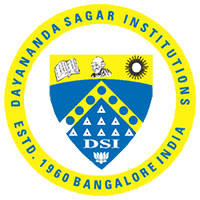
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**Mini project report**

**IOT based Forest Fire Detection System**

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Abstract

Fire, as one of the world's biggest calamities, must be identified at the right moment before it can do significant damage to the atmosphere, living beings and resources. In one way or another, these renewable resources are very essential to mankind. Forest fires are the most common hazards in forests which lead to serious destruction of forest wealth, biodiversity and natural habitat. According to a study, 75-80 percent of the various casualties caused by fire might have been prevented if the misfortune was detected quickly. Particularly in the case of a forest fire, this results in a significant loss to the environment and makes it extremely dangerous for the wildlife habitat. To avoid such losses, an automated system is needed that can provide early detection of any fire situation via any of the alarm systems. In order to achieve early detection, there are two most used traditional methods of human surveillance.

• Human observation

• Automation approach

Traditional methods of human surveillance are directly through human observation and through distant video surveillance. This requires 24/7 continuous monitoring. The automated fire alert detection system by which one can achieve surveillance through the automation approach of detection proposed in this project comprises three sensors, namely flame, temperature (DHT) and CO2 MQ135. These sensors detect change in a measurable physical quantity and intimate the nearest fire extinguishing station. Internet of Things (IoT) technology has brought revolution to each and every field of common man’s life by making everything smart and intelligent. IoT refers to a network of things which make a self-configuring network. The development of IOT based Forest Fire Detection System will be helpful in mapping emergency plans and making them more effective during the occurrence of any disaster. In this project, the intention is to build a Forest fire detection system using IoT which would detect the fire and send an emergency alert to the Authority through IoT. Here a GSM/GPRS module is used to communicate with IoT servers.

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# **Introduction**

A wildfire, forest fire, bushfire, wild-land fire or rural fire is an unplanned, uncontrolled fire in an area of combustible vegetation starting in rural and urban areas. Of late, forest fires have captured the attention of people worldwide. Over the last few years there have been devastating fires in the forests of South east Asia, Amazon and the Rocky Mountains of the USA. Such fires have not only led to threats to the biological diversity of these forests, but have also caused large-scale human suffering in neighboring lands, due to pollution of the environment. Forests play an important role in the global, ecological, environmental and recreational system. It greatly impacts the amount of greenhouse gasses, atmospheric carbon absorption, and reduces soil erosion. Forests contain many essential resources for human survival and social development that protect the balance of the Earth ecosystem. Forest fires are a recurrent phenomenon, natural or man-made, in many parts of the world. Global warming contributes to the increase in its number in recent years and the importance of these disasters. In this scenario, the frequency of forest fires has increased considerably due to climate change, human activities and other factors. The detection and monitoring of forest fires has become a global concern in forest fire prevention organizations. This system can monitor real-time related parameters, e.g., temperature, relative humidity, and send the data immediately to the computer of the monitoring center. The fire alert system has low power utilization and quicker handling capacity at a lower cost and maintenance. The Forest fire detection system uses advanced technology which will help in tracing out the forest fire in its initial stage. The development of IOT based Forest Fire Detection System will be helpful in mapping emergency plans and making them more effective during the occurrence of any disaster.

## Problem statement

Forest fires are common hazards in forests that cause a lot of harm to wildlife as well as the environment. It could be avoided if a robust system could be deployed in forest areas to detect the fire and alert the fire extinguishing authority to take immediate action. In this project, the intention is to build a Forest fire detection system using IoT which would detect the fire and send an emergency alert to the Authority through IoT. Here a GSM/GPRS module is used to communicate with IoT servers as usually in forest areas network bandwidth is very low or not available. Hence a 2G network is preferable to communicate with the server.

## Brief solution

In this project, we will design an IOT based forest fire detection system. The working of the project is pretty simple: detect the fire and send an emergency alert to Authority through IoT. Many researchers came up with the solution by using various types of control and detection systems. It is a detection system equipped with a GPS navigation system and a flame sensor.As shown in the schematic block diagram below, the project consists of Flame sensor, DHT11 Sensor, MQ135 Sensor, Arduino Nano & SIM808 GSM/GPRS module as its primary components. The fire can be detected by the flame sensor which gives a digital output that corresponds to the fire status and is received by the Arduino Nano.

