Grenze International Journal of Engineering and Technology, January Issue

Development of an IoT-based Anti-Smuggling System for Forest Trees

Chelliah M[1], Marimuthu C[2], Kowsalya M[3] and Sumathi P[4]
[1]Associate Professor/EEE, Unnamalai Institute of Technology, Kovilpatti, India
Email: chemoomu@gmail.com
[2]Assistant Professor/EIE, Government College of Technology, Coimbatore, India
Email: marimuthu@gct.ac.in
[3-4]Assistant Professor/ECE, Unnamalai Institute of Technology, Kovilpatti, India
Email: kowsalyamoorthi25@gmail.com, getsumathi@gmail.com

***Abstract*— The smuggling of trees, such as sandal, sagwan, etc is a common topic in mainstream media. Both the scarcity and high price of these trees make them a luxury item. Both the cosmetics industry and the medical field make use of these. There have been several instances of tree cutting and smuggling due to the large sums of money involved in selling this woodlands. It is necessary to implement preventative measures in order to limit this kind of smuggling and to rescue forests worldwide. Smuggling can be reduced with the implementation of such a system. As a result of human activities that harm wildlife, such as widespread tree cutting and unchecked hunting, wildlife protection has grown in importance. The project aimed at protecting forest trees and wildlife has thus been launched. With the help of wireless sensor networks, we can create a system that can detect vibrations to stop people from cutting down trees, temperatures to stop forest fires, and animal pulses to stop wildlife from disappearing. This will save a lot of natural resources from being lost in a forest disaster. This project's sensing gadget can measure vibration, pulse, and temperature; the data is subsequently transmitted to the forest office's IoT website. The forest office's Internet of Things (IoT) website will receive data from the sensor gadget, which in this instance can detect vibration, pulse, and temperature.**

I. INTRODUCTION

Stories involving tree smuggling have been appearing in the news for quite a while now. These trees are absolutely pricey. These are primarily found in the cosmetics and medical fields. Reason being, there are a lot of occurrences involving the cutting and smuggling of trees, and a great amount of money is involved in selling their wood. India isn't the only country dealing with this problem; China, Australia, and several African nations are as well. Considering the cost, one kilogram of Indian sandalwood can set you back 12,000 to 13,000 Indian rupees, whereas a metric tonne of Red Sanders will fetch you 10,000 rupees on the global market. The Indian government is attempting to restrict sandalwood exports in an effort to prevent the possible extinction of the Indian sandalwood tree, which has become threatened in recent years. According to the government, an individual's maximum allowable purchase limit is 3.8 kg. 1 The tree is already under government supervision, and it cannot be removed from any property, even private or temple grounds, until it reaches the age of thirty. It has come to light that there is currently no mechanism in place to identify instances of illicit logging or tree cutting.

Grenze ID: 01.GIJET.12.1.501_5

A system should be put in place at your business so that you can keep track of what's happening with my trees. An alarm system like this will let you know when something is wrong and give you the chance to fix it. Smugglers' trees are extremely valuable, but they're also quite costly and will be hard to come by in Indian markets. The most valuable sandalwood trees are hacked down by smugglers who sell them for exorbitant prices in India and utilize the wood for their own purposes. So, it's necessary to put a system in place to protect the valuable trees so that smugglers can't take them. As a result, we are developing a novel set of devices to ensure the safety of the forest ecosystem and the scandal wood trees. In addition, we have created a new system gadget that can prevent deforestation and limit the smuggling of trees. This will help us conserve forest habitats, which in turn will help us solve problems like global warming. At its core, this project is a RENESAS microcontroller that can manage all of the specified system's functions. The three main sensors utilized in this project - an accelerometer sensor, a flex sensor, and a temperature sensor have greatly improved the quality of the inputs. Data transmission from the tree unit to the microcontroller and subsequent stages is essentially handled by these sensors. The tree unit is a specialized piece of hardware that uses a GSM module to transmit data messages and go on to the next stage. An accelerometer sensor can detect and provide an output when applied to tree surfaces in close proximity to tree cutting operations. Consequently, the flex sensor is employed to transmit data to the main tree unit whenever the tree is bending or its branches are expanding. This project makes use of a temperature sensor installed in the tree's immediate vicinity; in the event of a fire, the sensor will activate and generate an output if the temperature rises above 40 degrees; a solar panel will generate electricity for the project; and a GSM module will serve as the data server. India ranks third globally for the illicit import of logged timber, according to a study published in the Hindustan Times by the International Union of Forest Research Organizations. Given an annual import forecast of With a value of more than 40 billion rupees, India accounts for approximately 10As a result, the timber trade shifted to nations with less stringent regulations for the trade, such as India and China, according to the research. Unlawful clearing of tropical forests may be the source of as much as 33 percent of the world's trafficked tropical wood, according to a report released at the 2016 United Nations Convention on Biological Diversity (CBD) conference in Cancun, Mexico (Brack, 2006). At this summit, 167 nations deliberated on worldwide strategies to preserve the planet's biodiversity. According to a report by CBD (2016), unlawful harvesting accounts for 42% of the total round wood and sawn wood trafficked globally, which is estimated to be 427 billion rupees each year. The illicit wood trade is dominated by several South East Asian nations, including Papua New Guinea, Cambodia, Burma, Russia, Brazil, Indonesia, and Burma. With an annual import value of Rs. 223 billion, China is the undisputed leader in the illicit trade of wood. With an annual value of Rs. 52 billion, Vietnam is the second largest importer of timber, according to the research. The primary driver of deforestation on a global scale, which has negative consequences for both the environment and government agencies, is the illegal felling and import of trees. Both the organic variety and the effects of climate change are exacerbated by the illicit wood traffic. A study found that organized forest crimes are a direct result of the illicit timber trade in certain regions of the world. Furthermore, criminals and antagonists often rely on the illicit timber trade for financial support. Some industrialized nations have legitimately imposed restrictions on the timber trade due to the need for timber.

