

A Review on Anti-Poaching Alarm for Valuable Trees

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Abstract— Theft of illegal trees, especially valuable species like teak and sandalwood, is a serious threat to the world's forests. This research presents a novel framework for forest preservation and anti-poaching that makes use of wireless sensor networks (WSNs) and the Internet of Things (IoT). The system uses tilt, vibration, and flame sensors, among other sensors, to identify forest fires and illicit logging in real time. The information gathered is sent to the forest authorities so that possible threats can be addressed quickly. This all-encompassing strategy tackles the urgent need for tactics to stop illegal activity endangering the sustainability of the global ecological system and natural resources. The potential of technology to protect priceless trees and avert ecological disasters is highlighted by its integration with environmental protection. The suggested approach emphasizes the significance of taking proactive steps in maintaining our forests and their priceless resources by providing a comprehensive response to stop the smuggling of trees, save biodiversity, and lessen the effects of climate change.

Index Terms— Internet of Things (IoT), Sensors, wireless sensor network, anti-poaching, WiFi module

I. INTRODUCTION

Forests are essential to both human life and the balance of the ecosystem, yet they are seriously threatened by illicit poaching, frequent fires, and widespread deforestation. Our suggested IoT-based solution is made up of two key modules to address these issues: a transmitter side that has sensors and controllers, and a reception side that has an Android phone incorporated into it. Using Internet of Things (IoT) technology, the main goal is to create an effective system for monitoring and preventing forest fires and illegal poaching. The wireless sensor nodes, which stand in for the transmitter side in this ecosystem, are essential components. These movable nodes can be installed on individual tree trunks to create a wireless sensor network that spans the entire forest. Every node has sensors installed that can identify fire and theft. The cloud receives the sensor data continuously, allowing enabling real-time monitoring of the forested area. The seamless data storage, processing, and visualization made possible by the cloud-based technology improves the general effectiveness of forest management. A controller module installed on the sensor nodes enables it to initiate particular actions in response to events that are detected. In the event of a forest fire, for example, the system & built-in application can trigger a water pump, assisting in the suppression of the fire and reducing possible damage.

The device has the ability to sound a buzzer in the event of illegal activity, like as poaching. This acts as an instant deterrence and notifies authorities in time to take appropriate action. For forest managers and authorities, the Android phone application represents the receiver side and offers an easy-to-use interface. Users are able to take quick action, receive real-time notifications, and remotely monitor the status of the forest with this application. By

acting as a central control point, the application enables users to efficiently manage and neutralize possible threats. The importance of this IoT-based system lies in its ability to provide proactive forest management, preventing disasters before they become catastrophic. Forest managers can make quick decisions and allocate resources more effectively because of the constant data streaming to the cloud, which guarantees they have access to the most recent information. In addition to improving the system & scalability, the integration of wireless sensor nodes with cloud technology facilitates international cooperation in tackling issues related to forests. The suggested system takes into account the growing need for cutting-edge technologies to protect forests in light of the threats that illegal activity, climate change, and human encroachment pose. This system uses Internet of Things (IoT) and cloud-based solutions to improve the monitoring and prevention of forest fires and poaching. It also supports the global initiative to combat climate change, preserve biodiversity, and ensure the sustainable development of our priceless forest resources.

II. LITERATURE SURVEY

Chhabra et al. [1] proposed that the system is an Internet of Things (IoT)-based solution meant to deal with the pressing problems of illegal poaching and forest fires. It is made up of two modules: a receiver module that is installed on an Android phone and a transmitter module that is mounted on each tree trunk with sensors and controls attached. Real-time monitoring is possible because the wireless sensor network constantly uploads data to the cloud. The sensor node's purpose is to identify forest fires and illicit logging. It detects tree-cutting activity using tilt and vibration sensors, and when it detects such activity, a buzzer sounds. The system uses a fire sensor to sense temperature variations in the event of a forest fire. It then activates a relay switch to start a water pump for combating the fire. The data gathered is forwarded to forest authority.

Acharya et al. [2] proposed the article on animal migration from forest areas to residential areas has increased as a result of the forest's declining tree population creating an unfavorable environment for wildlife survival. A system for monitoring and protecting trees from fires and human activity is suggested as a solution to this problem. The system makes use of PIR (Passive Infrared) sensors to track motion in the immediate vicinity and flame sensors to identify fires. Whether an animal or human is causing the reported movement is determined by the Surf algorithm. By supporting forest officials in defending trees from poaching occurrences as well as forest fires, this integrated approach seeks to improve overall efforts to conserve forests.

