A SMART DEVICE TO TRACK ILLEGAL FOREST ACTIVITIES

UNDER THE GUIDANCE OF

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CONTENTS:

INTRODUCTION

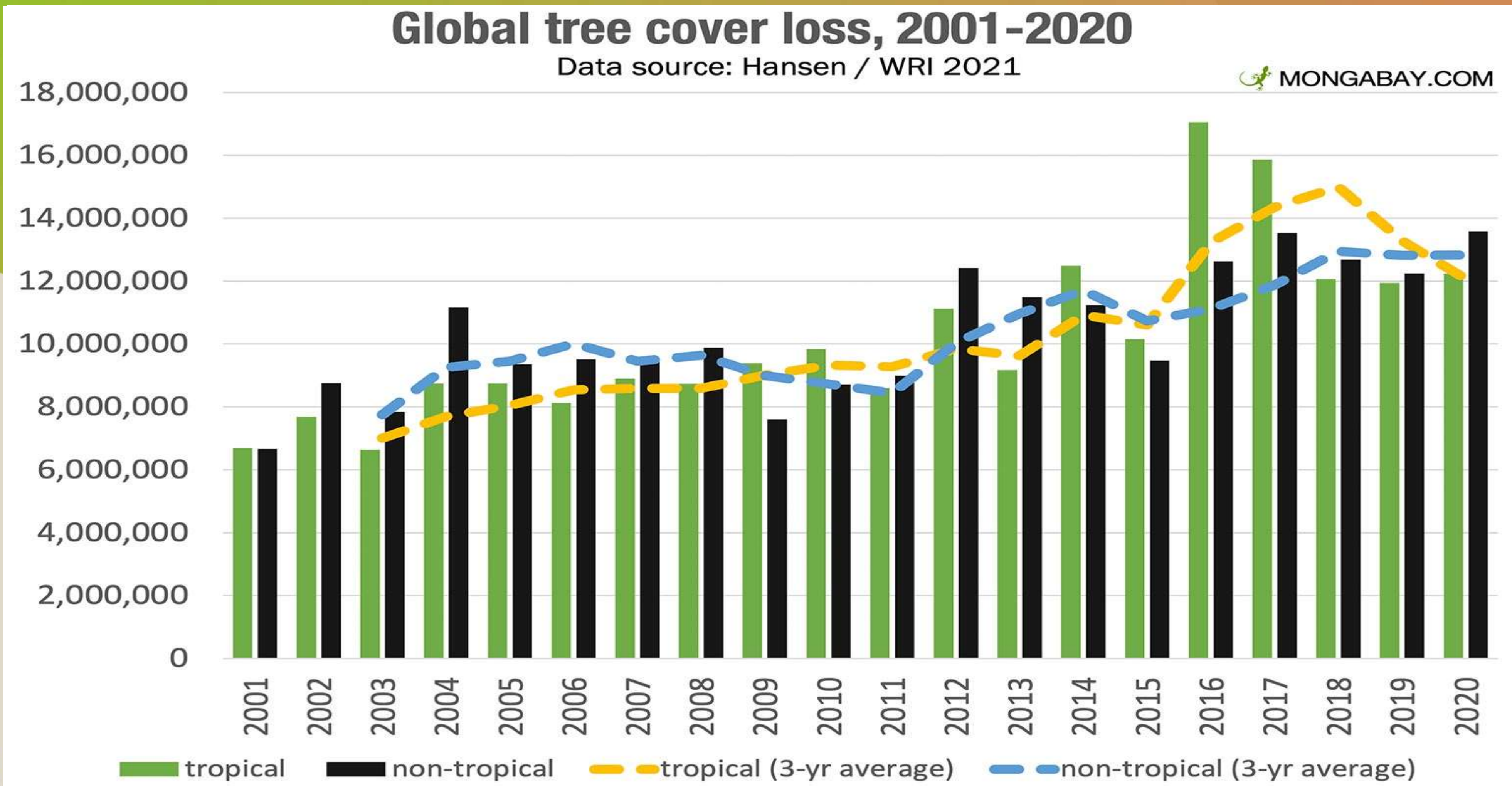
- Forests often called the lungs of our planet, are vast and complex ecosystems that play a fundamental role in sustaining life on Earth.
- The world's forests, vital reservoirs of biodiversity and essential components of Earth's ecosystems are under increasing threat from various illegal activities.
- Illegal forest activities, encompassing logging, poaching, land encroachments, and other illicit practices, pose severe environmental, social, and economic consequences.
- By using the latest innovative technologies we can develop a smart device that can help with the complex issue of illegal forest activities, examining the drivers behind these actions, their far-reaching impacts, and the pressing need for effective solutions.

