

A FOREST MONITORING SYSTEM BASED ON GRPS AND POWERED BY IOT

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Abstract: Forests are increasingly threatened by deforestation, climate change, and natural hazards such as wildfires and rising atmospheric pollution. Addressing these challenges requires efficient and real-time monitoring systems. This study presents an intelligent forest monitoring framework built on the Raspberry Pi Model 3, integrating both analog and digital sensors with advanced signal processing techniques. The system continuously measures key environmental parameters, including temperature, gas levels, and soil moisture, to assess forest conditions. In addition to environmental sensing, the proposed framework incorporates an audio classification module that analyzes ambient sounds using machine learning algorithms. Detected sounds are categorized into distinct classes such as chainsaw activity, vehicle movement, or natural forest noise, enabling early identification of illegal logging or human intrusion. The collected data is transmitted through an Internet-based platform and made accessible via mobile applications, ensuring real-time user interaction. Alerts and notifications are generated automatically when abnormal conditions—such as fire risks, elevated pollution levels, or unauthorized deforestation activities are detected. This IoT-based solution is designed to support forest management efforts by providing timely insights to government agencies, environmental organizations, and private stakeholders, thereby enhancing conservation strategies and disaster response capabilities.

Keywords: Internet of Things (IoT), Deforestation Detection, Remote Sensing, Forest Monitoring System, Internet of Things, analogical and digital sensors.

I. INTRODUCTION

Forests represent one of the most essential natural resources, playing a fundamental role in sustaining the Earth's ecological stability. They contribute to climate regulation, biodiversity conservation, and the overall health of ecosystems. However, forests are increasingly exposed to various threats, among which fire is a dominant factor. Fire has historically influenced forest evolution and management practices, with some ecosystems adapting to periodic burning caused by natural or human activities. Despite this, the majority of forest regions suffer severe damage from uncontrolled wildfires. Each year, extensive forest areas are destroyed, leading to significant economic losses, including damage to timber resources, residential structures, and the high financial burden associated with firefighting efforts. Moreover, wildfires adversely affect environmental quality, reduce recreational value, and pose serious risks to human life and livelihoods.

The Internet of Things (IoT) refers to a network of interconnected devices embedded with sensors, processing capabilities, and communication technologies that enable data exchange over existing internet infrastructure. Unlike traditional

machine-to-machine communication, IoT supports broader integration across multiple platforms, applications, and domains, enabling intelligent automation and real-time decision-making. The concept encompasses a wide range of devices, including medical implants, agricultural monitoring systems, environmental sensors, smart vehicles, and equipment used in emergency response operations. Modern implementations of IoT can be seen in smart home systems, such as connected thermostats and appliances, which allow remote monitoring and control through wireless networks. In the context of environmental monitoring, IoT offers significant potential for enhancing forest surveillance, enabling early detection of hazards, and improving response strategies.

II. LITERATURE SURVEY

A. IoT System for Forest Monitoring.

Forests are increasingly threatened by human activities such as deforestation, as well as natural hazards including wildfires and rising levels of harmful gases. These challenges highlight the need for efficient and continuous environmental monitoring systems. This paper presents an intelligent forest monitoring framework built using the Raspberry Pi Model 3, integrating both analog and digital sensors along with advanced signal processing techniques. The system continuously tracks key environmental parameters such as temperature, gas concentration, and soil moisture to assess forest conditions in real time.

In addition to environmental sensing, the proposed solution incorporates an audio analysis module that processes ambient sounds using classification algorithms. Based on this analysis, detected sounds are categorized into classes such as chainsaw activity, vehicle movement, or natural forest background noise, enabling the identification of potential threats like illegal logging or human intrusion.

The system ensures seamless user access to collected data through an internet-based platform and a dedicated mobile application. This allows users to monitor conditions remotely and receive instant alerts whenever critical events such as fire outbreaks, abnormal pollution levels, or unauthorized deforestation activities are detected.

The proposed “SeaForest” monitoring system represents an IoT-based solution designed for use by government agencies, environmental organizations, and private forest owners. By enabling early detection and rapid response, it aims to support effective forest management, reduce environmental damage, and enhance disaster preparedness.