Asha et al. [3] published the article that the fact that trees are so important to human life is demonstrated by the fact that they are used in medicine and cosmetics, among other fields. But the increasing number of high-value tree smuggling incidents—like those involving teak and sandalwood—threatens to endanger the world's forests. In order to address this problem, a reasonably priced system that makes use of RFID tags and four sensors in addition to a Wi-Fi module has been proposed. The purpose of this technology is to identify and stop illicit tree smuggling. When a detection is made, the system notifies forest officials or other appropriate authorities right once, allowing for quick action to save endangered and valuable treespecies as well as to maintain the world's forests.

Rao et al. [4] proposed the serious threat to the world's natural resources, the theft of valuable trees such as sandalwood, teak, and rosewood is on the rise and is causing both ecological and economic harm. Targeted for illegal trade, these uncommon and costly trees are essential for research on cosmetics and medicine. A preventive strategy is implemented using an anti-poaching system built on Wireless Sensor Network (WSN) and Internet of Things (IoT) technologies to address this problem. Three primary sensors are used in the proposed system: a tilt detector to measure a tree's inclination during cutting, a fire and smoke detector to detect forest fires early, and a sound detector to record noise related to illicit logging activities. The surveillance capabilities are improved by this integrated technology architecture, enabling the tracking and apprehension of illicit.

Ishitha et al. [5] proposed an Internet of Things-based Fire Alarm and Anti-poaching System (IAFS) to solve the urgent problems of forest fires and wildlife poaching. The suggested framework makes use of three sensors: temperature, smoke, and Light Dependent Resistors (LDR). It emphasizes the critical need for early detection of forest fires, which is especially evident in recent incidents like the Australian wildfires, and the detrimental impact of poaching on endangered species and ecosystems. An Arduino board serves as the system's central component, gathering data from these sensors and sending it to the cloud. The data is continuously monitored by the cloud platform, which may detect any intrusion or fire and send SMS alerts to forest authority. Recognizing the difficulties caused by the large and dense forest, the IAFS seeks to offer a remote monitoring option.

Sonwane et al. [6] proposed the growing problem of tree theft and smuggling is a serious danger to ecosystems and natural resources, resulting in financial losses for those who depend on the cultivation of trees. In this paper,

a microcontroller-based anti-poaching system that makes use of the Wireless Sensor Network (WSN) protocol is presented as a solution. The suggested system uses a MEMS accelerometer to monitor vibrations produced during tree-trimming in order to detect theft. Important parts are a 2.4 GHz CC2500 transceiver and a low-power MSP430F5528 microprocessor, which allow communication with a central Base Station from an unknown place where suspicious behavior is discovered. The effectiveness of WSN technology in overcoming communication constraints and lowering device energy usage, thereby increasing battery life, is the driving force behind its selection. The article offers a thorough summary of the embedded.

Jose et al. [7] proposed the human survival and ecological equilibrium to be maintained, forests are essential. But as living standards have increased and the human population has grown, there is a greater demand for forest resources, which is causing forest areas to disappear. This essay discusses the three primary factors that contribute to forest degradation: animal hunting, deforestation, and forest fires. Large tracts of forests are seriously threatened by forest fires, which can occur naturally or artificially and have an effect on regional and global ecosystems. The loss of forest cover is made worse by deforestation, which is frequently motivated by the demand for commercial land. The fragile equilibrium within the ecology and biodiversity are further disrupted by animal poaching. The study examines several methods for identifying forest fires, stopping wildlife poaching, and reducing deforestation, with an emphasis on systems for monitoring these types of forest losses.

Rathod et al. [8] proposed the major issues surrounding forest fires, highlighting the harm they cause to people, property, and the environment. It names three common causes of forest fires: lightning, human carelessness, and climate warming. Each year, wildfires in the US burn 1.2 million acres of forest on average. The theft of precious trees, including Indian sandalwood and Red Sanders, is emphasized as a worldwide issue with financial ramifications. While mentioning the use of simulation tools to predict forest fires, the text also points out issues with accuracy and execution time. The poaching of trees is becoming more and more common, and it primarily affects Sandalwood, Teakwood, Pine, and Rosewood. This is due to human selfishness. The efficiency of anti-poaching measures implemented by groups, including the Indian government, to address the issue has been called into question.