As a result, the timber trade shifted to nations with less stringent regulations for the trade, such as India and China, according to the research. The value of illegal wood products imported from China, Vietnam, and India increased by over 49% between 2006 and 2013. However, due to the implementation of strict regulations and legislation regarding the timber trade in the past several years, the amount of illicit wood trade in the United States decreased by nearly 33% and in Europe by 50%, respectively. The majority of India's illegal wood imports originate in Southeast Asian countries. According to a study (CBD, 2016), it is extremely difficult to reduce illegal logging and trade on a global scale without involving China and Indonesia due to their large wood trade markets and substantial wood product manufacturing capabilities. Woods are essential to the transition to a Green Economy in terms of acceptable development and poverty eradication since they generate water, biodiversity, medications, recycled agricultural additives, and surge counteractive action. Tropical forests in the Amazon Basin, as well as parts of Southeast Asia and central Africa, are the most heavily affected regions by deforestation and illegal logging. Research on the extent of illegal logging has shown that it accounts for over half (or 90%) of tropical forests. Meanwhile, the global estimate for illicit logging, including handling, is 30-100 billion USD, which is a significant amount that depletes natural resources.

Given that the most susceptible forest areas are the ones where 65% or more of all logging operations take place illegally, it is very unlikely that any estimates of illicit logging will be accurate. Criminal logging operations have also been known to cause violence, threats, deaths, and even atrocities against forest dwellers on occasion (Brack, 2006).

II. LITERATURE REVIEW

The main goal of this thesis is to safeguard commercial and precious trees and stop their theft, and to do so by using the newest technology. Narkari et al [1] describes how to use certain preventative methods to limit smuggling and preserve Earth's forest regions.
Prasad et al [2] discusses the three primary components to be utilized in the Module to be designed the Tree Unit, Area / Sub Server Unit, and Server Unit—has further reinforced the idea.
Harsha Puranik et al[3] discusses concept of creating a miniature sensor network utilizing temperature and accelerometer sensors is presented.
Akhil et al[4] proposes the model for reducing human interference and error involved in the surveillance of large areas, thereby reducing the problem of illegal chopping of trees.
Naveen Raj et al [5] built up a framework which can be utilized to limit sneaking and to spare woodlands around the world some preventive estimates.
Prem anand et al [6] propose a resolution for deforestation. Whenever the smugglers try to cut the trees, vibration sensor senses the vibration during they cut, the controller read it and gives an alert via transmitter to the monitoring unit of forest guard. The forest guard will see the information on the IOT link which is provided by the web developers.
Hedge [7] looks at the state of research on the use of Internet of Things (IoT) technologies for smuggling detection and prevention. The survey uses a systematic methodology and critically analyzes existing research to unveil pivotal findings and innovations in tree smuggling detection.
Alessandro etal[8] proposes and evaluates a framework for automatically detecting illegal tree-cutting activity in forests through audio event classification. To reduce the energy footprint and resource consumption for effective and pervasive detection of illegal tree cutting, an efficient and accurate audio classification solution based on convolutional neural networks is proposed, designed specifically for resource-constrained wireless edge devices.
Ahmad et al [9] proposes an algorithm for automatic detection of tree cutting in forest. The proposed algorithm is based on distance between parameters, along with K-means clustering, GMM and PCA for comparison.
Siddeswary et al [10] design an anti-smuggling system which is useful in Protected
Forest areas to prevent the Theft and illegal movement of commercial trees like Sandalwood, Teak, Sagwan., etc

