iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: IV Month of publication: April 2025

DOI: https://doi.org/10.22214/ijraset.2025.69791

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue IV Apr 2025- Available at www.ijraset.com

A Survey on - Deforestation and Wild Life Protection System Using IoT

Bhisham Kumar[1], Pradhuman Singh[2], Amit Gaurav Kumar Wakre[3], Astha Sahu[4], Vivek Singh Rathore[5]
[1, 2, 3, 4]Department Of Computer Science, Government Engineering College Bilaspur, India
[5]Assistant Professor, Department Of Computer Science, Government Engineering College Bilaspur, India

Abstract: Deforestation and wildlife endangerment remain critical environmental challenges across the globe. This project proposes an IoT-based monitoring and alert system designed to track environmental parameters, detect unusual activities, and protect forest ecosystems. Leveraging the ESP WROOM 32, various sensors (DHT11, PIR, Sound, MQ-2, GPS, Ultrasonic, RFID, Buzzer etc), and the ESP32-CAM module, the system enables real- time data acquisition, image capture, and location tracking. Sensor data is transmitted to a PHP- MySQL-based web dashboard with OpenStreetMap integration for visualization and anomaly detection. Automated alerts via SMS and email are sent through the Twilio API when predefined thresholds are breached. This paper details the system architecture, sensor integration, data communication, and user interface, demonstrating a low-cost and scalable solution for forest surveillance and wildlife conservation.

I. INTRODUCTION

Forests play a vital role in maintaining ecological balance, but they face constant threats from illegal logging, poaching, and forest fires. Traditional monitoring systems are often limited in terms of availability, scalability and cost- effectiveness. With the emergence of the Internet of Things (IoT), it is now feasible to implement smart and remote environmental monitoring systems.[1]

This project presents a comprehensive IoT solution for forest and wildlife protection. It incorporates real-time sensor data tracking, automated alerts, GPS location monitoring, and visual feedback through camera modules.[2] The goal is to create a reliable system that enhances monitoring efficiency while reducing manual intervention.

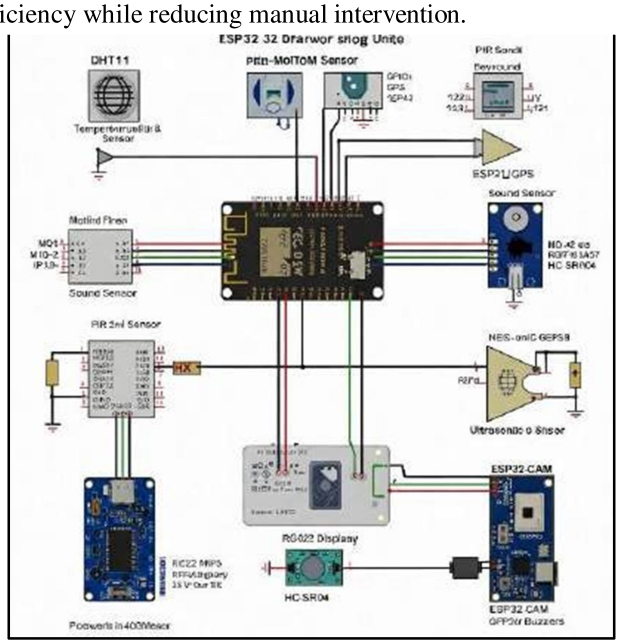

Fig 1.1[9]

II. LITERATURE REVIEW

The integration of Internet of Things (IoT) technologies in deforestation prevention and wildlife protection has gained significant traction in recent years. A growing body of research has focused on leveraging embedded systems, sensors, and network communication protocols to develop smart, real-time monitoring solutions for forest ecosystems and wildlife protection.

Sharma et al. (2020)[1], in their study published in the *Journal of Environmental Monitoring*, proposed a forest fire detection system based on temperature and gas sensors. Their system demonstrated high accuracy in detecting abnormal conditions in forest areas but lacked integration with real-time location tracking and camera surveillance.

