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FOREST FIRE PREDICTION AND ALERT SYSTEM USING BIG DATA TECHNOLOGY

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Abstract: *In this paper we discuss about the forest fire prediction and alert system using big data technology. Forest fire is considered as one of the major natural disaster. Our method is to collect and analyze the data from wireless sensor using hadoop tool to predict the forest fire before it occurs. Here we use machine learning tool called as Mahout which is used for clustering and filtering the datasets and it can be able to predict the valid output. By using GSM we can give alert message to people so that they can relocate to a safety place immediately, when fire occurs. Signal and Infrare image processing is used to monitor the signals and images of the entire forest for every 30 min and those data will be stored in datasets, by using those data we can be able to predict the forest fire in advance.*

Keyword: Fire prediction, wireless sensor, hadoop, temperature sensor, Mahout, GSM, Signal proceesing, Infrared image processing.

INTRODUCTION

Several million acres of forest are destroyed every year due to forest fire. Forest fire not only destroys many valuable trees but also destroys the vegetation in that area. 90% of the forest fire occurs due to humans. **"Crown Fires"** are spread quickly by wind moving across the tops of trees. **"Running crown fires"** are more dangerous because they burnt extremely hot, travel rapidly, and can change direction quickly. Lightning strikes the earth over 100000 times a day. 10 to 20% of these lightning strikes can caus fire. Forest fire is one of the major causes of global warming as tones of greenhouse gases are emitted into the atmosphere. Nowadays the detection mechanisms are used for watching towers, satellite imaging, long distance video recording, etc. But it will not provide any quicker response which is most important in forest fire detection. Video surveillance is a low cost system but it produces false alarm due to environmental condition like fog, clouds, dust and human activities. Another method is used to take snapshot of the forest by using visual camera, and it will be placed on the towers to cover the maximum area of the forest. A motor is used to rotate the camera 360° so that we get the full view of the forest. The images obtained using these cameras are processed by using a program or a code. These images are used to find forest fire by comparing it with the normal images. The major advantage of this method is that the system can be programmed to take into considerations of the environmental conditions and the effect of fog or clouds that can be eliminated The serious disadvantage is that it may sometime do not predict the fire considering the signals are due to environmental conditions. We also need to build towers to place the camera at a higher position so that it may increase the cost of the system. A good and effective method is the use of wireless sensor network. In this method the sensor module is deployed in the forest manually or through a helicopter. The sensor module consists of multiple sensors like temperature sensor, humidity sensor, etc. They collect the target environment information and continuously transfer it to the control center where the necessary process is carried out. Sensor nodes are less costly and even if it gets damaged in fire it won't be a great loss. WSN has the property of self configuration and hence

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need not be organized manually. **GPS** can be used to track the exact location of the fire that can be easily obtained and the nearest fire service can also be easily informed by using **GSM.**

II. METHODOLOGY

Big data is used to store huge amount of data that can be analyzed later. The data will be in the form of structured, unstructured or semi structured. Big data uses **Hadoop** tool for storing huge amount of data. In forest fire prediction, the data will be collected and stored in hadoop as unstructured form. **Hadoop** ecosystem components are pig, hive, map reduce, HDFS. **Map reduce** is a programming model, and an associated implementation for processing and generating large data sets with parallel and distributed algorithm on a cluster. In forest fire prediction Map Reduce plays an important role in forest fire prediction because it is used to reduce the large datasets into simpler datasets. **Hive** is the data warehouse infrastructure built on top of hadoop for providing data, query, analysis. Apache hive supports analysis of large datasets stored in hadoop's **HDFS**. I provides an SQL like language called **HiveQL** and it is use to convert data into map reduce. To accelerate queries in hadoop it provides indexes and bit map indexes. We use hadoop tool to store the data of forest fire prediction for analyzing**. Hive** is used to analyze the datasets of forest fire that are stored in hadoop **HDFS**. We can use machine learning tool to collect the temperature, rare trees, weather, gas, etc. it is used to store the scalability of large datasets. **Mahout** tool is one of the machine learning tool used in hadoop ecosystem. It's OS is independent**. Mahout** tool is used to filter and classify the datasets based on keyword. Cameras are used for monitoring the entire forest**. Signal processing and Infrared image processing** is also used to monitor the signal and image of the entire forest. By using the signal processing and multi sensor we can get an alert message from the server and can be able to predict the fire in advance.