III. PROPOSED SOLUTION AND IMPLEMENTATION

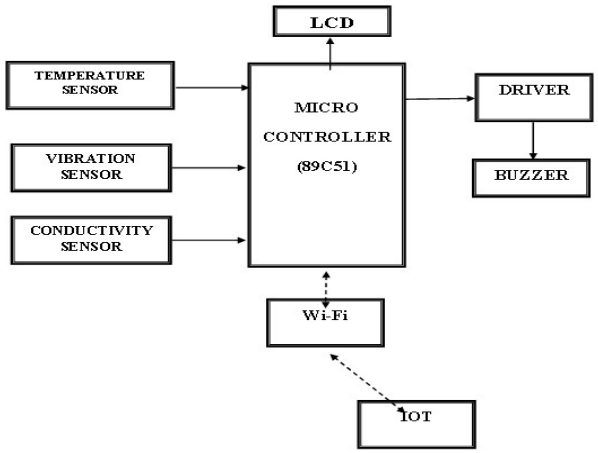

Fig 1. Block Diagram

To identify and stop tree smuggling, forest officials now mostly depend on manual patrols and surveillance.In order to look for any illegal logging or tree removal, human resources must patrol the forest regions.Basic sensors or surveillance cameras may be deployed in some forest regions, but the reach and efficiency of these systems are often limited. They may not provide real-time monitoring or cover the whole forest area. Placing the motion detectors, GPS trackers, and sound sensors in key locations throughout the forest as part of an integrated system.

Unauthorized tree cutting, vehicle movement, or chainsaw sounds may all be picked up by these sensors. Using wireless communication protocols such as LoRa or Wi-Fi, the embedded system will be linked to a central monitoring station. By doing so, the woodland region may be monitored in real-time, enabling the authorities to react quickly to any suspicious actions. After the sensors have gathered data, process it using data analytics tools. Algorithms that recognize patterns may help differentiate between natural forest operations and possible smuggling occurrences.Analysis of past data also reveals potential hotspots for illicit logging.
This discusses about the Method in which this Module is designed in Fig.1. The Module developed is an integration of hardware (Fig2) and software. The hardware is developed using sensors Temperature Sensor, Conductivity Sensor and Accelerometer.

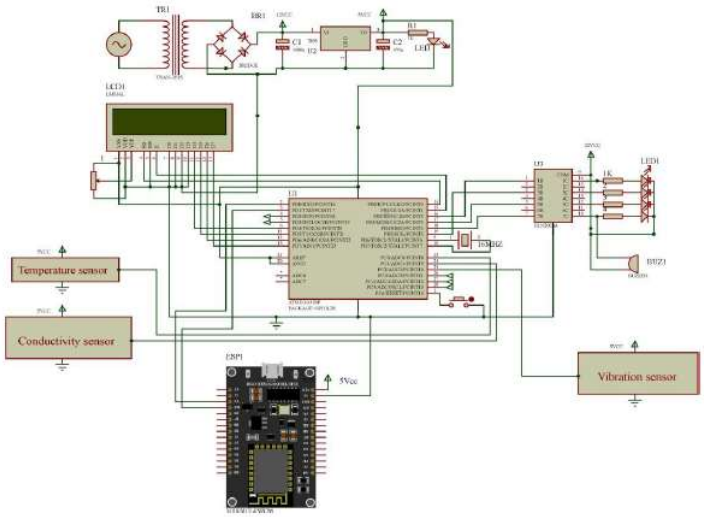

Fig 2. Circuit Diagram

A. SENSORS Selection

The sensors are like an organ system of this unit since they are ones which predict or inform about the tree's condition. Though small in size their capacity to sense the environment around them like temperature, moisture etc., make them most important part of any unit. Hence we need sensors that are reliable and rugged, at the same time they should be economical.
For the Hardware design here 3 sensors has been selected.

- Temperature sensor – LM35
- Vibration sensor – To sense the tree's bending movements.
- piezo sensor - To sense the 3 axes movements of the tree.

All the 3 sensors will give a varying analog output which should be interfaced to a Microcontroller.

