IoT based Forest Fire Detection System in Cloud Paradigm

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Abstract. The most common hazard in forest fires are accident as the forest themselves destroys the forests and can be great threat to wild life and peoples. The Internet of Things (IoT) is the physical device which is used to connect, store and enable the objects to collect information for exchanging the data through the internet based system. The main objective of paper is to predict the developing trend of the fire by monitoring temperature, humidity, etc. There are several types of sensors which can be used for the collections of temperature and humidity data as an input for IoT based system which increases the efficiency of process of fire detection. The proposed mechanism can be used a threshold value of each sensor to validate the data and take initiative to avoid the prerequisite of achieving high reliability prevention using this mechanism.

1. Introduction

The forests are major a part of environment on the world which also balancing the ecological system. The fire is typically observed after covering the outsized area and then its controlling is almost impossible sometimes. As a result other consequences of forest fires are long-term disastrous effects which impacts directly on local weather patterns, heating and extinction of rare species of the flora and fauna. The complete forests are filled with highly combustible things like dry leaves and branches of the several trees which are act as a fuel source for fire ignition and later fire stages.

As a part of the event of the fire detection system, it is mandatory to analyse the characteristics of the environment under normal and fire conditions. It is also required to develop a strong proposal, information on temperature and ratio under normal conditions was collected during the summer in Colombia and following observations are taken as [1][2]:

- The temperature and humidity values are reflecting the cyclical behavior at different stages of the day under normal conditions.
- It also maintains an inverse relationship between their magnitudes with temperature and humidity values under normal conditions. So, as the temperature increases, it decreases the humidity.
- The speed of variation is higher and as sensor node is activated under the sun-light, the rate of change in temperature observed at a fire place.
Most forest fires are occurred due to atmospheric temperature and occasional humidity which provide auspicious environments for fire to begin. These forests and the bio-diversity of India are increasing a greater chance of fire underneath tremendous pressure. It is significant to detect woodland fire by using early caution schemes. In India, there are normally conventional behaviors to reduce the impact of wooded area fire [3].

There are several methods to detect the forest fires including the watch towers monitoring using satellite images but it is still not sufficient because of complex forest infrastructure which requires lot of trained persons to operate. In order to protect these huge stretches of land and biodiversity, there is an important want to have a tremendous surveillance and early caution structures for the forest fire whilst in its establishing diploma of spreading shall be managed which will save you its unfold. Usually so that you can prevent fire in a forest vicinity there may additionally be a massive dependency on man power [4].

An efficient mechanism to avert wooded area fire may also be laid down in a greater way for it should be beneficial to officials and woodland involved authority. Through this approach, we create a machine if you desire to assist the woodland fire protection people to manipulate undesirable results on forest ecosystems and the natural world. For this purpose, sensing surroundings can be deployed with a large vast range of wireless sensor nodes [5].

A wooded fire area is a natural disaster consisting of a fire which destroys a forested location, and can be a splendid risk to those who live in forests as well as the natural world. Forest fires are usually started out by using lightning, however additionally by way of human negligence or arson, and might burn hundreds of square kilometers [6].

2. Related Work

Various researchers presented their solutions to deal with the problem. Some major contributions have been presented as follows:

- Fire forecasting is one of the critical research challenges of the Wireless Sensor Networks (WSN) network to save much of our environment. In the WSN fire-detection system, sensors nodes are installed inside a remote forest to transmit audible information to the station below, which is located by the forest department. Although the sensors nodes within the forest are made with GPS connectivity, the high cost of its supply motivates the authors of this paper to create a unique style of localization using Support Vector Machine. This information transfer system extends the life of the network and reduces congestion during data transfer from the forest area to the sub-station [7][8].

