IoT based Forest Fire Monitoring System

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1)Problem Statement Understanding:

As we all know, the forest is considered as one of the most important and indispensable resources, the prevention and detection of the forest fire, have been researched hotly in worldwide Forest Fire Prevention Departments. Based on the deficiencies of conventional forest fire detection on real time and monitoring accuracy, the wireless sensor network technique for forest fire detection was introduced, together with satellite monitoring, aerial patrolling and manual watching, an omni-bearing and stereoscopic air and ground forest-fire detection pattern was found so that the decision for fire-extinguishing or fire prevention can be made rightly and real-timely by related government departments.[2]

CAUSES OF FOREST FIRE

[3] Forest fires are caused by Natural causes as well as Man-made causes

- Natural causes- Many forest fires start from natural causes such as lightning which set trees on fire. However, rain extinguishes such fires without causing much damage. High atmospheric temperatures and dryness (low humidity) offer favourable circumstance for a fire to start.
- Man-made causes- Fire is caused when a source of fire like naked flame, cigarette or bidi, electric spark or any source of ignition comes into contact with inflammable material.

Traditionally Indian forests have been affected by fires. The menace has been aggravated with rising human and cattle population and the consequent increase in demand for Forest products by individuals and communities. Causes of forest fires can be divided into two broad categories: *environmental* (which are beyond control) and *human related* (which are controllable).

Environmental causes are largely related to climatic conditions such as temperature, wind speed and direction, level of moisture in soil and atmosphere and duration of dry spells. Other natural causes are the friction of bamboos swaying due to high wind velocity and rolling stones that result in sparks setting off fires in highly inflammable leaf litter on the forest floor.

Human related causes result from human activity as well as methods of forest management. These can be intentional or unintentional, for example:

- graziers and gatherers of various forest products starting small fires to obtain good grazing grass as well as to facilitate gathering of minor forest produce like flowers of *Madhuca indica* and leaves of *Diospyros melanoxylon*
- the centuries old practice of shifting cultivation (especially in the North-Eastern region of India and inparts of the States of Orissa and Andhra Pradesh).
- the use of fires by villagers to ward off wild animals
- fires lit intentionally by people living around forests for recreation
- fires started accidentally by careless visitors to forests who discard cigarette butts.

The causes of forest fire have been increasing rapidly. The problem has been accentuated by the growing human and cattle population. People enter forests ever more frequently
to graze cattle, collect fuelwood, timber and other minor forest produce. It has been estimated that 90% of forest fires in India are man-made

Classification of Forest Fire
Forest fire can broadly be classified into three categories;

- Natural or controlled forest fire.
- Forest fires caused by heat generated in the litter and other biomes in summer through carelessness of people (human neglect) and
- Forest fires purposely caused by local inhabitants.

Types of Forest Fire
There are two types of forest fire i) Surface Fire and ii) Crown Fire

Surface Fire-
A forest fire may burn primarily as a surface fire, spreading along the ground as the surface litter (senescent leaves and twigs and dry grasses etc) on the forest floor and is engulfed by the spreading flames.

Crown Fire-
The other type of forest fire is a crown fire in which the crown of trees and shrubs burn, often sustained by a surface fire. A crown fire is particularly very dangerous in a coniferous forest because resinous material given off burning logs burn furiously. On hill slopes, if the fire starts downhill, it spreads up fast as heated air adjacent to a slope tends to flow up the slope spreading flames

along with it. If the fire starts uphill, there is less likelihood of it spreading downwards.

EFFECT OF FOREST FIRE

[3] Fires are a major cause of forest degradation and have wide ranging adverse ecological, economic and social impacts, including:

- loss of valuable timber resources
- degradation of catchment areas
- loss of biodiversity and extinction of plants and animals
- loss of wildlife habitat and depletion of wildlife
- loss of natural regeneration and reduction in forest cover
- global warming
- loss of carbon sink resource and increase in percentage of CO_2 in atmosphere
- change in the microclimate of the area with unhealthy living conditions
- soil erosion affecting productivity of soils and production
- ozone layer depletion
- health problems leading to diseases
- loss of livelihood for tribal people and the rural poor, as approximately 300 million people are directly dependent upon collection of non-timber forest products from forest areas for their livelihood.