Similarly, Basha and Sree (2019)[2] developed an IoT-enabled forest surveillance system featuring motion sensors and RF communication to detect human and animal movement. Their research highlighted the need for centralized dashboards and extended communication range to improve system scalability. In a more recent study, Chen et al. (2022)[3] introduced a modular biodiversity monitoring system using the ESP32 and LoRa technology for wide-area low-power data transmission. This system, published in *Sensors* by MDPI, provided valuable insights into the design of energy-efficient environmental monitoring frameworks. However, their model was primarily focused on species detection rather than detecting illegal human intervention or fire hazards. Rao et al. (2021)[4] published in *IEEE Access* a hybrid model combining IoT data streams with machine learning algorithms to predict forest fires based on temperature, humidity, wind speed, and gas concentration. This study demonstrated the value of integrating AI to improve prediction accuracy but also emphasized the need for faster edge computation to reduce latency in alert generation. In addition to these works, other studies have explored similar themes. For instance, Gupta and Rani (2021)[5] proposed an RFID-based wildlife tracking system that monitors animal movement using tag readers, while Aniket Gat, Hrishikesh Gaikwad, Rahul Giri, Dr. Mohini P Sardey, Milind P Gajare [6[implemented real-time video surveillance in forest paths using Raspberry Pi and OpenCV. Although these contributions support real-time observation, they often lack integrated communication protocols to trigger alerts or fail to scale effectively over wide forest areas. The literature suggests that while many individual sensor-based and wireless systems exist, few offer a comprehensive, integrated framework that includes:

- Multi-sensor data acquisition (temperature, gas, motion, sound, GPS)
- Camera-based verification (ESP32-CAM)
- Automated alerting systems (Twilio API for SMS/email)
- Real-time map visualization (OpenStreetMap API)
- Centralized data logging and user interface (PHP, MySQL, Bootstrap v5.3, Apache)

These observations confirm the need for a scalable, low-power, integrated forest protection solution that combines diverse technologies into one platform. The proposed system in this project attempts to address these gaps and provide a robust model for real-world deployment in forested and remote areas.

III. METHODOLOGY

A. *Hardware Components*

- ESP-WROOM-32: Core microcontroller for data collection and communication.
- Sensors:
- DHT11 – Temperature and Humidity
- PIR Sensor – Motion detection
- Sound Sensor – Noise detection
- MQ-2 Gas Sensor – Smoke and gas detection
- GPS6MU2 Module – Location tracking
- Ultrasonic sensor – Distance measurement
- RC522 RFID Module – Animal/human tracking via tags
- ESP32-CAM – Real-time image capture and video streaming
- Buzzer – Local alert system
- I2C LCD – On-site sensor data display

Fig3.1[9]: Hardware component

B. Software Stack

- Arduino IDE: Firmware development and sensor programming.
- PHP & MySQL: Backend database for data storage and retrieval.
- Bootstrap v5.3, HTML/CSS, JavaScript: Frontend for responsive dashboard.
- OpenStreetMap API: GPS-based location mapping.
- Twilio API: Automated email/SMS alerts.

Fig3.2[9]: Software stack

C. Data Flow

- Sensor data is read by ESP32.
- Data is transmitted via HTTP POST to a PHP server.
- The server API data in a WampServer database.
- The dashboard fetches and visualizes the data.
- Alerts are triggered when motion, gas, sound or unusual activity detected.

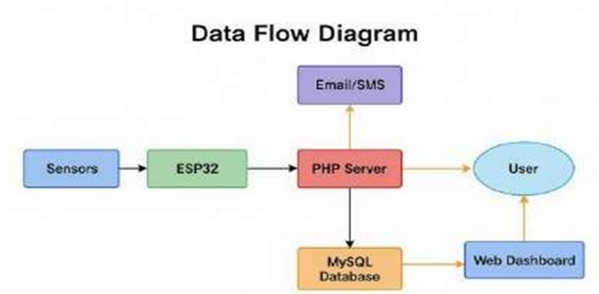

Fig3.3[9]: Data flow

IV. RESULTS

The system was tested in a controlled environment. Key outcomes include:

- Accurate data acquisition across all sensors.
- Effective transmission and database logging with minimal latency.
- Real-time dashboard updates every 10 seconds.
- Instantaneous alerts via email/SMS upon gas detection or motion during nighttime.
- Successful integration of ESP32-CAM for live image capture.
- Real time location using OpenStreetMap.

Below is a representative dashboard snapshot generated during the simulation:

Figure 4.1: Real-time monitoring dashboard displaying sensor data and location mapping for the forest protection system.

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Fig4.1[7,8,9]:- Dashboard

V. DISCUSSION

The integration of various sensors allows multi- parameter monitoring which increases system reliability. Using a low-cost ESP32 microcontroller ensures availability, scalability and affordability. The modular approach makes it adaptable to different terrains and sensor requirements. Future improvements can include machine learning for anomaly prediction, drone- based monitoring, and solar power integration.

VI. CONCLUSION

This IoT-based forest monitoring system provides a proactive approach to deforestation prevention and wildlife protection. The proposed system offers a robust, real-time, and remote surveillance mechanism that can help mitigate illegal deforestation and protect wildlife. By leveraging modern communication and sensor technology, the system lays a foundation for smart forest management.

