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Deforestation Control and Forest Monitoring using Internet of Trees

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ABSTRACT

Forests play an important role in the terrestrial carbon cycle and deforestation is a key driver of climate change. The manual monitoring of the forest to prevent unauthorized activities is a practically difficult job. There is a need for high-resolution, global forest monitoring tool. The four major operations that are essential in monitoring the forest are developed in this work, namely tree cutting detection, fire detection, landslide detection, and smoke detection using a sound sensor, temperature sensor, vibration & moisture sensor, and smoke sensor respectively. An Arduino UNO microcontroller is used along with the Wi-Fi module to communicate to the forest department. The sensed data from sensors is collected and sent to the authorized department via the Wi-Fi module. IoT has widely used technology in forest monitoring applications. In addition, this paper uses the NodeMCU module through which employees of the forest department can be notified over mobile phones if any sensed data crosses the threshold value.

Keywords : Deforestation Control, Forest Monitoring, Wireless Mechanism

I. INTRODUCTION

Forest is a conditional renewable resource which can be regenerated but needs a certain period of time to maintain its sustainable functioning. In India, the forest resources have been found to be depleting at a pace which is much high. Rapid industrialization, urbanization and over- exploitation have resulted not only in decline but also in permanent loss of forest cover to an alarming rate. The over-exploitation of forest resources has taken place beyond the sustained yields to fulfil the needs of humans, thus bringing a change in the net forest cover. With the current rate of population explosion, the world population could be expected to increase from 7.6 billion to about 10 billion in the next 30 to 35 years. The growing demand for food can be expected to rise by 50% in the given period, and it is a matter of serious concern. Rational utilization and proper management of the forest resources are the most viable ways to prevent mass destruction of forests and large-scale species extinction. It is necessary to find the links between the growing demands and meeting the demands in a sustainable manner.

In the earth's carbon cycle, forests play a significant role and deforestation is major cause of climate change. There is a need for high resolution, global forest surveillance device that can be used to detect illegal deforestation, enhance natural disaster management, conserve biodiversity and more effective and sustainable forestry. Various measures were taken to control such effects. Firstly, human power was used to keep an eye on the forest area. But through this the

human's life was put to risk and also, they were not able to watch the whole forest easily. So, All Terrestrial Vehicles were manufactured which would help for an easy and faster bird view of the forest ground. But all these were not that effective. So, when Internet of Things emerged, it gave rise to Internet of Trees where the things were connected to forest which would eventually provide regular update about the situation in forest.

The Internet of Things is an emerging trend that points a new path for the future, which a variety of heterogenous networks containing various user data are interconnected transparently through suitable protocol stack. This integration enables any transceiver to access the internet all the time and anywhere. So, under the Internet of Trees, we are trying to implement few modules which would enable forest department about the condition of forest with respect to time. The possible predictions would be the moisture level of soil, temperature check in the forest environment and also with the fire detection the spreading of forest fire can be controlled. Sound and vibration sensing modules would help in identifying the chainsaw sound and also the fall of tree, which would help in controlling the deforestation. The LED and buzzer which is implemented in forest department will be activated according to the conditions mentioned for vibration, temperature, moisture and fire. Accordingly, the alert will be sent to the nearby city for fire and temperature. An alert notification will be sent to the official forest executive in case of any emergency situation.

II. LITERATURE SURVEY

The study [1] is focused on the discussion of evolving of forests. It concentrated on the struggle between protecting forest and diversion towards their use for sustainable resources. About 1.52 million hectares of forest area were diverted for non-forestry use since 1980. Right from the year 1991 to 2019, there were many features included in forest report like district wise forest cover, separate head for forest cover in hill and tribal districts, details of villages in vicinity of forests, details of tree outside forest, special preference to very dense forest, bamboo resource were assessed, agroforestry and urban forestry, forest type and biodiversity.

The paper [2] describes mainly about the forest policy reforms which includes evolution of joint forest management approach. It also helps to understand the present status of the forest with respect to demand supply scenario of timber, fuel wood, fodder and non-wood forest products. It also describes about various management and policy initiatives in forestry sector in a comparative way of pre- and post-independence. Gradually, there was commencement of joint forest management leading to framing forest policies in the year 1992.

The study [3] identifies various powers and duties of officers and employees of forest department like principal chief conservator of forest which includes forest resource management, project team, evaluation team, wildlife team, development team, research and utilization, field director, chief conservator of forest, forest utilisation officer, range forest officers and foresters.

