International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

IOT-ENABLED WIRELESS SENSOR NETWORK-BASED EARLY DETECTION SYSTEM

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ABSTRACT

Under the present circumstances, the IoT industry is expanding quickly. We are all aware of the importance of the Internet of Things these days. These days, almost every industry uses it to make our lives a little bit simpler. Worldwide, forest fires have grown to be a serious concern, harming both human dwellings and forest ecosystems. The greenhouse effect and altered climate are two effects of such devastation. Regrettably, human activity is the primary cause of a greater proportion of forest fires. As a result, early detection of forest fires is essential to reducing the devastation they inflict. In this study, an IoT-based system and technique for early detection of forest fires are proposed. The focus of this study is on assessing several characteristics that might cause forest fires in order to identify them as early as feasible. This study proposes an Internet of Things (IoT)-based forest fire detection system that monitors parameters using sensors such as the MQ5 smoke sensor, DHT22 temperature and humidity sensor, Capacitive soil moisture sensor, and Flame sensor. A wi-fi capable microcontroller (NodeMCU) retrieves the readings from the sensor and uploads them to the cloud. The user receives a message or a call when these values are above a certain threshold. This strategy may prevent fatalities or at the very least encourage the installation of safety precautions. This paper's primary goal is to provide a method that may identify prospective fire threats as soon as feasible, averting the development of horrifying wildfires. With the help of our technology, it may be possible to anticipate and identify fires and notify the appropriate authorities in time for them to take appropriate action before the forest fire gets out of control.

Keywords: *Forest Fires, WSN, Detection, Visualization, Alert System, fire prevention*

I. INTRODUCTION

In India, the summer months have seen the greatest frequency of forest fires, particularly from April to June. Low humidity, high temperatures, and dry vegetation are associated with this time, which creates ideal circumstances for the occurrence of forest flames spreading. The Forest Survey of India reports that during the forest season, which ran from November 2020 to June 2021, 52,785 forest fires were discovered using the MODIS (Moderate Resolution Imaging Spectro-radiometer) sensor and 3,45,989 using the SNPP-VIIRS (Soumi-National Polar-orbiting Partnership – Visible Infrared Imaging Radiometer Suite). Forest fires are a serious hazard to both the economy and biodiversity. This may include harm to wood, other forest resources, animal habitat degradation, and the tourist sector. One famous instance of a forest fire that resulted in substantial losses for wildlife and financial damages in India is the fire that broke out in Uttarakhand in 2016 and burned for many months. The comptroller and auditor general of India (CAG) reported that the forest fires caused an estimated total monetary loss of 2,500 crore (about USD 340 million). Overall, they might result in considerable collateral damage, which highlights the urgent need for efficient forest fire management and prevention strategies. The creation of an intelligent surface system that gathers precise data for forest fire-related characteristics is the main topic of this article. The data is continuously visualized using a Wireless Sensor Network (WSN), and an alarm is sent out when the values cross a predefined threshold. The data is uploaded to an IoT cloud. Compared to getting satellite data, this may work out to be a quicker and less expensive option. Additionally, additional analysis of the data gathered may be utilized to assist prevent forest fires in the future. enabling timely notice and rapid action to stop the spread of the fire.

II. RELATED WORK

In a wireless sensor network (WSN), many sensor nodes are arranged geographically and linked to a central node that receives data from all of the sensors. There are one or more sensing elements in each sensor node. In addition to the sensors, there is a data processing unit, a communication component, and a power supply, which is often a battery. The central node receives the sensed data and forwards it to the intended destination. WSNs are often used in monitoring applications such as environment monitoring, border monitoring, meteorological variable collection, etc. According to [1], one example of a WSN application used several tiny nodes to monitor changes in the surrounding area. This data was then sent to the central cluster node, which then forwarded it to the server via a gate, allowing for simple data upkeep and scalability.

Data aggregation in WSNs is another technique for monitoring and detecting forest fires, as covered in [2]. This research suggests a technique that maximizes the operational efficiency of the network by using verified WSN energy to respond to forest fires more quickly and somewhat more effectively. A vast number of simulation experiments also support this. For jobs like the detection of earthquakes, landslides, floods, forest fires, etc., WSN may be a superior option[4]. It has been suggested that some components of sensors should only be kept active while the others are disabled in order to reduce their power consumption [8][9][10].

There have been many more studies on WSNs. One of them suggested combining data from many sources, which was then taken into account when reaching the final choice. This is really preferable than utilizing sources separately, and two methods based on the threshold ratio and Dempster-Shafer theory were used after the fusion [3].

In addition, studies like the ones covered in [5] have been carried out to improve the detection accuracy by the use of machine learning methods like logistic regression and support vector machine (SVM) classification. Despite its advantages, this method has drawbacks, including low energy, energy needed for data processing, restricted calculations, and sophisticated machine learning algorithms [6] [7].

In wooded settings, electricity availability might be a problem. Using batteries alone would be problematic since they don't last very long, and power distribution by cable would be expensive. As a result, researchers suggested that solar power systems be used as a backup power source in addition to rechargeable batteries being the main power source [3][12].

