Forest Fire Detection and Prevention System Using IoT

Malti Gautam Singh, Sharini Rithigaa, Deepa Raj, and Sharmila

Abstract In India, over the past 10 years, forest fires are uncontrollable which causes damages to a forest ecosystem, natural ecosystem, and biodiversity. An increase in population and change in climate causes the decline of Indian forests. The main objective of the proposed system is to design low cost and effective detection and prevention system using GSM modules. This proposed system can easily detect forest fire at the initial stage. In the monitoring, the hardware which we use is GSM modem, MQ-2 sensor, and the Flame sensor for transferring the data and also some devices. We will also use an MQ-2 sensor which will sense the gases like methane, CO_2, and smoke, etc., and a Flame sensor which will sense the forest fire and will send the data to the control unit. We will also use an LCD screen that will display the data then an alert will be sent to us. Instead of using a PC, we use an LCD screen due to its small size and portability which will make this system of low cost. And we used a rechargeable battery as a power supply in our project, and for providing charging to the battery, we used a solar panel. And, for the prevention method, we provide a water motor pump that is connected to a relay, where the relay will provide a set of input terminals for single or multiple control signals. This system provides us a remote, safe, accurate detection, and prevention from fire and smoke. So, this is the most effective system for monitoring forest fire that occurs in remote places with the help of the GSM module.

Keywords Fire detection · Alert · Internet of Things · Sensor · Monitor

M. G. Singh · Sharmila (✉)
Krishna Engineering College, Ghaziabad, India
e-mail: sharmila1ece@gmail.com

S. Rithigaa
Accenture Solution Pvt. Ltd, Bengaluru, India

D. Raj
System Engineer, Infosys Limited, Ghaziabad, India

1 Introduction

In India, forest fire occurrence is wide. Most of the occurrence of Indian forest fires is due to human involvement and natural. To prevent the spread of forest fire in initials, a good detection and prevention system is required to protect the forest ecosystem, natural ecosystem, and biodiversity so that we can control fire spreading on time and can also, prevent it by using the prevention method. The various elements which stop the authorities to act during the forest fire are communication problems, transportation facilities, weather conditions, etc. So, to stop the spreading of forest fire, we proposed a system which will help the officials and forest authorities. This project is based on a detection and prevention system with the help of a GSM module and some other devices. In this system, we provide several detectors are placed on every tree in the forest area which will help the forest authorities and officials to detect forest fire and smoke. We also placed sensors like MQ-2 which will sense other gases like methane, CO_2, and smoke, and the Flame sensor will sense forest fire which will sense the data and send it to the control unit. And for sending SMS messages, we will use the GSM modem which is used for wireless transmission. In this system, for transmission, we used a control unit to store the data and also we used an LCD screen that will display the data, then an alert will be sent to us and also we used buzzer which will beep during the occurrence of forest fire and LEDs will also be turned ON. And for supply, we use a rechargeable battery that is connected to the solar panel, where the solar panel will recharge the battery so that it can be used whenever it is required. Also, instead of using a PC, we use an LCD screen due to its small size and portability which will make this system of low cost.

The main influence of this paper is to propose efficient fire detection for forest using IoT technologies. Section 2 summarizes the literature survey of the proposed system. Section 3 discusses the proposed method to implement the system. Section 4 concludes the paper.

2 Related Work

A Global System for Mobile Communication (GSMs) and radio frequency (RF) modules are used to detect and surveillance system for forest fire detection. It is used to detect the forest fire and also surveillance it with the help of GSM and RF modules. In their proposed system, hardware has server, nodes, and head. This technology contains a Global System for Mobile Communication model, fire, sensor to detect fire, and RF system for the transmitting of data and also used an antenna to receive the data at the reception side. IoT-based forest fire detection system [1–6] is IOT-based technology used for forest fire detection. In their system, they assembled a fire finder utilizing NodeMCU which is interfaced with a temperature sensor, LCD, and smoke sensor, where the temperature sensor is used to sense the temperature and

smoke sensor used to sense the smoke in the environment. They attached the buzzer to the Arduino for the alert.