Some of the illegal forest activities examples:

- In Indonesia, as much as 50 million cubic meters of timber are estimated to be illegally cut down each year.
- At least one-fifth of Russia's annual timber harvest is taken illegally, and illegal harvesting may account for as much as 50 per cent of the total in East Asia.
- In Cambodia in 1997, the volume of illegally harvested logs was ten times that of the legal harvest..
- In Brazil, an estimated 80 per cent of timber extracted each year in the Amazon is removed illegally.

Effects of illegal forest activities.

- Reduce the income of local communities from legal and improved forest management and thereby give rise to further illegal activity.
- Create a cycle of bad governance, where corrupt politicians, government officials, and private individuals support bad governance in order to maintain their profits.
- Contribute to extensive deforestation and the destruction of biological diversity.
- Increase the risk of forest fires and distort forest product markets.


Global tree cover loss, 2001-2020
Data source: Hansen / WRI 2021
MONGABAY.COM
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
tropical
non-tropical
tropical (3-yr average)
non-tropical (3-yr average)

LITERATURE REVIEW

S.NO	AUTHOR	TITLE	YEAR	CONCEPT
1.	Giva Andriana Mutiara, Nanna Suryana Herman, Othman Mohd	Using Long-Range Wireless Sensor Network to Track the Illegal Cutting Log	2020	The overall concept of the document is to propose an integrated system that can identify and track the position of illegally cut logs in forests using a long-range wireless sensor network. The system aims to detect, track, and identify instances of illegal logging in real time, contributing to the reduction of forest degradation and preservation efforts.
2.	DavidC.Marvin, LianPinKoh, AntonyJ.Lynam, SergeWich, AndrewB.Davies, RameshKrishnamurthy	Integrating technologies for scalable ecology and conservation	2016	The main focus of the This Paper is on assessing and monitoring biodiversity using various technologies, including remote sensing, camera trapping, and GPS telemetry. Overall, the document emphasizes the importance of these technologies in understanding and conserving biodiversity.

Si no	AUTHOR	TITLE	YEAR	CONCEPT
3.	Robert F. Keefe, Ann M. Wempe Ryer M. Becker, Eloise G. Zimbelman	Positioning Methods and the Use of Location and Activity Data in Forests	2019	This paper discusses the search methodology and inclusion criteria for literature reviews in the field of forestry. It explains the use of Google Scholar as the primary database for reviewing literature and includes search terms related to positioning technologies for forestry and wildland fire applications
4.	Chethan A S1, Muneshwara M S2	Geo-tagging of plantation through limited internet connectivity	2021	This document is an extract from the International Journal of Aquatic Science, Vol 12, Issue 02, 2021. It provides information about cellular networks, the application of cellular networks, Firebase Database and Storage, a problem definition related to Geo-tagging, and the uploading of images and videos in low internet connectivity.

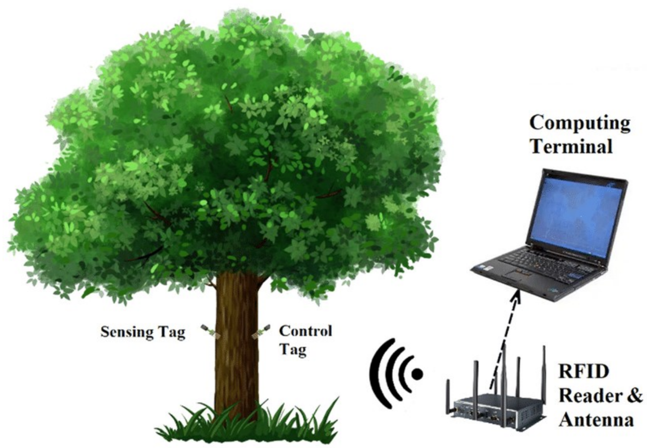
Si no	AUTHOR	TITLE	YEAR	CONCEPT
5	Alessio Fascista	Toward Integrated Large-Scale Environmental Monitoring Using WSN/UAV/Crowdsensing: A Review of Applications, Signal Processing, and Future Perspectives	2022	The document discusses the main applications of each technology, the signal processing techniques used in environmental monitoring, and the components of a high-level architecture for integrated monitoring. It also highlights the challenges and gaps in current monitoring systems and suggests future research directions.
6	Seokhoon Kim	Non-Contact Plant Growth Measurement Method and System Based on Ubiquitous Sensor Network Technologies	2011	This document discusses a non-contact plant growth measurement method and system based on ubiquitous sensor network technologies. It presents the architecture and components of the proposed system, as well as the plant growth process and issues with existing measurement tools.

