# **IoT based Forest Fire Detection and Prevention**

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# Abstract

This paper presents a survey on fire detection and alert system based on the Internet of Things (IoT). Here, a specific environment is monitored 24×7 and the user is alerted in case of any fatal situation. This can be implemented using a NodeMCU and a number of sensors for detecting different physical parameters that can go high during a fire-related accident. NodeMCU is an Internet of Things (IoT) based controller board with an on board wireless fidelity (Wi-Fi) module called ESP8266. Here two parameters are being monitored continuously - temperature and presence of smoke. Nowadays, there are many incidents happening about smuggling of trees, like Sandalwood, which are very expensive and rare in nature. This project design uses two different sensors namely fire sensor (to detect forest fires) and smoke sensor (to detect fire). Data generated from these sensors is continuously monitored by the forest officials with the help of ThingSpeak server. With respect to the sensors, their output devices are activated through relay switch. For all these sensors, a buzzer is activated when their conditions are violated.

## Introduction

Economic growth in modern industrialized societies has resulted in factories, complex office buildings, and dense apartment blocks located in metropolitan areas. Associated gas stations and oil reservoirs, which are all vulnerable to fire due to the flammable substances they house, are also found in these areas. When a fire occurs in such places, firefighting is hindered by the mazes of crowded buildings, high temperatures, smoke, and the danger of explosions Current firefighting systems are based on humans using deluge guns and chemical fire repression systems. However, in environments where humans cannot work effectively, it is desirable to extinguish a fire quickly using fire-fighting robots. Recently, in order to cope with catastrophic fire related accidents, research on firefighting robots has advanced in many countries.

# **Literature Survey**

Md Saifudaullah Bin Bahrudin et al. in "Development of Fire Alarm System using Raspberry Pi and Arduino Uno" presented a fire monitoring system that detects fire by the smoke that has generated by the fire. Camera is used to capture the fire image when a fire incident happens. The system remotely sends the image of the fired room on the web page and alerts the firefighter through SMS.

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Video Surveillance System is most generally utilized for identification of wild fire present in "Forest Fire Protection by Advanced Video Detection System". It is isolated into four classifications: (1) Video Cameras delicate in unmistakable range in light of acknowledgment of smoke amid sunlight and fire blazes at night, (2) Infrared (IR) Thermal Imaging cameras in view of discovery of warmth transition from the fire, (3) IR Spectrometer which distinguish unearthly attributes of smoke gases, and (4) Light Detection and Ranging (LiDaR) system which measures the laser light back scattered by smoke particles. The limitation of these systems was high false alert rate as a result of climatic conditions, for instance, proximity of fog, shadows, clean particles etc.

#### **Existing System**

In the existing systems, they are using ZigBee and RF technology to transmit data of the sensors. These technologies are implemented with in the short range of distance only. And there will be no continuous monitoring of the sensor parameters.

#### **Proposed System**

In this system, we have assembled fire finder utilizing NodeMCU which is interfaced with a fire sensor. The fire sensor detects the light, and smoke sensor detects any smoke produced because of consuming or fire. Buzzer associated with NodeMCU gives us an alert sign. In this system, we are using NodeMCU as controller and Wi-Fi module. In this system, we are using, fire sensor it is used to detect the fire occurrence in forest. These sensors are interfaced with Arduino UNO microcontroller and these parameters are send to ThingSpeak website by using NodeMCU controller. If any fire occurs a message will be sent to the authorized person.

# Block Diagram Hardware Description NodeMCU Microcontroller

NodeMCU is an open source LUA based firmware developed for ESP8266 Wi-Fi chip. NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. Since NodeMCU is open source platform, their hardware design is open for edit/modify/build. ESP8266 is Wi-Fi enabled System on Chip (SoC) module developed by Espressif Systems. It is mostly used for development of IoT (Internet of Things) embedded application.





## LCD

A Liquid Crystal Display (LCD) is a thin, flat display device made up of any number of colour or monochrome pixels arrayed in front of a light source or reflector.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to a controller is an LCD display.



## **GSM Module**

GSM stands for Global System for Mobile Communication. It is a digital cellular technology used for transmitting mobile voice and data services. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world.



#### Relay

A relay is an electrical switch that opens and closes under the control of another electrical circuit. A relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier.



## Water Motor

This DC 3-6 V Mini Micro Submersible Water Pump is a low cost, small size Submersible Pump Motor which can be operated from a 2.5~6 V power supply. It can take up to 120 liters per hour with a very low current consumption of 220 mA. Just connect tube pipe to the motor outlet, submerge it in water and power it.



#### **Fire Sensor**

This flame sensor or fire sensor module works on the concept that when a flame or fire is burning it emits IR signals. This IR signal is then received by the IR receiver on the fire sensor module to detect the flame or fire. The sensor has an operating voltage from 3V to 5.5V and has both digital and analog output.



#### **Smoke Sensor**

The MQ-2 is a smoke and combustible gas sensor from Winsen. It can detect flammable gas in a range of 300–10000 ppm. It's most common use is domestic gas leakage alarms and detectors with a high sensitivity to propane and smoke.



## **Power Supply**

All digital circuits require regulated power supply.



#### Buzzer

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows.



#### Kit Design



#### **Working Principle**

An IoT-based forest fire alarm system with NodeMCU typically works on the following principles:

**Sensor Network:** The system uses a network of sensors such as temperature, humidity, and smoke sensors, which are installed at different locations in the forest.

**Data collection:** The sensors collect the environmental data and send it to a central device, such as NodeMCU, which is capable of processing the data and transmitting it over the internet. Cloud-based analytics, i.e. in this system, we have assembled fire finder utilizing NodeMCU which is interfaced with a temperature sensor, a smoke sensor and signal. The temperature sensor detects the warmth and smoke sensor detects any smoke produced because of consuming or fire. A buzzer associated with Arduino gives us an alert sign. In this system, we are using NodeMCU as controller and Wi-Fi module. In this system, we are using, temperature sensor, smoke sensor and MEMS sensor. MEMs sensor is used to detect the tree falling condition. And these parameters are send to ThingSpeak website by using NodeMCU controller. If the system detects any abnormal behavior, such as a sudden rise in temperature or the presence of smoke, it triggers an alert mechanism. This can include sending alerts to forest rangers, fire departments, or other emergency services.

**Response Mechanism:** Once an alert is triggered, emergency response teams can be dispatched to the affected area to contain the fire. Overall, the IoT-based forest fire alarm system with NodeMCU helps to prevent and mitigate forest fires by providing real-time data and alerts to emergency response teams, enabling them to respond quickly and effectively to potential threats.

#### Flowchart



# Results

## ThingSpeak Channel created successfully



## ThingSpeak App Measuring Values from Sensors

After completing ThingSpeak Account setup successfully as shown above, its ready to give notifications to our mobile phone about system setup and fire alerts to mobile as shown below:



#### Advantages

The proposed system detects the forest fire at a faster rate compared to existing system. It has enhanced data collection feature.

The major aspect is that it reduces false alarm and also has accuracy due to various sensors present. It minimizes the human effort as it works automatically.

This is very affordable due to which can be easily accessed. The main objective of our project is to receive an alert message through an app to the respective user.

#### Applications

Fire detection and management plays a very crucial part in terms of safety. Therefore this proposed system can be implemented in malls, offices, data centers, etc.

#### 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.

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