The IoT-based fire detection system [7–9] is done to improve the security system and also increase the protection in a forest area. Their project aims to design a simple wireless and low-cost protection system and also to provide an alert to the control room so it can be controlled at the initial. This technology contains a temperature sensor with Arduino to detect fire and temperature in the forest environment. They connect the DHT-11 sensor to the NodeMCU board.

The wireless sensor networks (WSNs) are used for fire detection [3] which is done for the detection of forest fire in early stage and also takes preventive measures to protect the forest. In this, they used two sensors that are smoke and a fire sensor for the automatic fire detection system. They also use the GSM module and RF module to alert the officials and authorities (Fig. 1).

The main objective of the proposed method is quick, reliable, detection, and localization of fire. In this, due to the installed sensors, monitoring and detection are done and to alert the authorities and official message alerts are used.
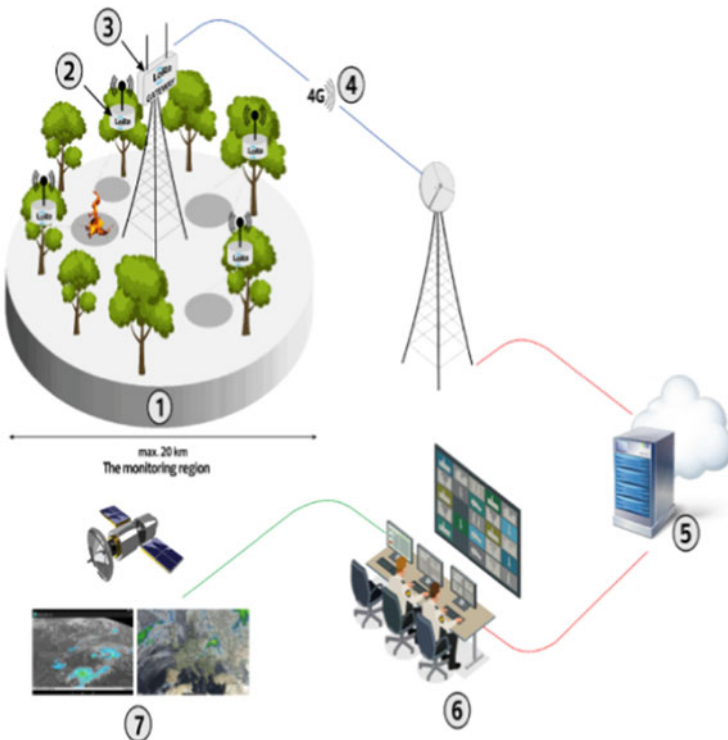

Fig. 1 Wireless sensor network

3   Proposed Method

To control forest fires on time, it is required to provide a system that is essential to the officials and forest authorities to prevent the spread of forest fire in beginning. A good detection and prevention system by using GSM modules and other components is required to protect the forest ecosystem, natural ecosystem, and biodiversity so that we can control fire spreading on time. In the sensing unit, we use several sensors to sense the environment in a forest area. The purpose of the study is to provide a detection and monitoring system by using GSM and RF modules with the help of real-time methods and to stop the forest fire at the beginning stage to protect biodiversity and also to detect poaching, deforestation, and natural disasters like landslides, etc. The all above data will be sent to the officials and forest authorities so that they can manage to take appropriate decisions at the beginning stage.

3.1   Methodology

In this proposed system, we design an IC sensor that will help us to sense the fire and smoke in the forest area. This system having a control unit that helps in determining the intensity of fire and smoke which will later show the rate of fire and smoke on an LCD screen and sends an SMS message with the help of a GSM modem. Our system comprises three important phases: detecting, communication, and processing unit.