B. Forest Fire Monitoring System Based on IoT Technology.

The conservation of forests has become a critical global concern due to their essential role in sustaining ecological balance and supporting biodiversity. Developing an effective and reliable surveillance system for forest environments presents numerous opportunities as well as significant challenges. Advanced monitoring solutions can greatly assist authorities by providing accurate, real-time data to support informed decision-making and timely intervention. In this context, the Forest Alert Monitoring System (SAFe) introduces an innovative approach to forest surveillance using Internet of Things (IoT) technologies. The proposed system focuses on enhancing environmental monitoring through the deployment of cost-effective sensor modules capable of continuously collecting

and transmitting data. By leveraging IoT connectivity, the system enables efficient, scalable, and real-time observation of forest conditions, contributing to improved management and protection of natural resources.

C. Smart Forest monitoring System.

Forests play a vital role in sustaining life on Earth by supporting air quality, soil health, and climate regulation. These ecosystem services are essential for both environmental stability and economic development. However, forests are increasingly at risk, with approximately 13 million hectares lost globally over the past decade due to deforestation and other human activities. This growing threat highlights the urgent need for advanced monitoring and prevention systems. Despite this necessity, the adoption of intelligent forest monitoring solutions remains limited to only a few regions worldwide.

To address this gap, the proposed system introduces a smart forest monitoring framework that leverages sensor networks, low-power communication, and renewable energy sources. The system is designed to deliver accurate, real-time data while maintaining energy efficiency and ease of maintenance compared to traditional conservation approaches. It consists of a network of low-power cameras, fire and smoke detectors, as well as humidity and temperature sensors. These devices are interconnected through a mesh network and powered by solar panels combined with rechargeable lithium batteries. A microcontroller processes the collected data and transmits it periodically to a centralized monitoring server.

The system is capable of generating early warning alerts when abnormal conditions such as fire or environmental changes are detected. To minimize environmental disruption, the hardware is designed to blend with the natural surroundings and requires only periodic maintenance. The generated alerts and data can be accessed by government authorities as well as the public, enabling timely response actions. While the system enhances monitoring and early detection, human intervention remains essential for effective resolution and forest protection.

III. METHODOLOGY

Step1: Problem Identification

Identify key forest issues such as deforestation, forest fires, illegal logging, and wildlife safety. Define the need for continuous and real-time monitoring.

Step2: System Design

Design an architecture that includes sensors, communication modules, cloud/server, and a user interface. Divide the system into hardware and software components.

Step 3: Data Collection using Sensors

Deploy sensors in the forest area to collect environmental data: Temperature and humidity sensors (for fire detection) Gas/smoke sensors (detect fire or pollution) Soil moisture sensors (monitor land condition) Motion sensors (track wildlife or intruders)

Step 4: Data Transmission

Use wireless communication technologies like IoT modules (Wi-Fi, GSM, LoRa) to send data from sensors to a central server or cloud platform.

Step5: Data Processing and Analysis

Process the collected data using software or cloud platforms. Apply algorithms or simple threshold conditions to detect abnormal situations like fire or illegal activity.

Step6: Alert System

Generate real-time alerts (SMS, app notification, or email) when abnormal conditions are detected, such as sudden temperature rise or smoke presence.

Step7: User Interface Development

Develop a web or mobile application/dashboard to display real-time data, alerts, and forest conditions for forest officials.

Step 8: Testing and Implementation

Test the system in a controlled environment, then deploy it in a real or simulated forest area. Check accuracy, response time, and reliability.

Step 9: Maintenance and Upgradation

Regularly maintain sensors and update software for better performance and future improvements.

IV. PROPOSED WORK

- A. The proposed system, the PIC 16f877a is chosen as the hardware core of general network node. In the external of PIC controller, temperature, Gas, and humidity sensors are configured to monitor the corresponding data. The data are processed in the PIC microcontroller and the processed data are transmitted to the receiver unit
- B. The receiver decides whether the environmental status leads to Forest fire or not. And it updates the values in the GPRS through the modem. The sensor values are processed and transmitted from the transmitting section through Zigbee. In the receiver end, these values are received by the controller and up dated in the internet through GPRS. The Abnormalities will be alerted through the internet.