The paper [4] is focused on the effects of all- terrain vehicles on forested lands and grasslands. The main outcome was on a continuum from undistributed to highly distributed, the degree to which they are affected and the level of disturbance level. The evaluation off dust effects on vegetation suggests that OHV's causes minor perturbations but can lead to high damage in the coming years. In total, using of such vehicles is dangerous and should not be continued.

The paper [5] proposes the idea of forest monitoring using sound recognition. This implementation deals specially with illegal logging. It identifies the illegal

logging by continuously recording the noise in the forest and then analysing it and decide by validating the segments. The tree can fall due to natural calamities too which cannot be identified by this system. So, in our project we have introduced vibration module too which would help in better identification of illegal logging.

III. PROPOSED SYSTEM

The proposed system aims to use different modules to measure key parameters in forest areas in regular basis, with no need of human interaction and to send the captured data via wireless communication to central platform i.e. forest department. A smart durable low-cost system to measure the humidity in soil which can also determine the possibility of flood, sound module to detect the chainsaw noise which would emerge at the times tree is being cut, vibration module to sense the frequency of tree fall to determine if the deforestation is because of human or natural calamities, smoke module to check the emergence of fire in forest area and temperature module to keep an update on temperature near forest area. All these modules are planted in forest with respective positioning relevant to their functionality. Node MCU is implemented along those modules in forest which wirelessly transfers data from modules to the forest department. A buzzer and LED light are used as an alert when there is an increment in threshold frequency of any module present in forest. Alert for sound is provided in forest so that a quicker action can be taken by the ones nearby. An alert for smoke and temperature is implemented in both forest department and nearby city to forest for a quick escape in case of forest fire. Alert for soil moisture, vibration, smoke and temperature is included in forest department with separate LED for each module alert. Alongside, blynk application is linked with the modules which would notify the forest executive in their phone whenever there is an emergency situation.

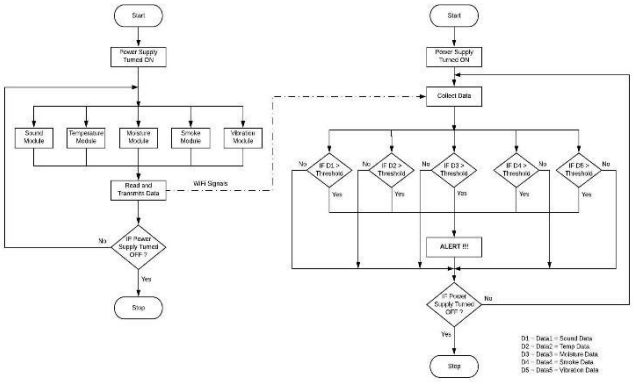

Fig. 1. Flowchart od Proposed System

IV. IMPLEMENTATION

The various modules used in the project are:

A. The Soil Moisture Module uses capacitance to measure dielectric permittivity off the surrounding medium. In soil, dielectric permittivity is a function of the water content.

```
int soilData;
int soilInPin = A0;
if (soilData < soilLimit) digitalWrite(soilLED,HIGH);
```

B. The Temperature Module features a complex sensor for temperature & humidity with a calibrated digital signal output. It ensures high reliability and excellent long-term stability by using the proprietary digital-signal-acquisition technique and temperature & humidity sensing technology.

```
radio.read(&temperatureData,
sizeof(temperatureData)); delay(250);
Serial.println("Temperature value: ");
Serial.println(temperatureData); delay(250);
if (tempData > tempLimit)
digitalWrite(temperatureLED,HIGH);
```

C. The Vibration module is based on the SW-420 and Comparator LM393 vibration sensors to detect whether there is any vibration above the threshold. The onboard potentiometer will change the threshold.

This array of sensors generates logical states depending on the vibration and the external force applied to it. This module gives logic LOW performance when there is no vibration.

```
long vibrationData;
int vibrationInPin = A2; radio.read(&vibrationData,
sizeof(vibrationData)); delay(250);
Serial.println("Vibration value: ");
Serial.println(vibrationData); delay(250);
if (vibrationData > vibrationLimit)
digitalWrite(vibrationLED,HIGH);
```

D. The sound module is used to notice the sound. Generally, this module is used to detect the intensity of sound. The applications of this module mainly include switch, security, as well as monitoring. The accuracy of this sensor can be changed for the ease of usage.

```
int soundData;
int soundLED = 2; int soundLimit = 900;
const int soundInPin = A1;
```