For the detecting unit, the sensor senses the changes in the surrounding environment, a sensor such as, i.e., MQ-2 sensor which has very high sensitivity towards propane, methane, LPG, CO_2, and hydrogen. These sensors help to sense a fire in the forest. By communication, we will receive the message or call on the registered mobile number when the input of the fire sensor or MQ-2 sensor is high and simultaneously. Our prevention system ON which switches the water motor ON to put out the fire or flame. Now, Fig. 2 shows the overall block diagram of this system.

3.2   System Design

For the system designing of this project, we divide it into two system design parts such as software and hardware parts. In hardware system design, we have done the hardware part which consists of four units in which various components are used such as MQ-2 gas sensor, AT89C52 microcontroller, encoder, decoder, RF module, and GSM module, etc. In software system design, we perform the programming and initialized it in the control unit.

1. **Hardware System Design**—To design the hardware system, the four units are considered such as sensing unit, control unit, and processing unit.
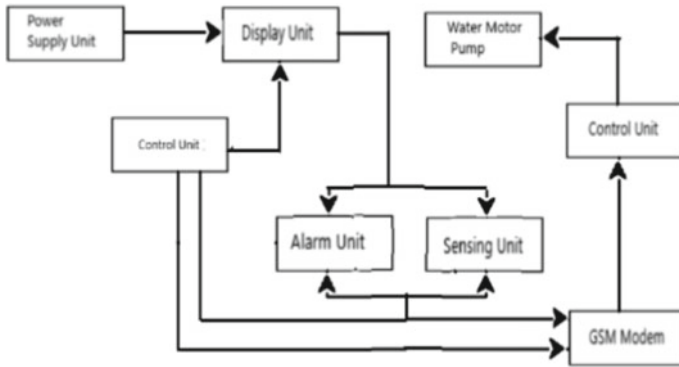
Fig. 2 Block diagram of the proposed system

2. **Software System Design**—In the software system design, we initialized and program the control unit.

3.3 Hardware System Design

Sensing Unit. In this unit, there are both sensors which are fire sensor and MQ-2 sensor. But the sensor works together in detecting the flame or fire when there is either smoke or flame is detected in the forest. Then, it sends the information of flame and smoke to the control unit and a red led glows as well as a piezoelectric buzzer starts to beep to alert the authorities. Figure 3 shows the block diagram of sensing unit.
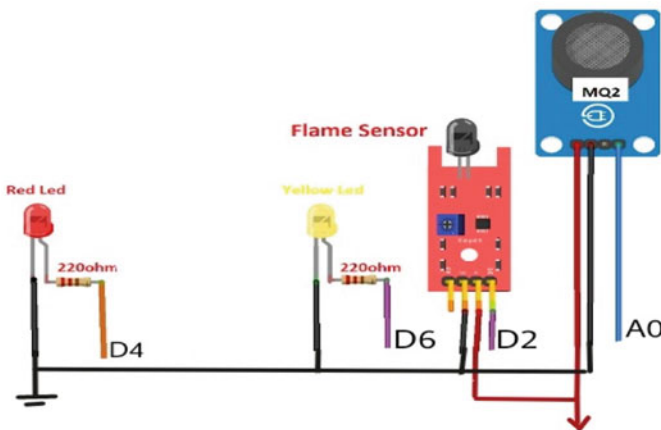
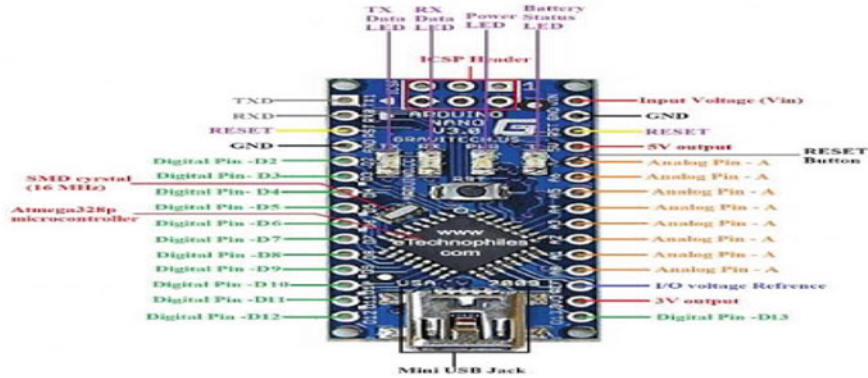