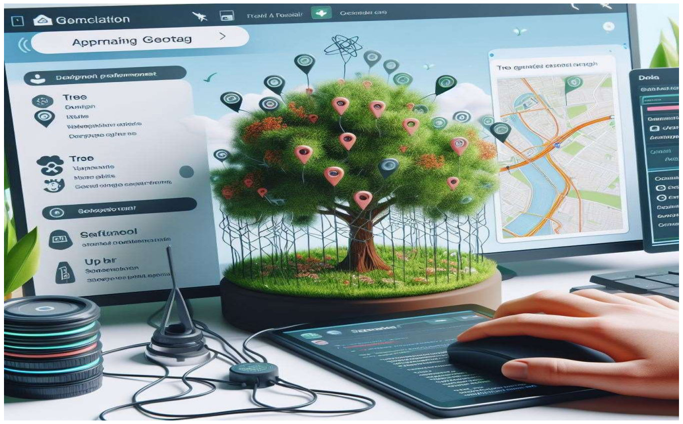
PROBLEM STATEMENT:

To track illegal forest activities by developing a smart device that consists of specialized integrated sensors that systemically monitor the trees in the forest and have real-time alerting capabilities to swiftly respond to anomlaious.

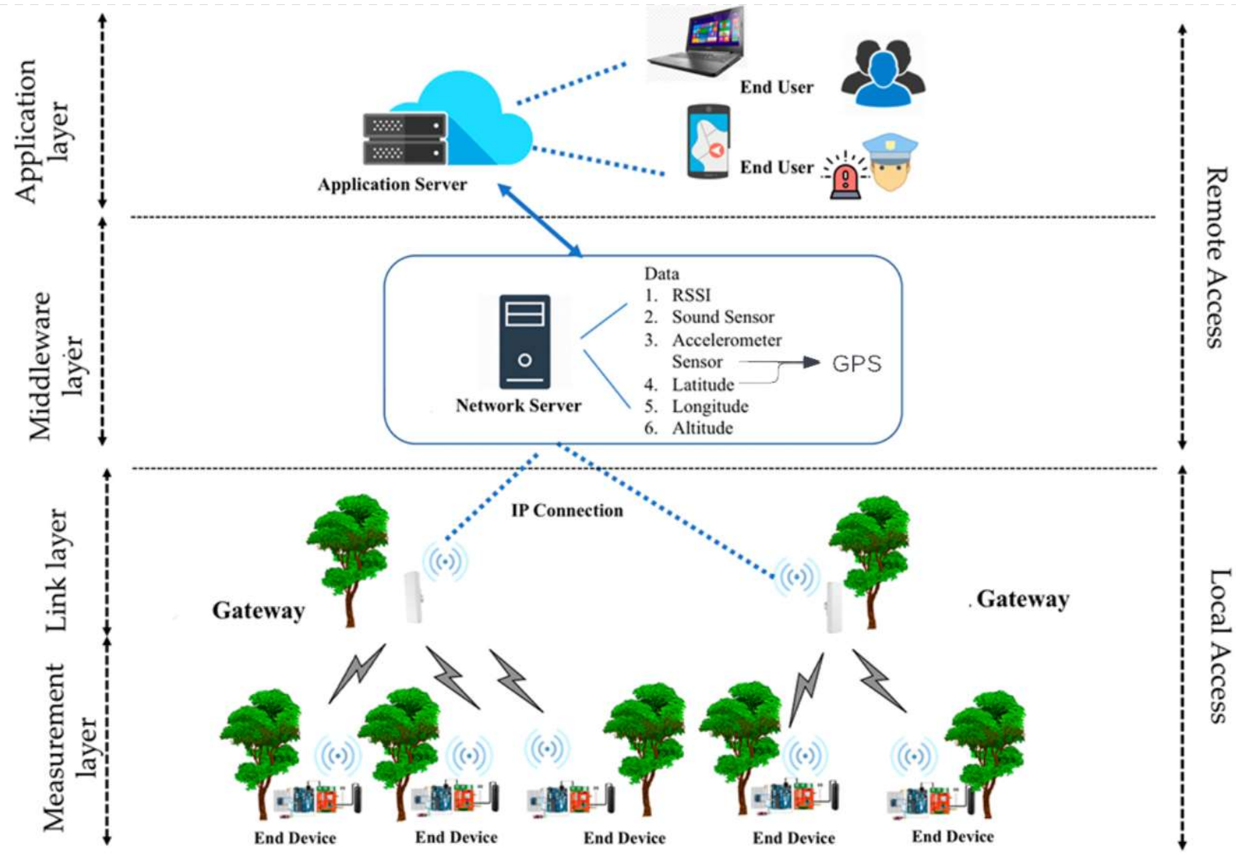
OBJECTIVES

- To identify sensors and technologies capable of accurately detecting and identifying illegal activities such as logging, poaching, and unauthorised land clearing in real-time.
- Implement geospatial monitoring capabilities to track the exact location of illegal activities, enabling rapid response and intervention by authorities.
- To Develop and design a device with robust security features to prevent tampering or disabling by individuals engaged in illegal activities, ensuring the device's integrity and reliability.
- To develop a mobile app application to store and monitor the integrated sensors network data





FLOWCHART


Application layer
Middleware layer
Link layer
Measurement layer
End User
End User
Application Server
Data
1. RSSI
2. Sound Sensor