- The fire alarms and alarm systems have been introduced that support a combination of smoke sensor and alarm device to create a life safety system style. However, such fire alarms are sometimes flawed and may respond to unrealistic fire signals that are classified as false alarms. There is a need for high-quality and intelligent fire systems that use multiple sensor values to detect real fire incidents. The model has sensors for collecting critical data from sensor nodes where symbolic logic converts data during linguistic diversity trained at ANFIS to attract potential fire hazards. The proposed view also creates alerts with a message sent to the users smartphone. The system uses a smaller size, less expensive sensors and ensures that this solution regenerates. MATLAB-based simulation was used for the tests and therefore the results show a satisfactory result [9][10].
The Internet of Things is about connecting things to other people through the internet, forcing itself because it is a new business approach in many fields. To create a quick and effective response in real time, IoT improves the process and provides emergency management with the necessary information and communication to use these assets. With this paper it is proposed that a rapid response to fire hazards be tested and evaluated using an IoT-based model. Fire is one of the major causes of accidental death in the world. To make the proposed program use an expensive Wi-Fi module, gas detection sensor, Flame sensor, awareness buzzer and temperature sensors. The sensors detect and alert the local emergency with information collected by the system, and alert organizations such as fire departments, police stations and hospitals by sending accurate location to both users and users using the module all connected. Therefore, a smart integrated system is designed for IoT to manage such risks where innocent people and property live [11][12].

Significant losses and high threats to the environment are common consequences of forest fires. This work describes a fire control that supports symbolic minds and decision-making processes that aim to improve fire prevention, detection and combat strategies. In this proposal, the natural monitoring of a number of hazardous substances is carried out by wireless sensor networks and analyzed with the proposed wireless controller. In this regard, climate variables, greenhouse gases and therefore oxygen levels are measured in real time to measure the presence of short-term fire hazards and to detect the recent occurrence of fires in various forest areas. In addition, the Analytic Hierarchy Process method has been used to detect fireside spreads, and, where necessary, environmental alerts are sent via the Web service and received via a mobile system [13][14].

The proposed method [15] help to detect fires and prevent the spread of fire, with an early warning system that warns local fire fighters. It also records a surveillance video in front of the center, helping to identify the causes of the fire, such as heat. Using 3600 rotating cameras and radiometry thermal sensors, the system detects abnormal temperature in a fireplace and informs the center station of location details. It also operates a water cannon system in addition to notifying local pump stations to assist fire fighters. Greece can be especially dangerous in the Mediterranean world when it comes to wildfires. The danger has been mounting under the influence of global climate change, and in the summer of 2007 about 200,000 hectares of cultivated land were burned.

The proposed system [16] which makes use of temperature and smoke sensors to detect fire emergencies and sends a wireless response to a server computer and server mobile which will instantly inform up to 5 remote authorized users by an SMS or a call. The authorized user has complete access to the system where the user takes appropriate actions such as turn on or off alert notification modify the threshold and reset the system. The system lacks direct automatic communication with the civil defense station as they have no specific system to receive and interpret the signal. The system does not communicate with the nearby buildings. The computer server used in the system could be it-self affected by the fire, on the other hand it is not efficient to have a separate server for each installed system.

In this system [17], the model is used to detect the fire, directly notify the fire department about the fire using an IoT server. The system uses different types of sensors to detect fire and alert the fire department over IoT by activating the fire buzzer there. It sends information about the incident by using Wireless Fidelity (Wi-Fi) connection to access the IoT server and transmit data over the
Internet so that the fire department team can use this information to take the suitable action. This system has less benefit in the absence of Internet service or slow Internet connection.

- The proposed system [18] used to early detect fire accidents, communicate with respective authorities and store the data that is related to the fire accident. The system uses smoke and Down Hill Control (DHC) sensors to detect fire. Whenever the temperature exceeds the limit, the system communicates with respective authorities. Then it activates fire sprinklers and keep them in position till temperature is reduced below a specific value. Fire accident related data is stored in a remote server for future use. In this system, heat sensor damage due to the fire may cause the sprinkler never turns-off.

3. Implementation results

A fire outbreak can be a major concern in homes, offices, industries etc. It is dangerous and requires high safety and control to avoid the destruction of life and property. One of the ways to prevent the risk is to install an automatic alarm detector in the danger areas, so the availability of Arduino based fire alarm and system was proposed. It is able to automatically detect heat in a given area, sounds an alarm, cuts to building pipes and sprays water to measure the intensity of a fire. The system uses DHT 11 sensor, buzzer, 5V DC (Direct Current motor), GSM (Global System for Mobile) Module sim800l to send SMS (Short Message Service) with LCD screen 16X2 and Atmeg328p Microcontroller. At the top, the goals of this program have been achieved which is why the program has worked so well [19][20].