Fig. 3 Circuit diagram of the sensing unit

Fig. 4 Schematic diagram of the sensing unit

Control Unit (Arduino Board and Relay). Arduino Nano board has ATmeag328 microcontroller. It is in a different package, either more or less it has some functions of the Arduino Duemilanove. For Arduino Nano, a mini USB cable is required instead of a standard one and it lacks a DC power jack. Figure 4 shows the Arduino Nano schematic diagram.

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Relay. It is a switch that is operated electrically. It has a set of input terminals that are required to control single or multiple signals, it is also a set of contact terminals which control a circuit through self-regulating small power signals. It is used for many reasons one of them is that we use a relay for high voltage or high current devices. While to power controls we use low voltage which will further energize the relay. Figure 5 shows the relay pin diagram. Figure 6 shows proposed system block diagram.

3.4 Software System Design

In the software system design, we initialized and program the control unit. Below shows the steps of initializing the control unit and programmed it:

- In the first step, we will monitor either there is any sense of smoke or flame in the forest with the help of sensors.
- In the second step, if there is smoke and flame in the environment, then the transmission will take place from the control unit, as the sensors will inform the control unit to take action.
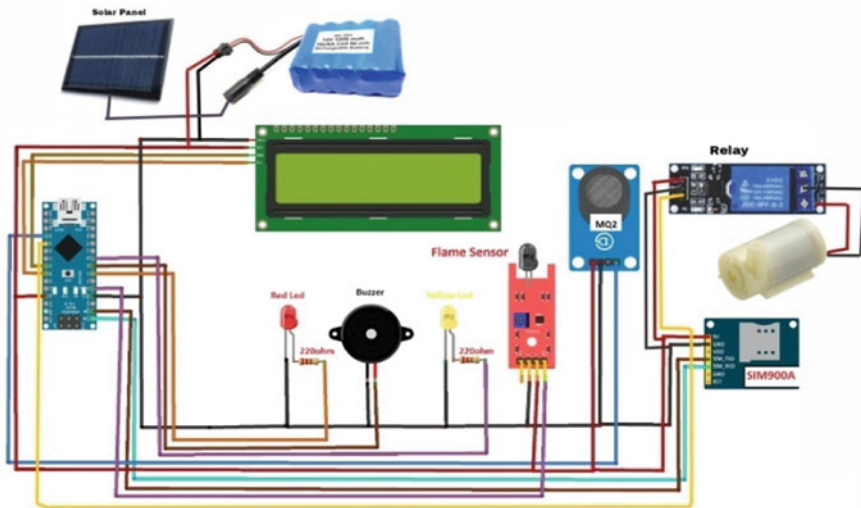
Fig. 5 Relay pin diagram

Fig. 6 Proposed system block diagram

- In the third step, after the transmission is done, reception will take place immediately with the help of LCD, buzzer, LEDs, and GSM module.

- In the fourth step, the Arduino Nano will display the message on a liquid crystal display and turns on the piezoelectric buzzer to make the sound to alert the officials and also sends a message to the official mobile number.
- At last, in the fifth step, the relay will start the water motor to put out the fire and works as a fire extinguisher.

4 Conclusion

Nowadays, monitoring is done by computerized which is very essential and useful for the officials and authorities of the forest. Instead of suppressing fire in later stages, it is easy to suppress it in the early stages. This system provides the detection and monitoring of forest fire at the early stages and it also sends message alerts to the forest authorities. The feature of this project is low cost, effective, flexible, wireless system, and power efficient. To block the fire to spread further, it gives instantaneous information to authorities.

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