3. Accelerometer Sensor
4. Latitude
5. Longitude
6. Altitude
GPS
Network Server
IP Connection
Gateway
Gateway
End Device
End Device
End Device
End Device
End Device
Remote Access
Local Access

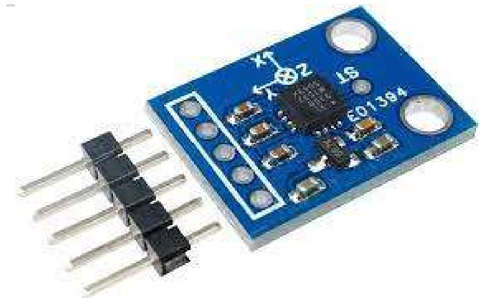
SENSORS

GPS SENSOR

- GPS stands for Global Positioning System. The system contains satellites and ground-based control installations. GPS sensor consists of a surface mount chip that processes signals from GPS satellites using a small rectangular antenna, often mounted on the top of the GPS chip.
- The GPS module is usually a small board on which the GPS sensor is mounted with additional components.
- GPS receiver is a device that includes data display and other components such as memory for data storage in addition to the GPS module.

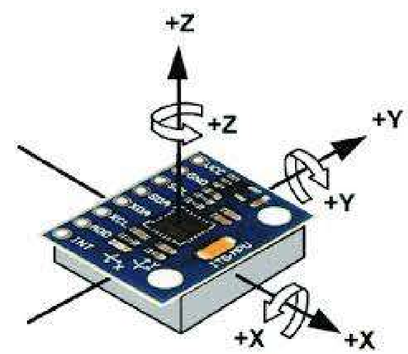
ACCELEROMETER SENSOR

An accelerometer is a device that measures the vibration, or acceleration of motion, of a structure. The force caused by the piezoelectric material produces an electrical charge that is proportional to the force exerted upon it. An accelerometer can only measure linear motion.