We will be obtaining various sensor readings from the proteus software which are fed into the microcontroller. From the microcontroller, the data will be uploaded to firebase that will be used with a web app UI to display the readings in a graphical format at the user end.
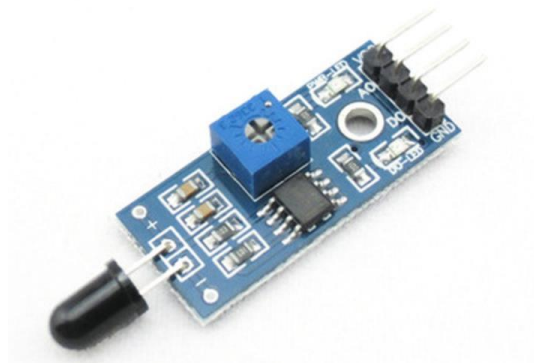
2)Software and Hardware Requirement:

Hardware required:

1) Arduino (ATmega328P)

2) The TMP36 temperature sensor is an easy way to measure temperature using an Arduino. The sensor can measure a fairly wide range of temperature (-50°C to 125°C)
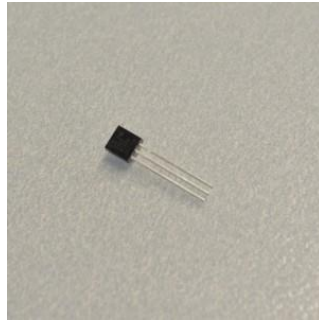
3) Flame sensor- For detecting fire for about a range of 3 feet.

4) MQ2 gas sensor - It can detect gases in the concentration of range 200 to 10000ppm.

5) Buzzer/Alarm, Power Supply, GSM module

Software required:
Arduino IDE, Proteus, Python, Firebase.

3)Additions and Updates:

In real life scenario, we can set a threshold value for the sensors and compare this to the real time readings which we get from the surroundings. If the real time value of the sensor is greater than the threshold value, we can alert the forest fire monitoring officials using alarm/buzzer if the situation gets alarming. This feature can be used in addition to the constant displaying of readings through web app.

Our next goal could be to detect and predict forest fire promptly and accurately in order to minimize the loss of forests, wild animals, and people in the forest fire. In our proposed paradigm, a large number of sensor nodes are densely deployed in a forest. Sensor nodes collect measured data (e.g., temperature, relative humidity) and send to their respective cluster nodes that collaboratively process the data by constructing a neural network. The neural network takes the measured data as input to produce weather index, which measures the likelihood for the weather to cause a fire. Cluster headers will send weather indexes to a manager node via the sink. Then the manager node concludes the forest fire danger rate based on received weather indexes and some other factors. In certain emergent situations, sensor nodes may detect smoke or abnormal temperature. They will directly send an emergence report to the manager node [1].

4)Application, Advantages, Challenges

Applications:

Forest fire surveillance system

Advantages:

1. Early detection and prediction of forest fires helps in prevention of the damage and loss of natural resources and wild life.

2. Forest fires also leads to soil erosion affecting the soil productivity which can be stopped with the help of this monitoring system.

3. Cluster of sensor nodes helps in detecting forest fires better than manual detection or satellite-based surveillance systems.

4. Reduction of forest fires would help in the stopping of ozone layer depletion.

Challenges:

1. Forest includes large area, hence the hardware required would be more and so the cost of deploying the system would be expensive and time consuming.

2. Sensors may get faulty and give faulty readings which needs to be taken care.

5)Conclusion:

In older days, manually fire detection approach is used. In current days, satellite-based surveillance system is used to detect forest fire but this works when fire is spread in the large area. So, these techniques are not efficient. According to a survey, approximately 80% losses are accrued in the forest due to the late detection of fire. So, to overcome this problem, we use the Internet of things technology.

6)References:

[1] Yu L, Wang N, Meng X (n.d.) Real-time forest fire detection with wireless sensor networks. In: Proceedings 2005 international conference on wireless communications, networking and mobile computing.

[2] Zhang Y, Cao N, Chang G, Zhou L, Yu X, Lou Y (2017) Wireless sensor routing protocol research based on forest fire protection. In: 2017 IEEE international conference on computational science and engineering (CSE) and IEEE international conference on embedded and ubiquitous computing (EUC).

[3] https://agritech.tnau.ac.in/agriculture/agri_majorareas_disastermgt_forestfire.html