Arduino compares the signal and triggers the SIM808 in case of fire incidents. SIM808 is a compact module that allows GPRS transmission, send/receive SMS, and making voice calls. The SIM808 module has two antennas included on it. The first is for a ring antenna which can be soldered directly on the board and the other is meant for an external antenna. Through AT commands, SIM808 communicates with thingspeak server.

## Components used

### Hardware components

* Arduino UNO <<[amazon links](https://docs.google.com/spreadsheets/d/188FSCLnrH7gheBhDjPV4PqIJtqKOIZhJ/edit?usp=sharing&ouid=103655246549530266996&rtpof=true&sd=true)>>
* SIM808 GPS/GPRS/GSM Module
* Sensors-
  + Flame
  + DHT
  + CO2 MQ135
* Buzzer, LEDs
* 9V- 1A Battery
* Breadboard
* 5 V DC power supply
* Jumper wires and cables.

### Software components

* Arduino IDE (1.8.13)
* ThingSpeak Account (Cloud)
* Software Serial

# **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 the daytime. 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 the 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 the beginning stage. This alert system has a 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 the Advanced Very High-Resolution Radiometer instrument is utilized to recognize hotspots. In South Korea, a 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 a temperature sensor and GPS modem, forest fire detection can be possible (Basu et al., 2018). Here, temperature sensors collected data were sent to the 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. In research done by Zhang et al. (2009), Pirbhulal et al. (2017), and Alahi et al. (2017) an ad hoc network using cluster topology for forest fire forecasting model was used to predict fire prone areas.

It was concluded that WSNs have greater advantages. In another research done by Demin et al. (2014), sensors were deployed and the weather data were collected. This data was used to calculate and prevent forest fires. In these researches, there was no real-time forest fire monitoring, only the data were collected and fire prone areas were predicted. Libelium (Solobera, 2010) developed a wasp mote which has four sensors for measuring gases, temperature and humidity. It gives early warnings and consumes very less energy. Shunyang X. Du, J. Yongping and W. Riming, Realization of Home Remote Control Network Based on Zigbee (2007), et al. deals with the design of remote monitoring and controlling systems. The system consists of a real-time home monitoring subsystem and a light control sub-system. A home server with a home camera caters for home status through video to client. A program that analyzes satellite data in near real time and converts information into instant messages and email alerts to track forest fires. ICIMOD helped design a system that uses satellite data to monitor and assess the damage of forest fires and then automatically sends SMS messages and emails to district forest officers and rangers so they are better able to monitor a fires growth and direction and alert populations when there may be a need to evacuate, L.N.Wang, et al. (avoid fire accidents on running trains using ZigBee wsn) proposed this system to avoid fire in running trains. When fire is noticed in any compartment, the temperature sensor senses the fire by the difference between the coach temperature and the critical temperature.

## <<Subheading 1 >>

The basic components of a literature review include:

Description of the technology used

Summary of the project’s main points

Discussion on the gap/problem and the existing solution.

Project’s contribution to the topic

## <<Subheading 2 >>

## <<Subheading 3>>

# **Implementations**

## Input Implementation

Explain briefly about the HW/SW/FW integrations and the framework of the project.

## Implementation of components

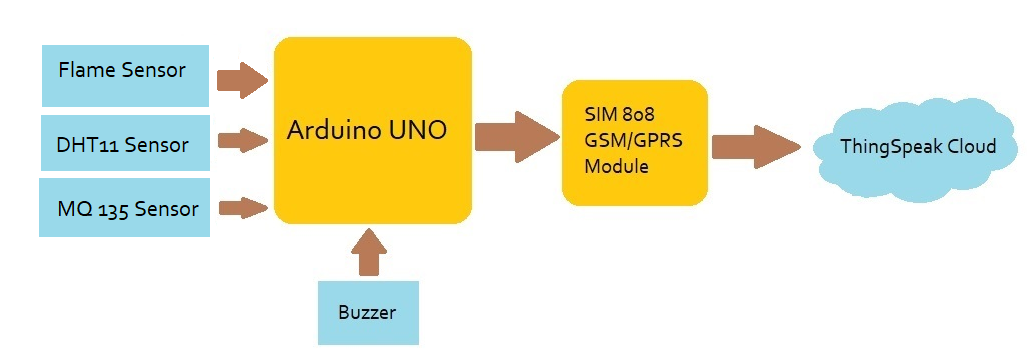
The Working procedure are as follows:

1. Connect the Flame sensor, DHT sensor and the CO2 sensor to the microcontroller (Arduino UNO) using Jumper wires and breadboard.
2. Also connect SIM808 module via Logic shifting resistors.
3. Connect the buzzer and LEDs for the alarming system.
4. Supply DC current (9V-1A) to SIM808 module to power it on.
5. 5V DC external supply is given to Arduino UNO for the working of UNO and the sensors.
6. After successful integration of hardware, Arduino IDE is used to code those components.
7. Cloud platform needs to be set up, where the real-time data will be received.