GYROSCOPE SENSOR

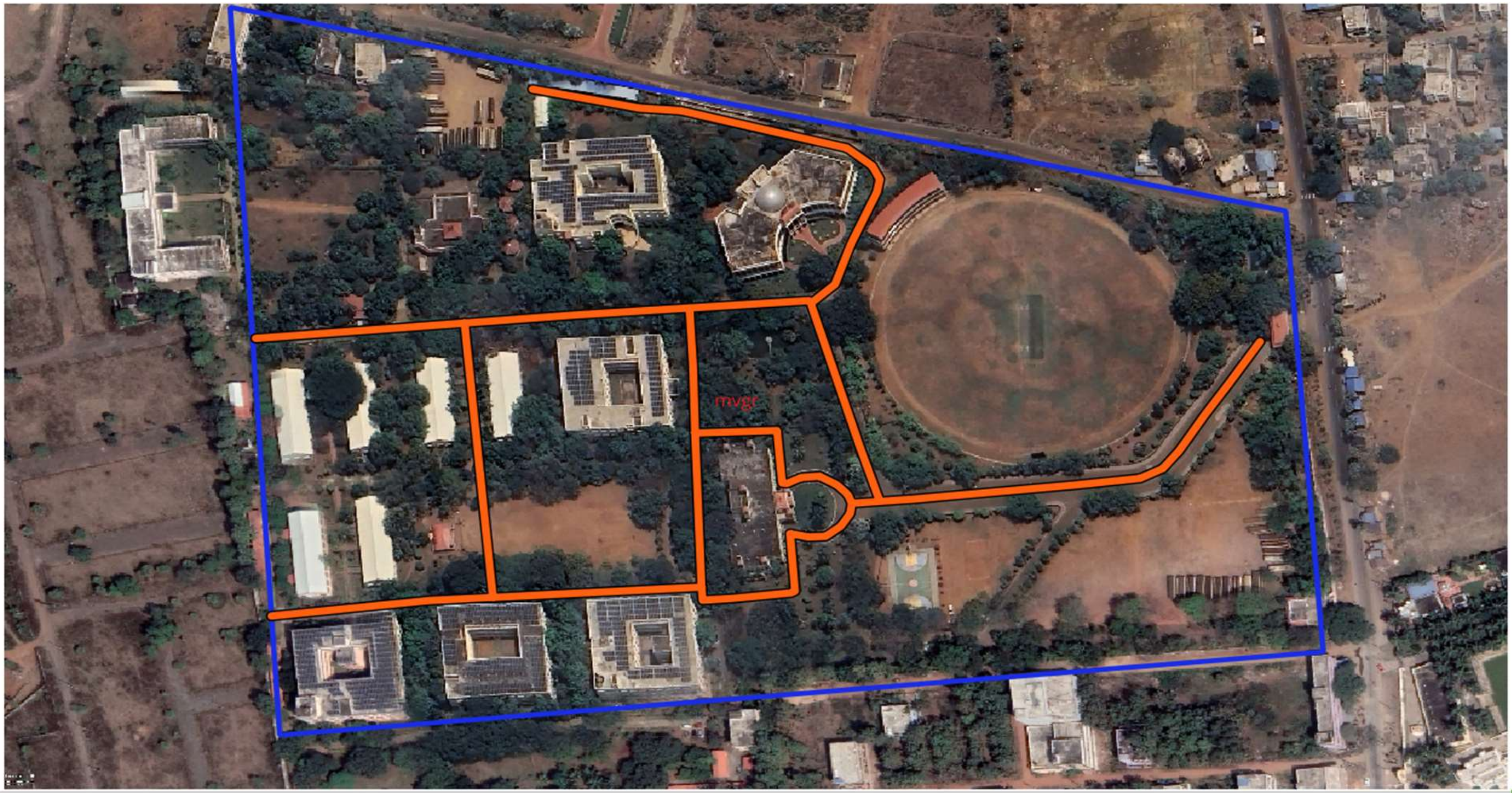
A Gyroscope sensor is a device that can measure and maintain the orientation and angular velocity of an object. These are more advanced than accelerometers. These can measure the tilt and lateral orientation of the object whereas an accelerometer can only measure the linear motion.



VIBRATION SENSOR

- A vibration sensor measures the amount and frequency of vibrations in a machine, system, or piece of equipment.
- It can also detect imbalances or other issues in an asset and predict future breakdowns.

Georeferencing of college-as pilot work

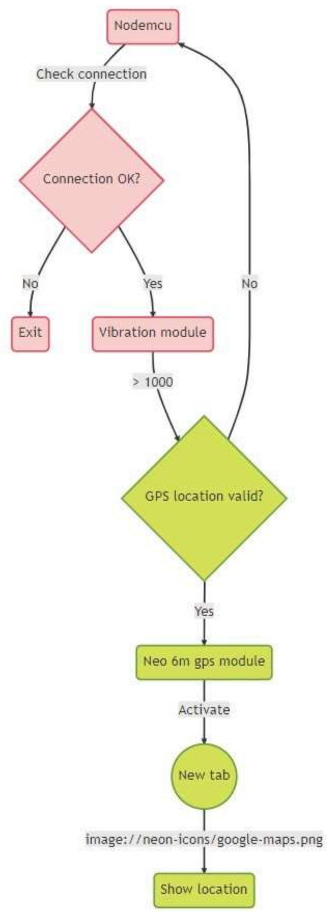


METHODOLOGY:

- The methodology for developing a smart device to track illegal forest activities using a GPS sensor, NodeMCU microcontroller, accelerometer sensor, and vibration sensor involves several key steps. First, the hardware components including the GPS sensor, NodeMCU microcontroller, accelerometer sensor, and vibration sensor need to be selected based on their specifications, compatibility, and suitability for forest monitoring applications.
- Once the hardware components are acquired, they need to be integrated and connected to the NodeMCU microcontroller, which serves as the central processing unit for the device. This involves designing and implementing the necessary circuitry and programming the microcontroller to interface with each sensor and collect data.

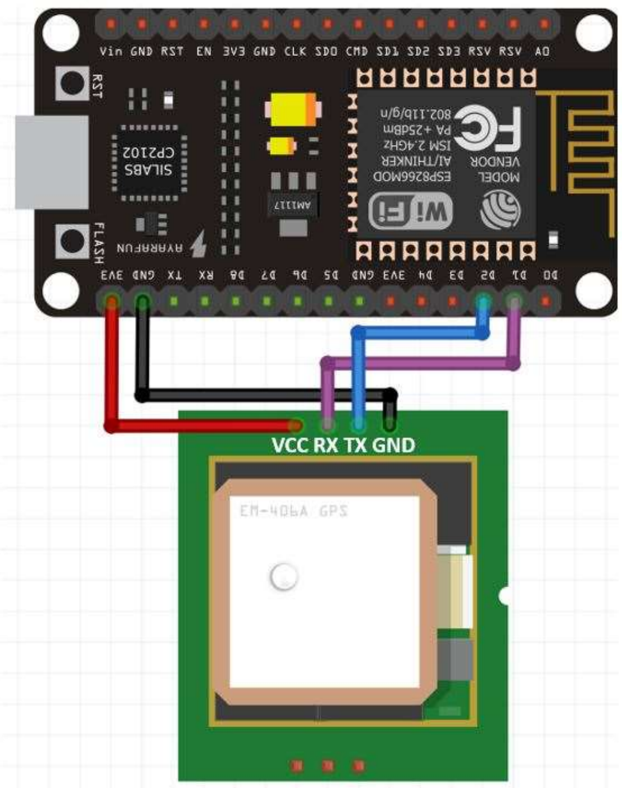
- Next, the device firmware needs to be developed to enable data logging, sensor data processing, and wireless communication with a central server or monitoring station.
- The firmware should include algorithms for real-time analysis of sensor data to detect and classify illegal forest activities based on predefined criteria such as sudden changes in device orientation or detected vibrations. Additionally, power management features should be implemented to optimize the device's energy efficiency and ensure long-term operation in remote forest environments.
- Once the hardware and firmware components are developed, the device needs to be tested and validated in simulated and real-world forest environments to assess its performance, reliability, and accuracy in detecting illegal activities.

Block diagram

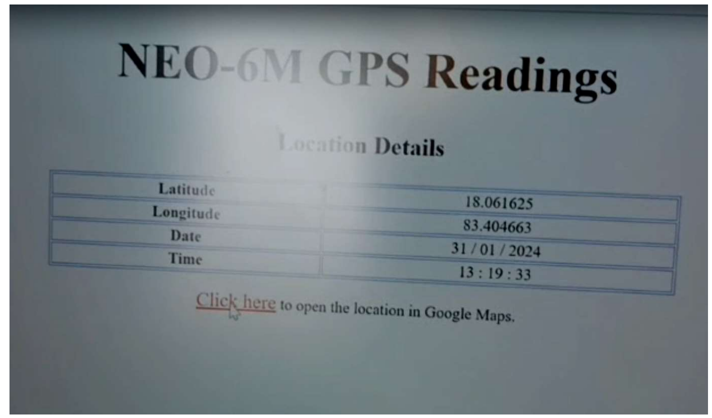

Nodemcu
Check connection
Connection OK?
No
Yes
No
Exit
Vibration module
> 1000
GPS location valid?
Yes
Neo 6m gps module
Activate
New tab
image://neon-icons/google-maps.png
Show location