Singh et al. [9] proposed the idea of “Digitalization of Forest”, which entails integrating cutting-edge technology into forest ecosystems, such as Wireless Sensor Networks, Internet of Trees, Internet of Things (IoT), and Deep Learning. Enhancing data collection, analysis, and monitoring for research and development in forests is the main goal. Intelligent sensing and monitoring systems are discussed, with a focus on applications related to illicit logging, poaching, and forest fire events. Without requiring modifications to the current forest deployment systems, the study suggests universal designs that can be used for next research and development in fields like flora analysis and forest fire forecasts. The work also discusses ways to improve tribal livelihood, market small-scale forest goods, and keep an eye on wildlife in the forest ecosystem.

Kumar et al. [10] proposed the ongoing problem of illicit activity, specifically the smuggling of valuable trees from protected forest areas, like teakwood, sandalwood, and sagwan. The multi-million dollar industry of illegal logging not only exacerbates deforestation but also has a negative impact on local communities financial stability. Governments suffer large financial losses as a result of the illicit removal and export of timber. These losses include lost tax and duty income as well as higher expenses related to stopping illegal logging. Known variously as wood theft or the operations of the “timber mafia”, the practice entails a number of illicit behaviors, including as using dubious means to get access to forests, extracting timber without a permit, chopping down endangered or protected species, and extracting more timber than is permitted.

III. MATERIALS AND METHODS

A. MATERIALS

ESP 32: ESP32 is a low-cost, low-power Microcontroller with an integrated Wi-Fi and Bluetooth. It is the successor to the ESP8266 which is also a low-cost Wi-Fi microchip albeit with limited vastly limited functionality. It is an integrated antenna and RF balun, power amplifier, low-noise amplifiers, filters, and power management module. The entire solution takes up the least amount of printed circuit board area. This board is used with 2.4 GHz dual-mode Wi-Fi and Bluetooth chips by TSMC 40nm low power technology, power and RF properties best, which is safe, reliable, and scale-able to a variety of applications it is very easy to decipher the reasons for ESP32's popularity.

TILT SENSOR: MPU6050 sensor module is complete 6-axis Motion Tracking Device. It combines 3-axis Gyroscope, 3-axis Accelerometer and Digital Motion Processor all in small package. Also, it has additional feature of on-chip Temperature sensor. It has I2C bus interface to communicate with the microcontrollers. The MPU6050

combines a three-axis accelerometer and a three-axis gyroscope in a single IC, providing a compact and convenient solution for measuring both linear acceleration and angular velocity. This integration simplifies the sensor setup and reduces the need for multiple sensors, saving space and reducing costs. The MPU6050 features high resolution analog-to-digital converters (ADCs) for precise measurement of acceleration and rotation. This allows for accurate detection of even small tilt angles, providing reliable tilt sensing capabilities. The MPU6050 provides digital output via an I2C (Inter-Integrated Circuit) interface, making it compatible with a wide range of microcontrollers and other digital systems. This simplifies the integration process and allows for straightforward communication and data acquisition. The sensitivity of the MPU6050's accelerometer and gyroscope can be adjusted to suit the specific application requirements. This flexibility enables customization of the sensor's response to tilt angles, ensuring optimal performance and sensitivity in different scenarios. The MPU6050's accelerometer and gyroscope data can be combined using sensor fusion algorithms, such as complementary filtering or Kalman filtering, to improve the accuracy and stability of the tilt measurements. These algorithms help mitigate sensor noise and compensate for errors, providing more reliable tilt sensing results. While the MPU6050 can be used as a tilt sensor, its capabilities extend beyond tilt sensing.

FIRE SENSOR: The DHT-11 Digital Temperature And Humidity Sensor is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin. The DHT11 sensor is an affordable alternative for fire detection, making it ideal for projects with limited budgets. The DHT11 is easy to connect and interface with microcontrollers and development boards. The device has a simple 3-pin interface (VCC, data, and ground) and a single-wire digital communication protocol, making it straightforward to integrate into fire detection systems. The DHT11 is mostly used for measuring temperature and humidity, but it can also aid in fire detection. A temperature rise above a certain threshold may signify a fire or overheating in the surrounding region.

