the transmitting device which can transmit the reference signal over a global area through its wide spread network.



FIG 5 SIM900A GSM Module

#### ***SIM900A GSM MODULE Features***

- Single supply voltage: 5 V
- Power saving mode: Typical power consumption in SLEEP mode is 1.5mA
- Frequency bands: SIM900A Dual-band: EGSM900, DCS1800. The SIM900A can search the two frequency bands automatically. The frequency bands also can be set by AT command.
- GSM class: Small MS
- GPRS connectivity: GPRS multi-slot class 10 (default) , GPRS multi-slot class 8 (option)
- Transmitting power: Class 4 (2W) at EGSM 900, Class 1 (1W) at DCS 1800
- Operating Temperature: -30°C to +80°C
- Storage Temperature: -5°C to +90°C
- DATA GPRS: download transfer max is 85.6KBps, Upload transfer max 42.8KBps
- Supports CSD, USSD, SMS, FAX
- Supports MIC and Audio Input
- Speaker Input
- Features keypad interface
- Features display interface
- Features Real Time Clock
- Supports UART interface

- Supports single SIM card
- Firmware upgrade by debug port
- Communication by using AT commands.

Arduino GSM shield The Arduino GSM Shield connects an Arduino to the internet using the GPRS wireless network. A GSM library contained in the Arduino IDE enables an Arduino board to do most of the operations you can do with a GSM phone: place and receive voice calls, send and receive SMS, and connect to the internet over a GPRS network (Arduino, 2014).

#### vi. **LI-ION BATTERY:**

A lithium-ion battery or Li-ion battery is a type of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace applications.

In the batteries, lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge, and back when charging. Li-ion batteries use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. The batteries have a high energy density, no memory effect and low self-discharge.

#### vii. **The LCD Display:**

This is used for displaying the current status of the circuit and the actions taken by the circuit. It displays if fire is occurred or not.

#### viii. **The Arduino UNO:**

It is an open-source microcontroller-based kit for building digital devices and interactive objects that can sense and control objects in the physical world. It is based on microcontroller board designs, manufactured by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino has a specific software associated with it which provides an integrated development environment (IDE) based on the Processing project, which includes support for the C and C++ programming languages. In this project this is the main workhorse. This controls the entire circuit and makes all the decisions.

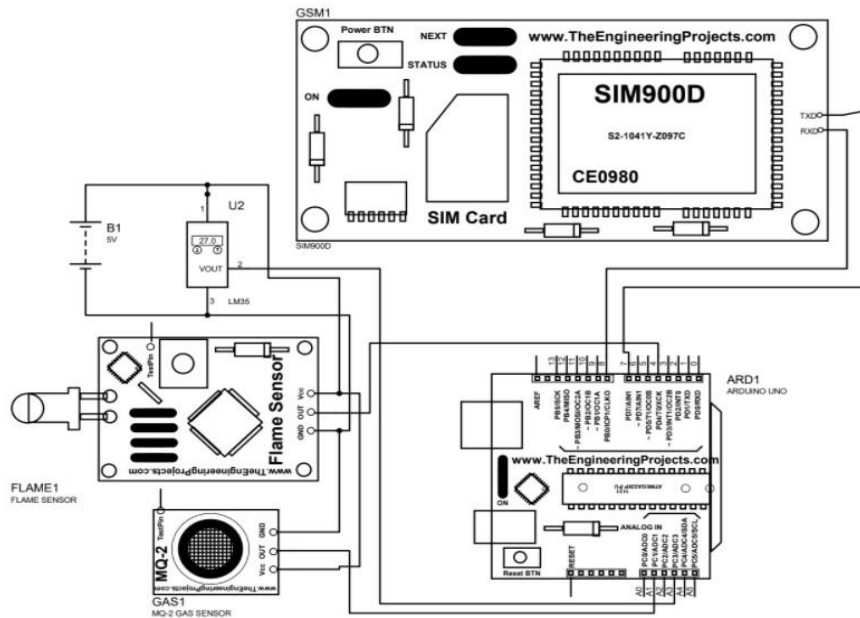


FIG 6. Module of Wireless Forest Fire Detection

## 2.Working:

In this project we have used the smoke sensor, temperature sensor, toxic gas sensor and flame sensor which are connected to output of Arduino UNO. Arduino UNO is connected to GSM and GPS module which is powered by 12v solar panel. Since the sensors in the system powered by the GSM module is powered by solar energy there is no need for conventional electrical energy. Hence the system is cost effective.

When the fire occurs, the sensors sense the fire according to their functions.