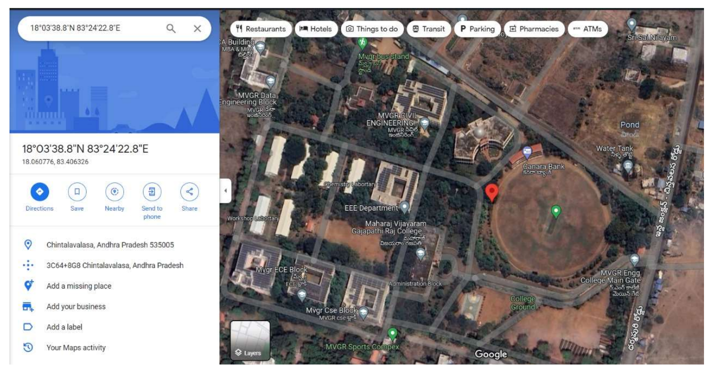
TESTING:
NODE MCU WITH GPS MODULE

- Testing the GPS functionality with the NodeMCU microcontroller involves several steps to ensure accurate positioning and reliable data transmission. Initially, the GPS module is connected to the NodeMCU, and the necessary libraries are imported into the Arduino IDE for programming.
- A simple code is then written to initialize the GPS module and extract location data. During testing, the NodeMCU is powered on in an open area with a clear view of the sky to allow the GPS module to acquire satellite signals.
- The device's serial monitor is used to monitor the output from the GPS module, verifying that it is successfully receiving latitude, longitude, and altitude coordinates.
- Additionally, the accuracy of the GPS positioning is assessed by comparing the obtained coordinates with known reference points or using online mapping services.
- Finally, the GPS data transmission to a central server or storage device is tested to ensure seamless integration with the overall smart device system. Through rigorous testing of GPS functionality with the NodeMCU, any issues or limitations can be addressed, ensuring reliable and precise location tracking capabilities for monitoring illegal forest activities.