The fire detectors include air and soil temperature moisture sensors. Both prices are worth it has high alarm levels. Both prices must be high in order avoid false alarms caused natural features that can be increased only one flexibility. For example, because of open air activity, effects such as fog, fog or rain is often seen as rising within the amount of smoke I felt therefore continuous daylight can do it rising temperatures. These events should be reported without alarm alarm.

A temperature sensors (LM35) are common devices integrated into a silicon substrate. The result of temperature sensor are used for alarming the detector to check the actual conditions of environment and other sensor data and also set as simple comparison for operation of the thermostat or as a heating event interrupt. Then further, the fire detectot enable the ultrasonic and humidity sensors for monitoring the actual conditions of forest.

An ultrasonic sensor is used for measuring the distance of forest trees based on ultrasonic waves and it is faster than audible sounds. An accelerometer sensor (ADXL335) is also used for calculating the acceleration of wind in the forest to sense the actual speed of the air.

The Humidity Sensors (DHTII) is designed specifically for high volume users. It measures the humidity of current forest environment and generates an alert if humidity increases which may causes the fire to the forest. There is a soil moisture sensor also used for testing the soil level of forest ground as it found more dry level which enhances the occurrences of fire in the forests.

The Light Dependent Resistant (LDR) is used to complete the circuitry of the connected components and it is light sensitive so as the more light observed its resistance becomes higher and more voltages are recorded which also alter the fire detectors.

Fire safety can be an important part of the lifestyle. Security measures are being taken against organizations, businesses and relatives. But forest fires go unnoticed. Forests are essential for human
survival and social development. Forests protect the balance of the earth and the environment. This paper presents an inexpensive automatic fire protection system for the purpose of the forest using the GSM fire detection system.

The outcome of proposed mechanism is a successful running system which gives a solution to our problem statement and gives justice to our problem objective. A system has been developed that helps us in the early detection and prediction of forest fires. The results have been summarized here:

- All hardware components connected in our work are giving correct values and there is no defect in them.
- All software components are working correctly there by showing no error as such.
- The sensors are detecting the environment for the conditions and sending the environmental conditions values to our cloud Thingspeak with the help of NodeMCU.
- The cloud API is continuously displaying the current values in the form of a graph which helps us in continuous monitoring of the environment.
- Different graphs for different sensors used in our paper of early detection and prediction of fires (Figure 1-4).
- The threshold values of all the sensors used have been preset in cloud API.
- As soon as the present values exceed the preset values, an email is triggered to the admin which gets information about the environmental conditions not being in the ideal state.
- As long as present values are less than preset threshold values, there shall be display of all values with respect to time in the form of graphs.
- An easy and continuous monitoring of the environmental conditions of forests can be achieved.

Thus, presented mechanism helps us to achieve the objective of making this paper which helps in prediction and early detection of forest fires.

![Accelerometer Sensor](image1.png)

**Figure 1.** Analysis of result of accelerometer sensor
Figure 2. Analysis of result of Soil Moisture Sensor

Figure 3. Analysis of result of LDR Sensor

Figure 4. Analysis of result of UltraSonic Sensor
It has observed that all the sensors are tested and performed efficiently over the ThingSpeak as shown in figure 1-4. Its results are recorded and analyzed which indicates the fire detection system with IoT can perform and can be simulated.

4. Conclusion and Future Scope

In this paper, an IoT Infrastructure for forest fire detection system has been designed to detect fire at earlier stage. The most important objective in fire surveillance is early and reliable detection and localization of the fire. The data collected through different sensors located at different locations and information will be sent to Arduino Uno placed in various places. As a result the proposed model is tested with ThingSpeak web interface and sensor data is recorded for testing of fire detection.

The system will process the information and send mail using GSM module to the nearby fire service station with the location of the fire using GPS module. Several types of sensors used in the system are DHT11: Humidity sensor, soil moisture sensor and LM35: Temperature sensor, LDR sensor, ADXL335: Accelerometer sensor, Ultrasonic Range sensor. Early detection and prediction will lower the count of forest fires in the entire world and save our planet Earth.

In future, we can develop this model to minimize the energy consumption of all sensors and complete networks considering the node distribution among clusters using distributed sensing.

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