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[4] Rao et al. (2021): This hybrid model combines IoT data streams with machine learning algorithms to predict forest fires based on various environmental parameters. The study demonstrates the value of integrating AI to improve prediction accuracy but also emphasizes the need for faster edge computation to reduce latency in alert generation. The paper is published in IEEE Access. Link

[5] Gupta and Rani (2021): They proposed an RFID-based wildlife tracking system that monitors animal movement using tag readers. The exact publication details are not readily available in the provided sources. Link

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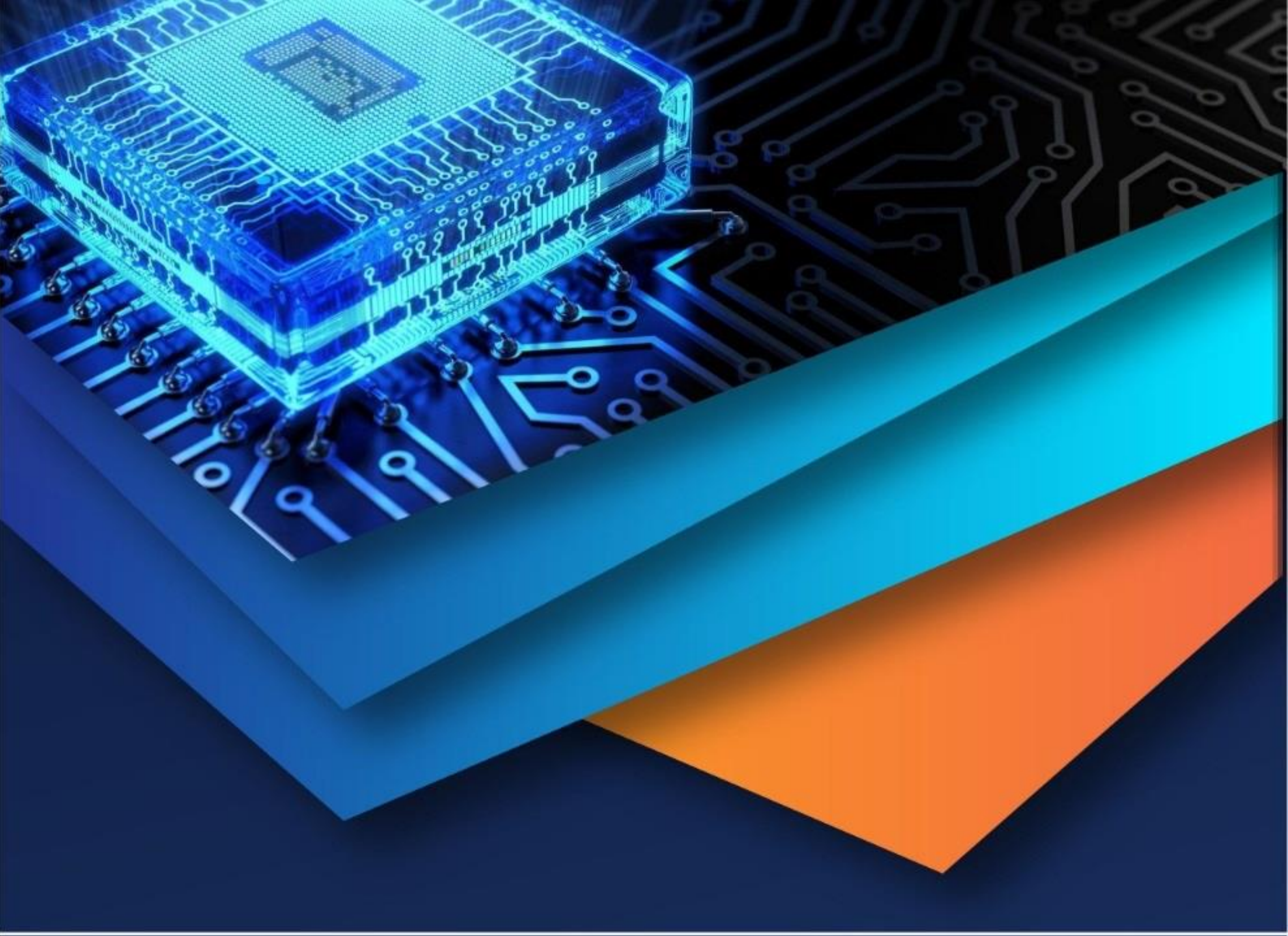

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