Once all the data is received, the intensity of the fire will be estimated and the level of the wild fire will be determined.

# Block diagram/Flow chart

# The diagrammatic representation for project is as follows:



After successful completion of hardware as per the above circuit diagram, the IoT platform needs to be set up, where the real-time data will be received. Here Thingspeak is used to store the parameters and show them in GUI.

For setting up the Thingspeak account follow the steps below:

○ First, go to https://thingspeak.com/ and create a new free Mathworks account if you don’t have a Mathworks account before.

○ Sign in to Thingspeak using your credentials and click on “New Channel”.

Now fill up the details of the project like Name, Field names, etc. Then click on “Save channel”.

○ Record the Credentials

○ Select the created channel and record the following credentials.

○ Channel ID, which is at the top of the channel view.

○ Write API key, which can be found on the API Keys tab of your channel view.

○ Add widgets to your GUI

○ Click on “Add Widgets” and add four appropriate widgets like gauges, numeric displays, and indicators. In my case, I have taken the Indicator for Fire Alert. Select appropriate field names for each widget.

## Innovation

The already existing system or the system that has been used currently in detecting forest fire is not efficient enough to detect the fire in the initial stage. It can detect only when the fire is widely affecting the forest. This caused many damages. But the cost of these devices is very high. These are not making use of the IOT that is the main disadvantage of these systems. If it makes use of the IOT it can detect and warn the fire in the early stages. Thus, in this project, the main focus is to detect the fire in the early stages and creates a high-pitched ringing sound or alarm that ranges up to 3 km to help save the wildlife and the humans present around the affected area. On detection it also immediately intimates the nearest fire extinguishing office by sending a pre-recorded message via call indicating the occurrence of fire

followed by an SMS which will be sent to the officer-in-charge which will contain the GPS location or the coordinates of the place of occurrence of fire. In the next step, the details of the damage including the temperature readings will be uploaded to a cloud platform for future analysis

# **Output**

<<Test cases>>

# Output/Result

The output of the proposed system is as follows:

The fire and smoke sensors detect the respective elements and this initializes an alert and activates the system. This, in turn, sends the location, which is detected by the GPS module, with an alert message via SMS to the user with the help of the GSM module that has been incorporated into the system. Once the user receives the alert message, the required action can be taken to control and cease the fire.

The wireless transmission using RF, from one node to another node was experimented up to 1m. As there would not be any obstructions in the forest, the RF modules can work up to one meter efficiently. For GSM module to work properly, there should be a minimum network coverage to send an SMS with location. The nodes can be placed 1m away from each other, for maximum coverage of the forest area with minimum number of nodes and to perform with good efficiency. The fire and smoke sensors were tested up to 1m

<<Include the screenshot(s) if applicable>>

# **Conclusion**

Early cautioning and quick reaction to a fire breakout are the main approaches to dodge incredible misfortunes and natural and social legacy harms. Hence, the most critical objectives in flame observation are fast and solid identification and restriction of the fire. It is substantially less demanding to stifle a fire when the beginning area is known, and keeping in mind that it is in its beginning periods. Data about the advance of flame is likewise profoundly profitable for dealing with the fire amid every one of its stages. In light of this data, the fire battling staff can be guided on focus to hinder the fire before it achieves social legacy destinations and to smother it rapidly by using the required putting out fires’ hardware and vehicles.

The improved system can be deployed for tenement appliances and in industries also. However, the system above is meant for sincere opinion news only. As a tomorrow aggravation, several-decision companies through the IOT landing are studying an object and the exploration is being done to effectuate this enormous toil.

The fire and smoke sensors detect the respective elements and this initializes an alert and activates the system. This, in turn, sends the location, which is detected by the GPS module, with an alert message via SMS to the user with the help of the GSM module that has been incorporated into the system.

## Future improvements/Scope of the project

In the future, we can develop this model to minimize the energy consumption of all sensors. Also, industrial sensors can be used for better ranging and accuracy. We can also install a wind sensor to the system which helps to determine the direction of the fire and the rate at which it will spread. Along with this we can implement an automatic fire extinguisher system. As soon as a sensor detects fire, the extinguisher gets activated

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