SOUND SENSOR: The LM393 sound sensor is an electronic component designed to detect and measure sound levels in its surrounding environment. It is commonly used in various applications, such as noise monitoring, sound-activated switches, and alarm systems. The LM393 sound sensor module is a compact circuit board that includes an LM393 dual comparator chip, a microphone or sound sensor device, and supporting components. The LM393 integrated circuit has two independent voltage comparators that compare an input voltage to a reference voltage and generate a digital output signal. The module's sound sensor detects and converts sound waves to electrical impulses. The LM393 chip processes the signals and produces a digital output signal based on a preset threshold or sensitivity level. The module often includes a potentiometer or trimmer resistor for adjusting the sensitivity of the sound sensor. This component allows you to alter the threshold for the sensor to generate an output signal based on the detected sound strength. The LM393 sound sensor module outputs a digital signal that might be high (logic level 1) or low (logic level 0). When the detected sound level exceeds the defined threshold, the output increases; otherwise, it remains lower. The digital output can be simply connected to microcontrollers, Arduino boards, and other digital devices for processing or triggering actions depending on sound detection.

RELAY: A relay is usually an electro-mechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability.

BATTERY: A 9V DC battery is a portable power source commonly used in electronic devices, small appliances, and various applications that require a compact and relatively higher voltage power supply.

DC MOTOR: A submersible mini pump is a compact and waterproof pump designed to operate underwater or in liquid-filled environments. It is commonly used for various applications that require the transfer, circulation, or drainage of liquids.

ARDUINO IDE: Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio, which can be used for programming Arduino.

BLINK APPLICATION: Blynk is a toolset for all makers, inventors, designers, teachers, nerds and geeks who would love to use their smartphones to control electronics like Arduino, RaspberryPi and similar ones. We've done all the hard work of establishing internet connection, building an app and writing hardware code.

B. MATERIALS

The IOT based solution is designed for protection of valuable trees from getting exploited from smuggling or fire. This undertaking presents a Microcontroller, sound sensor and IOT based WSN hub to distinguish robbery/sneaking adding to the insurance of vital and expensive types of tree. This System involves a design a

portable wireless sensor node which will be a part of a Wireless Sensor Network. The suggested system will consist of two modules one involving sensors and controller module which will be at tree spot and another one is Android phone. We built an application which will continuously receive sensor data. This is an IOT based project where we upload sensor data continuously to cloud. Using built application we can turn on the water pump in case of forest fire and we can turn on alarm other devices in smuggling case. This system is like from anywhere we can monitor and control. The application provides an additional measure in case of any other emergencies to signal to nearest checkpoint to avoid further damage to forest. It can be used to avoid the smuggling of the trees which would stop the deforestation. Implementing an anti-poaching alert with an ESP32 microcontroller, tilt sensor, and temperature sensor involves multiple steps. Here's a summary of the methodology:

Hardware Setup, Connect the ESP32 microcontroller to the tilt and temperature sensors. Make sure the ESP32 is powered and linked to the sensors' appropriate interfaces. **Sensor Calibration,** Determine the tilt sensor's baseline measurements while the tree is stable and erect. Calibrate the temperature sensor to ensure accuracy and correct any offsets. **Data Acquisition,** Continuously read data from the tilt sensor to monitor tree orientation. The tilt sensor will indicate whether the tree has been tilted or moved from its normal position. Monitor the temperature sensor to get real-time measurements of the environment.

Threshold Settings: Set a reasonable threshold value for the tilt sensor to detect major deviations from typical tree positions. The threshold can be determined through experimentation or by assessing the sensor's sensitivity. Set a temperature threshold to detect variations that could signal human activity or a fire.

Alarm Triggering, compare current tilt data to threshold value. If the tilt exceeds the defined threshold, the anti-poaching alert will sound. Keep track of the temperature data and compare them to the threshold you set. If the temperature surpasses the threshold, it may signal a fire or human activity. Trigger the alarm. **Alarm actions:** When the alert is triggered, take appropriate actions to prevent or apprehend poachers, such as sounding a loud alarm, sending warnings to authorities, or activating a video surveillance system. The alarm system can integrate with a network interface to send real-time notifications to stakeholders or centralized control centres. **Monitoring and Logging,** continuously record sensor data, such as tilt angles and temperature, for analysis and examination.

Testing and Validation: Test the anti-poaching alarm system for reliability, accuracy, and responsiveness in various environments. Validate the system's effectiveness in detecting and preventing poaching incidents through field tests and feedback from stakeholders.