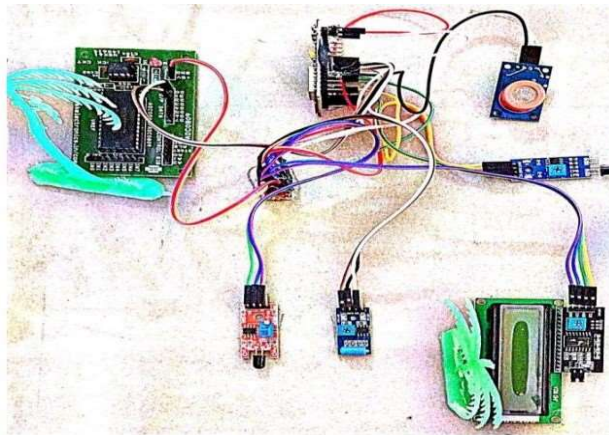


Fig. 1. Represent the proposed model diagram

V. RESULTS

The developed Forest Monitoring System demonstrates effective real-time observation of environmental conditions through the integration of sensors and IoT technologies. It continuously acquires critical data, including temperature, humidity, soil moisture, and smoke levels, providing a comprehensive view of the forest environment.

The system is capable of identifying unusual patterns, such as rapid increases in temperature or the presence of smoke, enabling early detection of potential fire hazards. Upon detecting such anomalies, an automated alert mechanism promptly notifies users via mobile or web-based applications, facilitating timely response and preventive measures.

VI. CONCLUSION

The Forest Monitoring System provides an efficient and reliable solution for real-time monitoring of forest conditions using IoT and sensor technology. It helps in early detection of forest fires and illegal activities, ensuring quick response and better protection of natural resources. Overall, the system supports sustainable forest management and enhances environmental safety.

VII. FUTURE ENHANCEMENT

The current forest monitoring system provides real-time environmental data and basic alert mechanisms; however, several advanced improvements can significantly enhance its efficiency, scalability, and intelligence in the future. one of the key enhancements involves the integration of **artificial intelligence and machine learning algorithms** to enable predictive analysis. Instead of only detecting events such as forest fires or illegal activities after they occur, the system can analyse historical and real-time data to forecast potential risks. This proactive approach will help authorities take preventive measures well in advance. the adoption of **drone-based monitoring systems**. Drones equipped with thermal imaging and high-resolution cameras can cover large and inaccessible forest areas quickly, The incorporation of **satellite data** can further expand the system's coverage. Satellite imagery can be used to monitor deforestation, vegetation health, and climatic changes on a large scale. the development of a **mobile and web-based application with GPS integration** can improve accessibility and usability.

REFERENCES

- [1]. National Forest Inventory Romania 2008-2012 <http://roifn.ro/site/rezultate-ifn-1/> accessed 15 February 2019.
- [2]. "Greece wildfires: Dozens dead in Attica region". BBC. 24 July 2018.
- [3]. S. Madakam, R. Ramaswamy and S. Tripathi, "Internet of Things (IoT): A Literature Review,"

- Journal of Computer and Communications, 2015, 3, pp. 164-173 Science, 2011
- [4]. J.L. Dupuy, P. Vachet, J. Marechal, J. Melendez, A.J., de Castro, "Thermal infrared emission-transmission measurements in flames from a cylindrical forest fuel burner", *International Journal of Wildland Fire*, 16 (3), pp. 324-340, 2007.
 - [5].
 - [6].
 - [7]. D. Riaño, E. Chuvieco, S.L. Ustin, J. Salas, J.R. Rodríguez-Pérez, L.M. Ribeiro, D.X. Viegas, J.M. Moreno, H. Fernández, "Estimation of shrub height for fuel-type mapping combining airborne LiDAR and simultaneous color infrared ortho imaging", *International Journal of Wildland Fire*, 16 (3), pp. 341-348, 2007
 - [8].
 - [9]. Y.G Sahin, T. Ince, "Early Forest Fire Detection Using Radio-Acoustic Sounding System", *Sensors*, pp 1485- 1498, 2009.
 - [10]. J. Papán, M. Jurečka, J. Púchyová, "WSN for Forest Monitoring to Prevent Illegal Logging", *Proceedings of In future developments*, the proposed system can be significantly enhanced by incorporating artificial intelligence and machine learning techniques to enable more accurate prediction of forest fires and detection of illegal activities. The integration of advanced analytics would allow the system to identify patterns and provide early warnings before critical situations arise.