III. PROPOSED FIRE DETECTION MECHANISM

The proposed method consists of varieties of standalone boxes, and each box consistingof various sensors like humidity and temperature sensors. These boxes are spread around the entire forest area, so that we can be able to monitor the entire forest area.

3.1. Sensor Deployment

Sensor deployment is one of the most significant factor as it determines the efficiency of the entire system

1. The entire forest with minimum number of nodes should be covered by the sensor
2. The rate of spread of fire can be calculated easily, only if the distance between the sensor are equal
3. The sensors must be positioned such that false alarms are avoide These sensors collect the data wirelessly and transmit the data to a base station. The sensors form a cluster and are active always. They sense the parameters every 15 minutes and if there is a possibility of fire detected then the parameters will be measured every 2 minutes. This purpose is to reduce the usage of battery power. These sensors cannot be powered using electricity so they need to be deployed deep into the forest. Solar panels are used for powering the rechargeable batteries.

3.2 Topology Design

Based on the density of trees in the area, the topology of the sensor nodes must be preplanned. When the density of trees is more then there are more chances of fire as the trees more often rub each other producing heat due to friction. In such cases the number of sensors deployed must be higher. While considering the energy restriction the detection of forest fire as early as possible must not be compromised.

IV. MATERIAS USED

4.1 Temperature Sensor

One of the main changes that happen when a fire occurs is the increase in temperature of the environment. This might be considered as the cause of forest fire or due to change in temperature during summer. Due to forest fire the change in temperature can be differentiated from other environmental factors as the rate of change of temperature due to fire will be rapid. Here we use **LM35** is as fire sensor and this can be able to measure the temperature only in the range of **-55°C to 150°C**

4.2 Humidity Sensor

By measuring humidity We can detect and predict fire greatly. When a fire occurs the air becomes dry and the humidity will be low. And there is a maximum possibility of occurrence of fire when the air is dry than being moistures.

4.3 Battery

The battery used for this project must be rechargeable, small, light, cheap, environmental friendly, fast in charging and discharging, reliable, long lasting, etc. Not all these are satisfied in one battery but **Liion** battery seems to suit this purpose.

4.4 GSM

Global System For Mobile Communication is a digital mobile telephony system that is widely used in every parts of the world. GSM is used to send alert messages to the neighbor areas quickly. It is the most widely used in three digital wireless telephony technologies **(TDMA**, **GSM, and CDMA).** GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the900 MHz or 1800 MHz frequency band. GSM is used to send status about the occurrence of fire in the forest. GSM is interfaced to the microcontroller through **RS 232 to USART** terminals.

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4.5 Zig Bee

Zigbee is a specification for communication in a wireless personal area network (WPAN). Zigbee is based on an **IEEE 802.15** standard. It consumes low power with transmission distance of 10 to 100 meters line of sight. It can transmit data over long distance through intermediate devices such as by forming mesh network. Zigbee has a defined rate of 250 Kbit/s, and best suited for intermittent data transmissions from a sensor or input device. It is simple to use and much less expensive than other