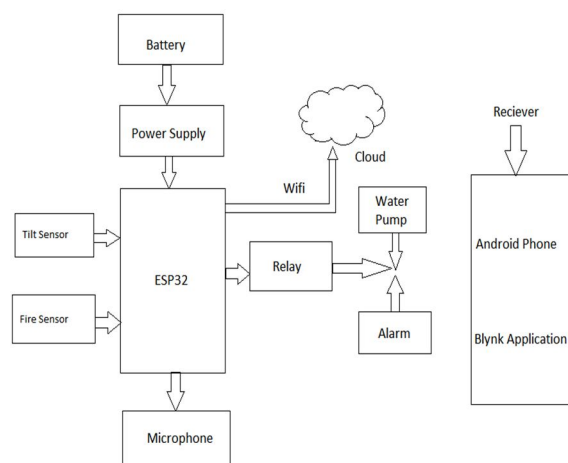


Figure.1 Block Diagram

Figure 1 depicts an anti-poaching warning for precious trees using ESP32, an electronics platform with user-friendly hardware and software. ESP32 boards can read inputs and generate outputs. Tilt sensor measures tilting position with relation to Gravity is employed in a variety of applications. This allows for easy direction of orientation or inclination. Fire sensor is an LM35, a temperature measuring device with an analog output voltage proportional to temperature. The sound sensor measures the intensity of sound waves and converts them into electrical impulses. Relay is the device which controls switching operation between water pump and alarm based upon the arduino output. Cloud 108 is used to store necessary data and use it accordingly. Blynk application is used to view the data and control the output accordingly.

IV. DISCUSSION ON PROPOSED SYSTEM AND RESULTS

The system monitors when the tree logging occurs, the sound generated due to axing the tree is sensed by the sound sensor. Also if the tree bends, the buzzer is activated. And if in case forest fires, when the temperature of the surroundings increases its sensed by the temperature of the surroundings increases its sensed by the temperature sensor, through the relay switch the water pump is turned on. Then this generated data is send to the forest officer if any event occurs so that appropriate action can be taken. Whenever a tree experience a logging the tilt sensor used mpu6050 connected to cloud via esp32 initiates buzzer and sends a notification through blynk to all the connected devices. Whenever fire sensor observes increase in temperature indicating the possible occurrence of fire it automatically turns on the water pump through relay and notifies in the blynk application.

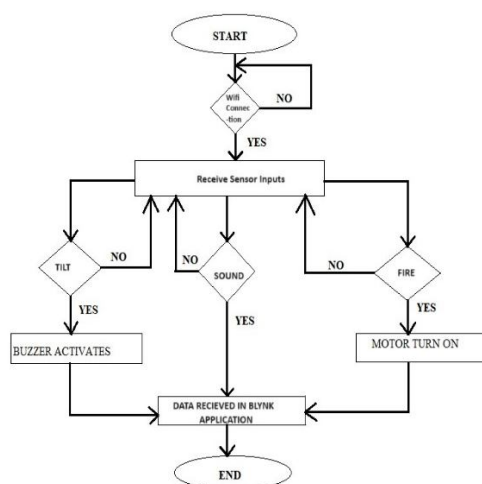


Figure.2 Flowchart

The flowchart provided offer a visual representation of the procedural methodologies employed throughout the study.

V. CONCLUSION

To sum up, the suggested approach is a big step in the right direction toward solving the urgent problem of illicit logging and tree-cutting in forests. The system offers a complete solution by combining cutting-edge technology like tilt and vibration sensors to identify tree axing sounds and bending tree-activated buzzers as safety precautions. The use of temperature sensors to activate a water pump via a relay switch in the case of a forest fire shows a proactive strategy to battling fires. Because these issues are interrelated and have a cumulative effect on the health of forests, the authors support an integrated approach. Experiments investigating the causes of a surge in forest fires emphasize the importance of climatic elements. There are more fires in forests than in other surface places, and extreme temperatures and moderate humidity are important contributing factors. The conversation about the potential for ecotourism in the BTFC region highlights the ongoing risks posed by logging, poaching, and poor management. A cooperative and knowledgeable approach involving law enforcement, frequent patrols, public education, overfishing, invasive species, policy discrepancies, ranger shortages, and water contamination is required in light of the drawbacks that have been found. Real-time technology, notably the Internet of Things (IoT), is positioned as a critical tool for monitoring and intervention in the article due to its emphasis on the critical role that forests play in maintaining environmental balance and the negative effects of degradation. In addition to addressing environmental issues, the suggested IoT-based strategy for the Management of Forest Products cycle shows promise for improving indigenous populations standard of living. In conclusion, the study highlights a comprehensive, technology-driven strategy for sustainable forest management, wildlife preservation, and the general well-being of nearby communities. It also acknowledges the various issues that forests face. This all-encompassing approach supports the overarching objective of striking a harmonic balance between human activity and environmental preservation.

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