E. The smoke module is a smoke sensing device that indicates fire.

```
int smokeData;
int smokeInPin = A3; radio.read(&smokeData,
sizeof(smokeData)); delay(250); Serial.println("Smoke
value: "); Serial.println(smokeData); delay(250);
if (smokeData > smokeLimit)
digitalWrite(smokeLED,HIGH);
```

V. RESULT

Transmitter End:

- Data is collected from all the sensors and stored in transmitter Arduino UNO
- Transmits the collected data to Receiver
- Check data of sound sensor if the value exceeds the limit, power is supplied to Buzzer and LED pin
- Check data of all the sensors
- If any of the value exceeds the threshold, send a high flag to NodeMCU
- Repeats the process after a specified interval At NodeMCU:
- Check if the received flag is high
- If high push alert Notification to the server
- Else make the flag low

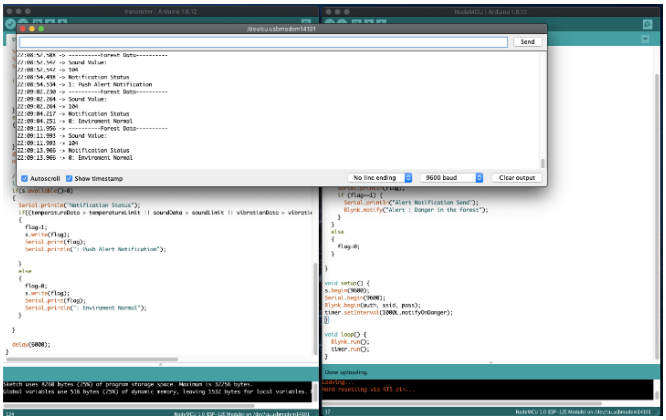

Fig. 2. Process at Transmitter End At Arduino UNO:

Receiver End:

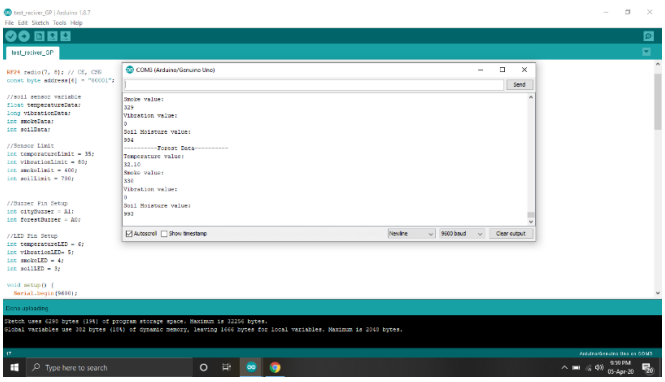

Fig. 3. Output at Reciever End At Arduino UNO:

- Check if any data is received from the transmitter
- Check all the values of received data
- If any of the value exceeds the limit, alert forest department by supplying power to the buzzer and respective LED
- Only if a drastic change in temperature, alert nearby city in forest
- At mobile:

- If danger at the forest NodeMCU sends a signal, forest executive mobile receives a notification "Danger in the forest".

Fig.4. Notification Alert on Forest Executive Phone

Fig.5. LED Alert in Forest Department

VI. CONCLUSION

For any country forests are major environmental resource. Various measures are being carried out in developing measures to protect them to avoid major drawbacks in future. Deforestation control and forest monitoring uses different modules to measure key parameters in forest areas in regular basis, with no need of human interaction and to send the captured data via wireless communication to central platform i.e. forest department. Various modules to analyze sound, moisture, vibration, smoke and temperature are implemented in forest area. Buzzer and LED are connected in forest department and nearby areas as an alerting medium. A notification system is also enabled in the forest executive's phone. Through this project our view on forest have definitely changed of course in a more positive way and also have got a better learning opportunity not only in Internet of Things but also Internet of Trees. This is a smart durable low-cost system which can be enhanced in future by adding more features.

VII. FUTURE SCOPE

Since the alert notification is passed on using the third-party application by name "Blynk", a separate application can be created specifically for forest department which not just provide an alert for something is wrong but specifically describe what went wrong. Also, a data visualization analysis can be obtained using Machine Learning algorithms for processes like data extraction, data filtering and query conditions from the data stored using various modules implemented in this project. Synthetic aperture radar (SAR) observations can be used which will be available no matter what the weather condition for building an effective early warning system.

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