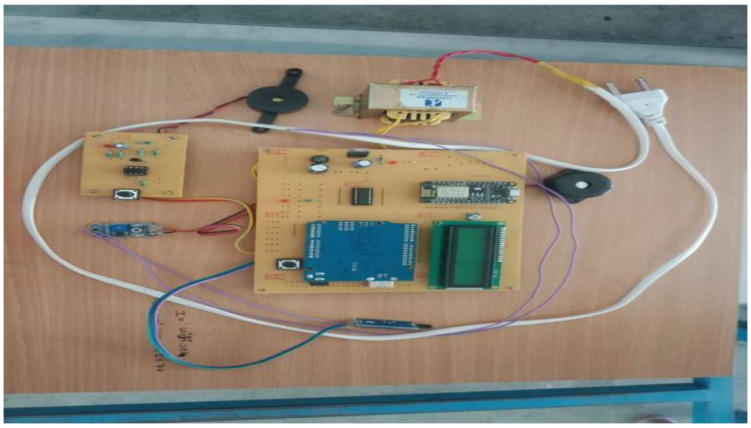

Fig 3. Hardware Setup

The above hardware configuration is created to illustrate a scenario involving the smuggling of trees in a protected forest setting.Here,the microcontroller connected to a little plastic tree has sensors like an piezo sensor, a conductivity sensor, and a temperature sensor.

IV. Results and Discussion

Fig 4. IoT message for proposed system

From above IoT message of fig 4, the system enables remote monitoring of forested areas, including remote or inaccessible regions, enhancing surveillance capabilities.

A. Tree Status

The below snaps are the tree status as displayed on the LCD and the same is transmitted to the Server through GPRS in a string format as explained before. These are the readings of the 3 sensors processed and displayed by the Microcontroller.

Fig 5. Status of Broken Tree

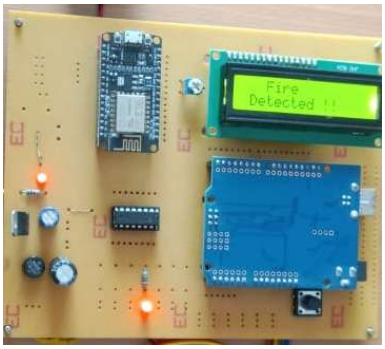

Fig 4.3 Status of Tree if Fire is obtained

V. Conclusion and Future Enhancements

Smuggling operations may be better controlled and halted with the use of this dependable and efficient technique.This is how system to prevent illegal logging in areas where humans can't guarantee the safety of trees.Aside from its primary function, the system also plays a significant role in mitigating climate change.Indirectly, the creatures' native environment is protected. Deforestation is therefore mitigated. In this way, the delicate ecological balance is preserved.

While there are numerous approaches to tree protection, this one makes use of a clever technique that involves connecting a few sensors placed around trees to a state-of-the-art microprocessor.To get the tree status remotely, the most recent cloud computing solution was used, which involves Amazon Web Services as the server.Keeping the Forest Service informed of the trees' status around the clock is essential.

Reference

[1] Narhari R. Kotkar ,"Anti-Smuggling System for Trees in Forest using Flex Sensor and Zigbee" International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 3, Issue 9,September 2014.

[2] Prasad R. Khandar, K. Deivanai ,"Preventive System for Forests" -International Journal of Computer Science Trends and Technology (I JCST) – Volume 4 Issue 1, Feb 2016
[3] Harsha Puranik, B. N. Bansode, S. S. Kataria "Anti Smuggling Alarm System for Trees in Forest Using Android", International Journal of Emerging Technology and Advanced Engineering (ISSN2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 10, October 2014.
[4] Akhil Gunda, Shreya Lokray, Vaishnavi Suthram," Implementation of a Forest Monitoring and Alerting System" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 08 | Aug 2020
[5] Naveenraj M, Arunprasath, Jeevabarathi C.T, Srinivasan R," IoT Based Anti-Poaching Alarm System for Trees in Forest" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-6S, April 2019
[6] R, Prem Ananth and M, Surya and K.R, Vikasini and A, Seetha, Anti-Smuggling System for Trees in Forest Using Vibration Sensor and NRF (July 22, 2019). International Journal of Emerging Technology and Innovative Engineering Volume 5, Issue 7, July 2019
[7] Hegde, "An Intelligent Anti-Smuggling System for Trees". International Journal for Research in Applied Science and Engineering Technology. 7. 3123-3126. 10.22214/ijraset.2019.5516.
[8] Andreadis, Alessandro, Giovanni Giambene, and Riccardo Zambon. 2021. "Monitoring Illegal Tree Cutting through Ultra-Low-Power Smart IoT Devices" Sensors 21, no. 22: 7593.
[9] Sheikh Fahad Ahmad, Deepak Kumar Singh," Automatic detection of tree cutting in forests using acoustic properties" Journal of King Saud University – Computer and Information Sciences,vol.34, pg.no 757-763,2022
[10] Siddeswary Yadav S.T, Dr.M.MEENAKSHI, "Antismuggling System for Trees in Forest with Solar Power Generation", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), 2017.