Lora Based Forest Monitoring System

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***Abstract*— A LoRa based forest monitoring system is an innovative solution for forest monitoring and management, which utilizes LoRaWAN (Long Range Wide Area Network) technology to collect and transmit environmental data from remote forest areas to a central control center. This system is designed to enable real-time monitoring of various environmental parameters such as temperature, humidity, air quality, and soil moisture, among others. The system is composed of sensor nodes that are strategically placed throughout the forest, each of which is equipped with a LoRa transceiver module, sensors, and a microcontroller. The sensors measure various environmental parameters, and the microcontroller processes the data and sends it to the LoRa transceiver module. The transceiver module then transmits the data to the nearest LoRa gateway, which in turn forwards the data to the central control center using the LoRaWAN protocol.**

***Index Terms*—Lora, Forest, temperature, humidity, soil moisture**

I. INTRODUCTION

The main objective of this project is to communicate from remote forest area to city using LoRa technology. Various parameters are noted/tracked, and this information is transmitted using LoRa. The transmitted information is received in the city through a LoRa module and thereby the received data is stored in Google Firebase Deforestation is a very crucial thing which is happening in large scale caused by various parameters like forest fire, landslide, floods etc. The cause of forest fires is not easy to track and to detect early with the help of this technology it can become easy, and water can be sprinkled to avoid further damage. Along with this soil moisture and rain can be detected for further advancement of this technology. It is very difficult to monitor these activities happening in the forest area as it is a remote place with less technological support. Using LoRa as a communication act like a bridge of communication between a remote place and city by using LoRa technology it becomes easy to monitor such activities going on in a remote forest.

II. LITERATURE REVIEW

Ritesh Rastogi et a1.[1] "LoRa and Edge Computing based System Architecture for Sustainable Forest Monitoring" The combination of LoRa, and edge computing can provide an efficient system architecture for sustainable forest monitoring. LoRa sensors can collect environmental data over a long-range wireless network, and edge computing can be used to process the data closer to where it is generated, reducing latency and bandwidth usage. This system architecture can help predict the occurrence of wildfires and the spread of diseases, helping ensure the health and preservation of our natural ecosystems.

Hammad Aamer et a1.[2] "A Very Low Cost, Open, Wireless, Internet of Things (IoT) Air Quality Monitoring Platform" The increasing levels of air pollution pose a significant threat to the environment and human health. Air quality monitoring has become an essential aspect of modern urban life, with many people relying on air quality data to make decisions about their daily activities. In recent years, the Internet of Things (IoT) has emerged as a promising technology to address this issue. It is low cost, making it accessible to a wider range of users. It is open, allowing for customization and modification of the system to suit specific needs. It is wireless, eliminating the need for complex wiring and infrastructure. Additionally, it is IoT-based, providing real-time data and remote access to the system.

A. Kumar et fa1.[3]"Air Quality Monitoring System Based on ISO/IEC/IEEE 21451 Standards" Air pollution has become a major concern due to its harmful effects on human health and the environment.

ISO/IEC/IEEE 21451 standards provide a common framework for sensor communication protocols and data formats. The proposed air quality monitoring system based on ISO/IEC/IEEE 21451 standards provides an

effective solution for monitoring air quality parameters. The use of these standards ensures interoperability, flexibility, and cost-effectiveness, making the system suitable for various applications.

Genwei Guo et a1.[4] "A Model with Leaf Area Index and Trunk Diameter for LoRaWAN Radio Propagation in Eastern China Mixed Forest" Every node in LoRaWAN is connected by radio transmission. The radio signal may be attenuated when it is deployed in a forest due to diffraction, reflection, scattering, and absorption effects produced by different obstacles like trees and bushes. To design effective wireless systems that can function in mixed forests, it is necessary to better understand the propagation characteristics of these difficult radio propagation environments. However, due to the potential for significant impacts from various environmental factors (such as vegetation type, density, tree height, and weather), modeling forest radio propagation is comparatively challenging.

Anita Gehlot et a1.[5] "Digitalization of forest using the Internet of Things (IoT)" Digitalization of forests using the Internet of Things (IoT) is an emerging trend that has gained significant attention in recent years. This approach involves the integration of IoT devices with forest management systems to improve forest management, conservation, and sustainability. In this survey paper, we will provide an overview of the current state of the art in the digitalization of forests using IoT and discuss the challenges and opportunities of this technology in the forestry sector.

Gagan Parmar et a1.[6] "An IoT Based Low-Cost Air Pollution Monitoring System" Air pollution has become a major global concern as it poses a serious threat to human health, natural resources, and the environment. Due to the increase in urbanization, industrialization, and the use of fossil fuels, air pollution has risen dramatically in recent years. The continuous monitoring of air quality is necessary to mitigate the effects of air pollution on human health and the environment. In recent years, the Internet of Things (IoT) has emerged as a promising technology for monitoring air quality in a cost-effective and efficient manner.