WPANs such as **Bluetooth and Wi-Fi.**

V. ALGORITHM

1. All the nodes should be initialized and synchronized to same clock
2. A cluster of nodes will be connected to a base station, and all the base station are connected to the control center
3. When humidity of air is high**, LM 35** senses the temperature and transmit it to the base station every 30 minutes
4. When the humidity of the air reduces there is more possibility for the fire hence the rate of measurement will be increased to every 15 minutes
5. If the temperature is less than the threshold value then the node enters the sleep state else the sensor continuously senses the temperature and transmits the result to the base station
6. When a node senses fire it sends a danger packet to its neighboring nodes and the timer is started and it will run till it gets a fire alert. This is to calculate the rate of spread of fire and the direction of spread
7. The base station collects all the values and calculates the rate and direction of spread of fire
8. Through the GSM, alert messages is sent to nearby villages to relocate the people to a safe locality This is a simple method where we have a less overhead in the data packets, and this topology is easy to expand. The energy consumption is also less as the node senses the parameters only on certain intervals which are controlled by the base station

VI. WORKING OF FIRE DETECTOR

6.1Prediction of fire

It is necessary for us to detect the fire as early as possible and it would be better if it is predicted in advance. The fire usually occurs when the humidity of the air is lower and the temperature is higher. Thus if the humidity of the air is below a threshold value and the temperature is higher than the threshold value then an alert signal is sent to the control center After the alert signal is given to control signal we can relocate our area or else we can predict ourselves from the fire. Once the fire is predicted at a particular location then the necessary precautionary measures are carried out. The fire may occur even without being predicted. This prediction will work only when the fire arises due to increase in the relative temperature but when the fire occurs due to incidents such as lightning or manmade events or due to crown fires then the fire cannot be predicted.

6.2 Detection of fire

When the temperature in a particular node gets increased over a fixed threshold value then the alert is sent to the control center. The threshold value will always be fixed above the maximum temperature which is experienced in that particular region to avoid any false alarm due to the increase in the atmospheric temperature. As soon as the fire is detected in a particular node the alert will be sent to the control center and also to the neighboring nodes. Once the nearer nodes get the alert, timer gets started and it is run till the nearer node detects the fire. This is used to find the rate of spread of the fire in the forest. When the rate of spread is known then the necessary action can be taken immediately. All the nodes are equally spaced in order to easily find the rate of spread of fire. The rate of spread directly depends on the speed of air blowing. And also the fire usually spreads upwards in a hilly area. These are taken into considerations while designing the detection system.

6.3 Finding the direction and rate of spread of fire

The direction of spread of fire is more important to prevent further damage to the forest and wildlife. This can be obtained by using the data collected from the sensor nodes. Normally the fire spreads in all the directions hence when a fire is detected in a node then it sends danger alert packets to all the neighboring nodes and all the neighboring nodes start a timer and measure the time between the reception of the alert packets and the detection of fire. This is done for all the neighboring nodes.

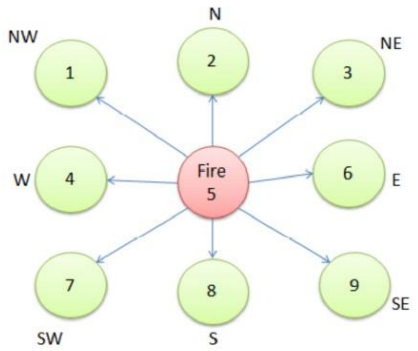

Figure 6.3: **Fire detected node sending alert packets to neighboring node**

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In the above method the middle node 5 detects the fire first and it sends alert packets to all eight neighbors. If any one of the node interrupts it won't affect the remaining nodes, because we can provide secondary node for all nine nodes. Backup should be available in the secondary node and it will be analyzed for every half an hour. Hence the rate of spread of fire in all the eight directions can be found.

$$\text{Rate of spread of fire} = \frac{\text{Distance between two nodes}}{\text{Time interval between reception of alert and fire detection}}$$

VII. CONCLUSION

The objective of this paper is to reduce the damage and destruction that are caused by the forest fire to the life and property of humans and also wild animals. Apart from early detection of forest fire we have also attempted to predict the fire in advance with the help of the data obtained from the sensors that are deployed in the forest.

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