Temperature sensor detect the temperature if it goes beyond a certain critical point. Smoke sensor detect the smoke. Smoke alarms provide a critical early warning of fire, allowing additional time to escape. Toxic gas sensor detects dust particles in smoke, flame sensor detects flame or fire. The signals and measurements collected from these sensors are transmitted to the control centre using GSM module to automatically analyse and combine sensor information and detect the presence of fire or smoke.

The sensors collect the data and transmit to the central unit as well as alert is sent via call or message using GSM which shows “FIRE ALERT”. The GSM Module sends a text message to the user’s phone number from the SIM Card that is inserted into the module. The code run on the Arduino determines which number to send the message to, how many times the message needs to be sent, and some other details. Now that the user has been alerted, the job of the system is over. It is now up to the user to take preventive measures.

This module is responsible for the communication part of the circuit. It takes information from the Arduino where to send information and what information is to be sent. It uses a GSM SIM card for communication purposes. It is basically just a MODEM which uses serial communication to interface with and need Hayes compatible AT commands for communication with the Arduino. The alert message and the phone number of the recipient is given by the user through the Arduino code. As soon as fire is detected an SMS will be sent to the recipient’s phone number from the SIM card inserted into the module.



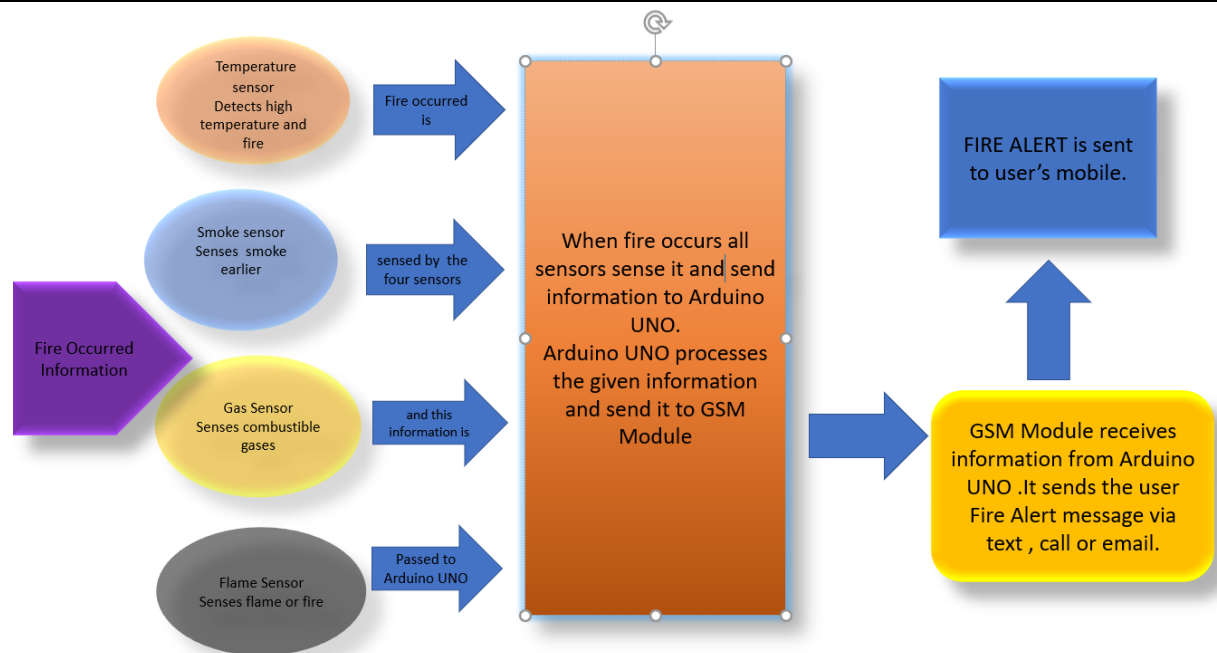


FIG 7: Working of The System

### 3.APPLICATIONS

- One important application of wireless sensor networks is sensing and controlling forest fire.
- This system can also be used in residential buildings, hospitals, banks etc.
- Supports direct message to the appropriate authorities.
- Immediately notifies everyone via their mobile phones through call or SMS.
- SMS based Fire Alarm system are very useful in remote locations where human interaction is limited.
- This system gives warning immediately to mobile number used and hence remedy actions can be taken quickly. This helps to prevent major damages and losses created by a fire accident.

### 4.ADVANTAGES:

The main advantage of installing fire detection and alarm systems is the early warning benefit. The fire detection and alarm systems can be installed just about anywhere in the forest. Early warning is essential to effective fire safety because fires can occur anytime and anyplace.

