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Intelligent Forest Fire Detection Using IOT Cloud And Data Fusion Approach

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***Abstract*—**Fire is a common disastrous phenomenon that constitutes a serious threat. Forest fire always starts by one of two ways such as naturally caused or humancaused. Recently, in Australia fire broke out and the fire situation worsened significantly and impact to Australian fishing and tourism, billion of animals were killed, 46 millions of land were burned and cause the extinction of flora and fauna. Another example is about Bandipur National Park Karnataka State in 2019. Forest fire lasts for five days burning 10920 arcs land. Like this, so many disasters have happened in our world. To overcome this, we propose an idea for detecting forest fire by collecting various data and performing data fusion using wireless sensors and algorithm to produce an alert message whenever a fire breaks out in the forest areas. The process of early detection and monitoring of a fire event leads to efficient control of the fire and makes feasible the immediate evacuation of the entire area.

***Keywords*—**Forest Fire, Wireless Sensors, Land, Detection. etc

I. INTRODUCTION

Forests are the protectors of the earth's ecological balance. Unfortunately, the forest fire is usually only observed when it has already spread over a large area, making its control and stoppage arduous and even impossible at times. This chapter discusses forest fire and its cause, consequences, fire detection and suppression Techniques.

Forest fire is an uncontrolled fire that occurs mainly in forest areas, although it can also invade urban or agricultural areas. Among the main causes of wildfires, human factors, either intentional or accidental, are the most usual ones. The number and impact of forest fires are expected to grow as a consequence of global warming. The result is a devastating loss and irreparable damage to the environment and atmosphere (30% of carbon dioxide (CO2) in the atmosphere comes from forest fires) [1], in addition to irreparable damage to the ecology (huge amounts of smoke and carbon dioxide (CO2) in the atmosphere).

Among other terrible consequences of forest fires are long-term disastrous effects such as impacts on local weather patterns, global warming, and extinction of rare species of the flora and fauna. The problem with forest fires is that the forests are usually remote, abandoned/unmanaged areas filled with trees, dry and parching wood, leaves, and so forth that act as a fuel source.

These elements form a highly combustible material and represent the perfect context for initial-fire ignition and act as fuel for later stages of the fire. The fire ignition may be caused through human actions like smoking or barbeque parties or by natural reasons such as high temperature in a hot summer day or a broken glass working as a collective lens focusing the sunlight on a small spot for a length of time thus leading to fire-ignition. Once ignition starts, combustible material may easily fuel to feed the fires central spot which then becomes bigger and wider.

The initial stage of ignition is normally referred to as "surface fire" stage. This may then lead to feeding on adjoining trees and the fire flame becomes higher and higher, thus becoming "crown fire." Mostly, at this stage, the fire becomes uncontrollable and damage to the landscape may become excessive and could last for a very long time depending on prevailing weather conditions and the terrain. Millions of hectares of forest are destroyed by fire every year.

Areas destroyed by these fires are large and produce more carbon monoxide than the overall automobile traffic. Monitoring of the potential risk areas and early detection of fire can significantly shorten the reaction time and also reduce the potential damage as well as the cost of fire fighting. Known rules apply here: 1 minute--1 cup of water, 2 minutes--100 litres of water, 10minutes--1,000 litres of water. The objective is to detect the fire as fast as possible and its exact

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localization and early notification to the fire units is vital. This is the deficiency that the present invention attempts to remedy, employing detection of a forest fire at the very early stage,

II. MODULES

- Data Collection
- Data Fusion
- Fire Detection using KNN
- Sending Alert Message

A. Data Collection :

- Temperature and humidity data are collected using multiple sensor nodes and pushed to channels in IoT cloud.
- Sensor Nodes are DHT11 modules interfaced with NodeMCU.
- Data's are collected in two stages. Using two sensor nodes.
- Data is collected first time for 30 minutes, in which during last 10 minutes, senor nodes where exposed to artificially created fire. This data is used for training the KNN for fire detection.
- For the second time data is processed live by the IoT cloud for fire detection testing.

B. Data Fusion :

- Data fusion is the process of integrating multiple data sources to produce more consistent, accurate, and useful information than that provided by any individual data source.
- This is often categorized as low, intermediate, or high, depending on the processing stage at which fusion takes place.
- Low-level data fusion combines several sources of raw data to produce new raw data and the expectation is that fused data is more informative .

C. Fire Detection Using Knn:

- Generation of data for training
- KNN Algorithm

Step 1 − Load Training and Testing data
Step 2 − Choose the value of K
Step 3 − For each point in the test data
3.1 − Calculate the distance between test data and each row of training data with the help of Euclidean distance.
3.2 − Now, based on the distance value, sort them in ascending order.
3.3 − Next, choose the top K rows from the sorted array.
3.4 − Now, assign a class to the test point based on most frequent class of these rows.

D. Sending Alert Messages

- React App watches the fire status in the Fused Data and Predicted Data Channel and if prediction shows fire presence, it will trigger another ThingSpeak App called ThingHTTP App
- SMS gateway API's are pre-configured in the ThingHTTP App
- On activation, ThingHTTP App send the pre-configured request to the SMS gateway server.
- SMS gateway server send the SMS according to the received request

III. CONCLUSION

Forest fires are becoming more frequent, even though the fire has always been a natural and beneficial part of many ecosystems, climate change and other human-caused factors are fundamentally changing the frequency, the intensity of wildfires, fire patterns and their behaviours.

We have designed an intelligent system for Forest Fire Detection which overcomes the limitation of the Existing technologies of Forest Fire Detection. In this project, we have developed a system which can reduce catastrophic events caused due to fire.

This system detects the Wildfire as early as possible before the fire spreads over a large area and prevents poaching. In the experiment conducted as part of the project, the implemented system was successful in predicting fire. Even though the experiment was carried out with two sensor nodes, any number of sensor nodes can be added for covering a large area forming a cluster of sensor nodes.

The Extended Kalman Filter algorithm used for data fusion can be further fine-tuned for the better fusion of data. One of the major setbacks faced during the experimentation where the limitations of ThinkSpeak IoT cloud platform and the limitations brought by the free account and the toolbox licensing. So the entire implementation doesn't use any functions for major algorithm implementations.

The initial plan was to implement decision tree, but due to the limitations of the ThinkSpeak Analysis App not allowing functions which restricted from writing recursive functions and not having the toolbox licensing at the using Free ThingSpeak account, the algorithm for detection of fire was changed to K-Nearest Neighbors Algorithm, which was implemented without using any major functions, which also worked perfectly well. Another concern for this project is sensor node connectivity to the cloud server, which needs further research for developing power and cost-efficient connectivity system, which will be another project by itself.

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