Swapnil Bagwari et a1.[7] "Disaster Monitoring based on IoT and Long Range Assisted Framework" Disaster monitoring is an important area of research and development, and the use of the Internet of Things (IoT) and Long Range Assisted Framework (LRAF) has emerged as a promising approach to improve the effectiveness and efficiency of disaster monitoring systems. In this survey paper, we will review the current state of the art in disaster monitoring based on IoT and LRAF.

Roberto Vega-Rodríguez et a1.[8] "Low Cost LoRa based Network for Forest Fire Detection" The survey paper also discusses the different components of a LoRaWAN-based WSN for forest fire detection, including the sensors, gateways, and cloud platforms. It also highlights some of the challenges associated with deploying and maintaining LoRaWAN-based WSNs, such as the need for line-of-sight communication and interference from other wireless networks. Overall, the survey paper concludes that LoRaWAN-based WSNs are a promising solution for forest fire detection due to their low cost, long-range communication capabilities, and low power consumption.

Khaled A. Ghamry et a1.[9] "Unmanned Aerial Vehicle Based Forest Fire Monitoring and Detection Using Image Processing Technique" Forest fires are a significant environmental issue that causes significant damage to the environment and wildlife. Traditional forest fire monitoring and detection methods such as satellite-based monitoring, ground-based monitoring, and aerial surveillance using manned aircraft have limitations such as cost, time-consuming, and safety concerns. Unmanned Aerial Vehicles (UAVs) equipped with cameras and sensors have emerged as a promising technology for forest fire monitoring and detection. UAVs can fly at low altitudes, capture high-resolution images and videos, and quickly cover large areas of forests.

Matthias Budde et a1.[10] "Enabling low-cost particulate matter measurement for participatory sensing scenarios" This paper proposes a low-cost solution for measuring particulate matter (PM) in participatory sensing scenarios. To test the effectiveness of the sensor, the authors conducted experiments in both laboratory and real-world settings. In the laboratory, they exposed the sensor to different levels of PM and compared its readings to those of a reference instrument. In the real-world setting, they distributed the sensors to community members in a low-income neighborhood and compared the results to those of a reference instrument located at a nearby air quality monitoring station.

Kiruthika.R et a1.[11] " Low-Cost Pollution Control and Air Quality Monitoring System using Raspberry Pi for Internet of Things" The Internet of Things (IoT) is a growing trend in which everyday objects are connected to the internet, allowing for remote monitoring, control, and analysis. In recent years, IoT has been used for a variety of applications, including pollution control and air quality monitoring. The Raspberry Pi is a low-cost, credit-card-sized computer that has become popular in the IoT community due to its small size, low power consumption, and versatility. In this survey paper, we will explore the use of Raspberry Pi-based systems for low-cost pollution control and air quality monitoring.

Arnab Kumar Saha et a1.[12] "A Raspberry Pi Controlled Cloud Based Air and Sound Pollution Monitoring System with Temperature and Humidity Sensing" Air and sound pollution monitoring systems have gained increasing importance in recent years due to the harmful effects of pollution on human health and the environment. These systems provide real-time data on the levels of pollutants in the air and noise levels in the surrounding environment. In addition, monitoring temperature and humidity levels can provide important information for understanding the impact of weather on pollution levels. This survey paper discusses the development of a Raspberry Pi controlled cloud-based air and sound pollution monitoring system with temperature and humidity sensing.

Mohammed Othman Aljahdali et a1.[13] "Monitoring Mangrove Forest Degradation and Regeneration: Landsat Time Series Analysis of Moisture and Vegetation Indices at Rabigh Lagoon, Red Sea" The results of the study showed that the mangrove forest in the study area has experienced a significant decline in its extent, with a loss of approximately 40% of its area between 1987 and 2018. The authors also found that the NDVI and EVI indices showed a positive correlation with the mangrove forest cover, while the NDMI and TCW indices showed a negative correlation with the mangrove forest cover. The study also highlighted the potential of using Landsat time series analysis for monitoring the regeneration of mangrove forests, as the authors observed the regeneration of mangroves in some areas of the study site.

Barbara Fussi et a1[14] "Forest genetic monitoring: an overview of concepts and definitions" Forest genetic monitoring is the systematic collection and analysis of genetic data from trees or forest populations over time to evaluate changes in genetic diversity and structure, and to detect any genetic changes or adaptations that may occur due to environmental factors or human activities. This type of monitoring is important for understanding the dynamics of forest ecosystems, predicting their future health and resilience, and informing forest management decisions.

Hannaneh Hojaiji et a1.[15] "Temperature and Humidity Calibration of a Low-Cost Wireless Dust Sensor for real Time Monitoring" Calibration of low-cost wireless dust sensors for temperature and humidity is critical for accurate and reliable real-time monitoring of air quality. The process of calibration involves exposing the sensor to different temperature and humidity levels and comparing the readings with a calibrated reference sensor. However, several challenges must be addressed to ensure accurate and reliable measurements. Researchers are working

towards developing new techniques and methodologies to overcome these challenges and improve the performance of low-cost wireless dust sensors.