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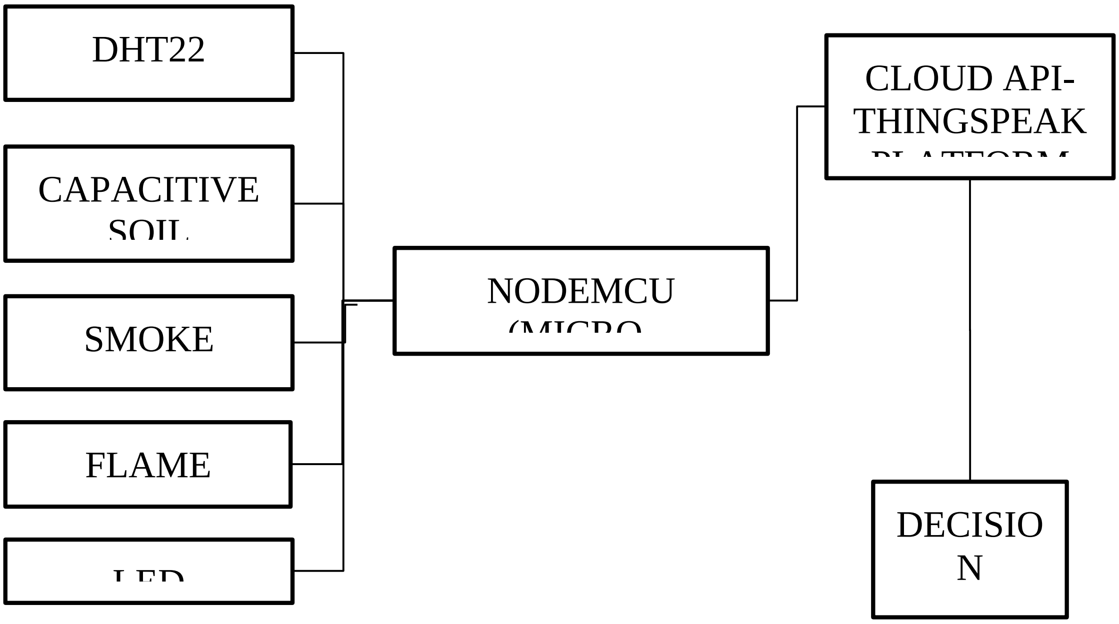

Fig 1: Block Diagram of Proposed System

III. PROPOSED WSN SYSTEM

Forest fires may have both natural and man-made causes, on average, all around the globe. The atmosphere gets hot and dry, particularly in the summer, which makes it more probable that forest fires may develop. acting as fuel for them as a consequence. One of the key contributing elements to these tragedies is global warming. Such an incident not only results in the loss of thousands of hectares of forest land, but it also has a substantial influence on the economy, public assets, resources and services, and animal habitat. Every year, citizens and firefighters alike face a major threat of horrific catastrophes. Therefore, early detection of these forest fires is important to averting such catastrophic results. In this research, we have constructed a model consisting of a number of wireless sensor networks that continually monitor several forest fire-related parameters, including temperature, humidity, soil moisture, and the quantity of smoke present in a given location. All of the sensor nodes' data is delivered concurrently to a central node named NodeMCU, which uploads the collected information to an Internet of Things cloud called Thingspeak. On the other hand, graphs and widgets are used to continuously see the data on the cloud. Every sensor has a predetermined threshold that, when attained, activates an alert via the usage of a web-based service called IFTTT (If This, Then That), which employs applets to connect multiple internet platforms and services. It sends notifications via automated calls, messages, emails, etc. There are numerous different kinds of devices that may be used to monitor and identify such situations. The MQ5 smoke sensor, the DHT22 humidity and temperature sensor, the capacitive soil moisture sensor, and the flame sensor are all employed in our system. The data from each of these sensors is delivered to the base station, which uploads it to the server for additional analysis, visualization, and decision-making.

Fig 2: Test results for a particular period of time

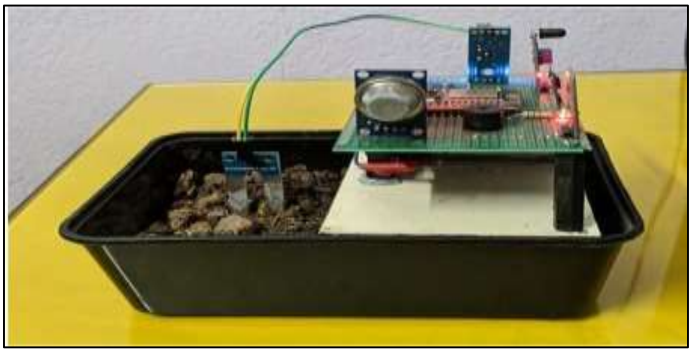

Fig 3: Sensor node assembled for fire detection

IV. RESULT AND DISCUSSION

Extensive testing has been conducted on the suggested design of the forest fire detection system. With the necessary precision, the sensors used here can identify any environmental factor that might endanger forest regions. The DHT22 sensor, MQ5 sensor, capacitive soil moisture sensor, and flame sensor are the four primary sensors included in the design. The model discussed above is seen in Figure 2. The system underwent testing in a range of environmental circumstances. Many environmental parameter sensor readings have been thoroughly validated, and the data was successfully registered on the cloud-based Internet of Things monitoring system. The graph for various characteristics that the sensors recorded during a certain time period is shown in Figure 3. Additionally, the alarm system based on calls and messages was successfully tested after a controlled candle flame was used to simulate a fire. Similar to how dry soil was used to test soil moisture, hot air blowers were used to test temperature and humidity, and smoke from burned paper was used to test smoke sensors. Parameter values changed as anticipated, and the user's device successfully received the corresponding warnings.

V. CONCLUSION

It has been recommended that the formerly in place WSN node be constructed and upgraded in order to monitor and precisely detect forest fires at an early stage. The sensor system was effective in identifying a number of basic meteorological factors that directly affect forest fires, in addition to accounting for a few other components of forest fires. The graph's data display of the parameters was quick and accurate. One of the goals for the remaining work in this research is to further improve and optimize the sensing node using several different techniques, such as camera imaging and clever programming algorithms. At the end of the project, the highly applicable WSN system that was supplied to identify forest fires early on proved to be very helpful in preventing forest fires.

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