1. Early detection can help to avoid damaged caused by forest fire to vegetation and living organisms(animals).
2. With the help of GSM and GPS module we can get fire alert immediately, sensed by different sensors, with the help of SMS and Call.
3. Cost of this project is low.
4. This system is easy for installation and operation.
5. Due to multisensory if any sensor gets damaged, the alternative sensors can be used for forest fire detection purpose

## 5.DISADVANTAGES:

1. Due to technical fault sometimes, the system can fail to give the satisfactorily results.
2. Sometimes due to lack of network or network failure, we can get late SMS, call or notification of the fire occurred
3. This system only helps to detect the fire occurred and not has features to extinguish the fire.

## 6.FUTURE SCOPE:

The project gives emphasis on using modern technology of remote sensing and other techniques to equip the forest authority and organizations in their work for forest conservation. Due to the lack of efficient staff and emergency plan there is a greater need to use much efficient systems. It is difficult for authorities to manage huge forest areas and to be present at a time of accidents. This system uses advance technology which will help in tracing out the forest fire in its initial stage. This system also has future scope, as we can use wind sensor to detect direction of smoke and hence further damage can be avoided by using automatic fire extinguisher. In upcoming time, we can also add the fire extinguisher system to stop the spread of fire. As Solar panel is used in this system to generate electricity, system is suitable to install at low cost. It is a affordable and easy to operate system hence can be install at many places in further years.

## 7.CONCLUSION:

Using this GSM based forest fire detection and prevention system, temperature and smoke concentration of the forest area can be easily obtained. The system is low cost, simple and efficient since it involves less components. Algorithm used can be easily implemented and the sensors regularly keep providing the readings for monitoring purpose. One of the fundamental points of interest of this framework is its adaptability. There is scope of connecting a few more sensors for more accurate fire detection.

The invented system achieves 90% fire detection rate and 10% false detection rate. The invented method was compared with other methods in the literature and had good performance in terms of higher fire detection rate and less false alarm rate. Since the proposed project is easy for the installation due to the simple arrangements, the time frame for developing and integrating the subsystems and installation process is less. Even for the demonstration purpose we can put up the fire manually in any plain land and we can test for the working of these components.

## 8. REFERENCES:

1. U. Arun Ganesh, M. Anand, S. Arun, M. Dinesh, P. Gunaseelan and R. Karthik (2013) "Forest Fire Detection Using Optimized Solar – Powered Zigbee Wireless Sensor Networks", International Journal of Scientific & Engineering Research, Volume 4, Issue 6, June-2013 586 ISSN 2229-5518 IJSER
2. Chong, C.Y. and Kumar, S.P. (2003) Sensor networks: evolution, opportunities, and challenges. In Proceedings of IEEE 91(8): 1247–1256.
3. Antoine-santoni, T., Santucci, J.F., De gentili, E. and Costa, B. (2008) "Wildfire impact on deterministic deployment of a wireless sensor network by a discrete event simulation". In Proceedings of the Fourteenth Mediterranean Electro Technical Conference, Ajaccio, France, 5–7 May 2008, 204– 209.
4. R. Chandrasekharan, Ashiq M.I, Dr. V. Prakash (2015) "Forest Fire Detection using Temperature Sensors Powered by Tree and Auto Alarming using GSM" Volume II, Issue III, March 2015 IJRSI ISSN 2321 – 2705.
5. Bayo, A., Antolin, D., Medrano, N., Calvo, B., and Celma, S., "Development of a Wireless Sensor Network System for Early Forest Fire Detection", Smart Objects: Systems, Technologies and Applications (RFID Sys Tech), VDE CONFERENCE PUBLICATIONS, pp. 1–7, 2010.
6. Hefeeda, M., and Bagheri, M., "Wireless Sensor Networks for Early Detection of Forest Fires", IEEE International Conference on MobileAdhoc and Sensor Systems, 2007, IEEE CONFERENCE PUBLICATIONS, pp.1-6, 2007.
7. Muheden, Karwan, Ebubekir Erdem, and Sercan Vançin (2016) "Design and implementation of the mobile fire alarm system using wireless sensor networks" 2016 IEEE 17th International Symposium on Computational Intelligence and Informatics (CINTI).
8. Sheetal Prusty, Suman Sekhar Sahoo (2017) "DETECTION OF FOREST FIRE BY USING GSM & GPS TECHNOLOGY" ISSN 2322-0031, Vol. 5, Issue 2, 2017