Syazwan Essa et a1.[16] "IoT-Based Environmental Monitoring System for Brunei Peat Swamp Forest" The IoT-based environmental monitoring system would involve deploying a network of sensors throughout the forest to collect data on key environmental variables, such as temperature, humidity, soil moisture, and water levels. The data collected by the sensors would be transmitted wirelessly to a central server, where it could be analyzed in real-time to identify patterns and trends in the forest ecosystem. One key advantage of an IoT-based environmental monitoring system is that it can provide a much more comprehensive picture of the health of the forest than traditional monitoring methods.

XiuYing Liang et a1.[17] "The Rapid Detection of Undisturbed Soil Moisture Content Based on BPNN" The rapid detection of undisturbed soil moisture content is an important task in agricultural and environmental research. In this study, a method based on backpropagation neural network (BPNN) is proposed for rapid detection of undisturbed soil moisture content. The method uses near-infrared (NIR) spectroscopy to obtain spectral data of soil samples, and BPNN is trained using these spectral data and

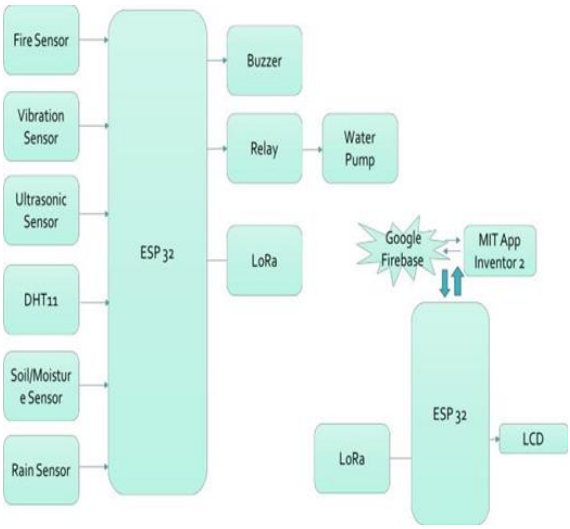
corresponding soil moisture content values measured by conventional methods. The BPNN model was optimized by adjusting the number of hidden layers, the number of neurons in each layer, and the learning rate. The performance of the optimized BPNN model was evaluated using a validation dataset, and the results showed that the model had a high accuracy in predicting soil moisture content.

T.B.Ibrahim et a1.[18] "A survey of lorawan based wireless sensor network for environmental monitoring abstract" The survey begins by introducing the LoRaWAN protocol and its key features, including its modulation scheme, network architecture, and security mechanisms. The paper then discusses the challenges of deploying WSNs for environmental monitoring, including issues related to power management, node placement, and data aggregation. Several case studies of LoRaWAN-based WSNs for environmental monitoring are presented, including applications in agriculture, air quality monitoring, water quality monitoring, and wildlife conservation. The paper also discusses the limitations of LoRaWAN-based WSNs, including their limited data rate and sensitivity to interference.

YongMin Liu et a1.[19] "" Forest fires are a significant threat to natural ecosystems and human lives. Wireless sensor networ Forest fire monitoring, detection and decision-making systems by wireless sensor network ks (WSNs) have emerged as promising technology for monitoring, detecting, and managing forest fires. The paper begins by discussing the challenges associated with forest fire detection and monitoring, such as the vastness of the forest area and the dynamic nature of the fire. Then, it presents the architecture and components of a typical WSN-based forest fire monitoring system, including sensor nodes, sink nodes, and a base station. Next, the paper reviews the various sensing technologies used in WSNs for forest fire detection, such as temperature sensors, smoke sensors, and humidity sensors. It also discusses the data communication protocols and data aggregation techniques used to transmit and process data in WSNs.

Borison Ningthoujam et a1.[20] "Image and Ultrasonic Sensor fusion for object size detection" In this paper, a novel approach for fusing image and ultrasonic sensor data for object size detection is presented. The approach involves preprocessing the image data to extract object features and segment the object from the background. The distance measurements from the ultrasonic sensor to estimate the size of the object in three-dimensional space is made. We evaluate our approach on a dataset of real-world objects and demonstrate that the fusion of image and ultrasonic sensor data can improve the accuracy of object size detection compared to using either sensor individually. The approach has potential applications in robotics, automation, and other fields where accurate object size detection is important.

IV. HELPFUL HINTS



V. CONCLUSION

By using LoRa technology, it played a vital role in connecting the remote forest with city and provide various alerts and notifications generated from a remote forest area to the user located in city and the information shared using LoRa was later stored in Google Firebase where it became easy to keep track of these data.

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