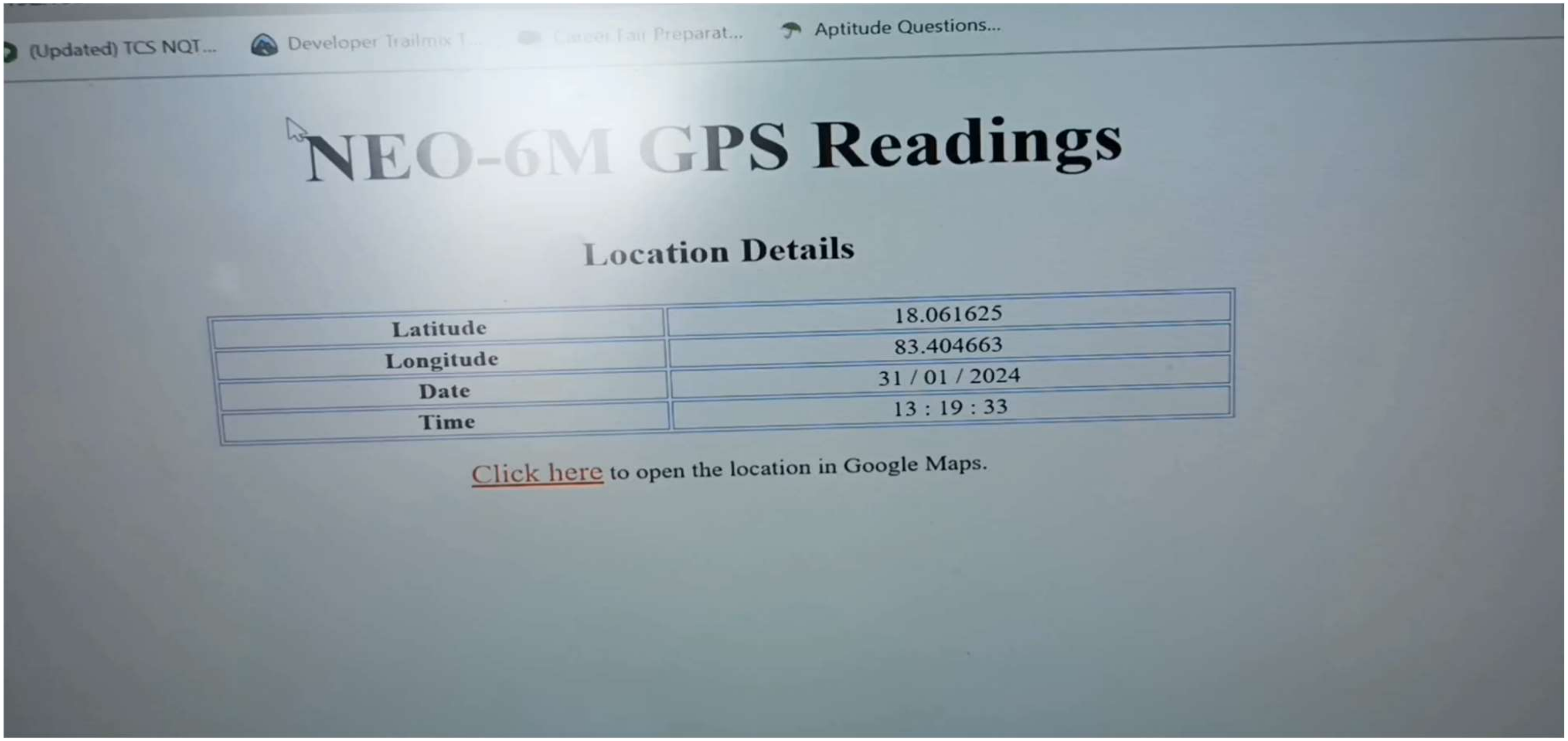


NEO-6M GPS Module



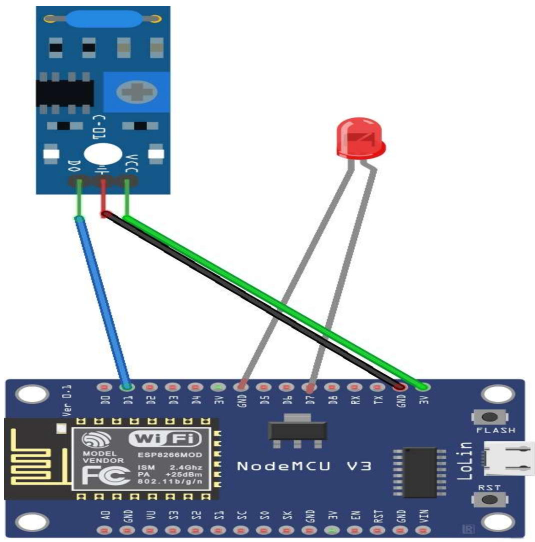


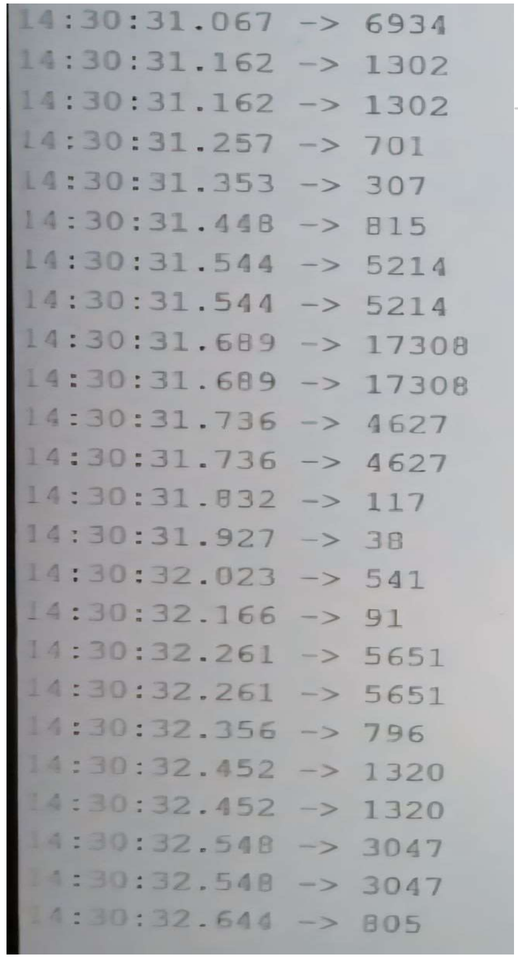
GPS SENSOR TESTING

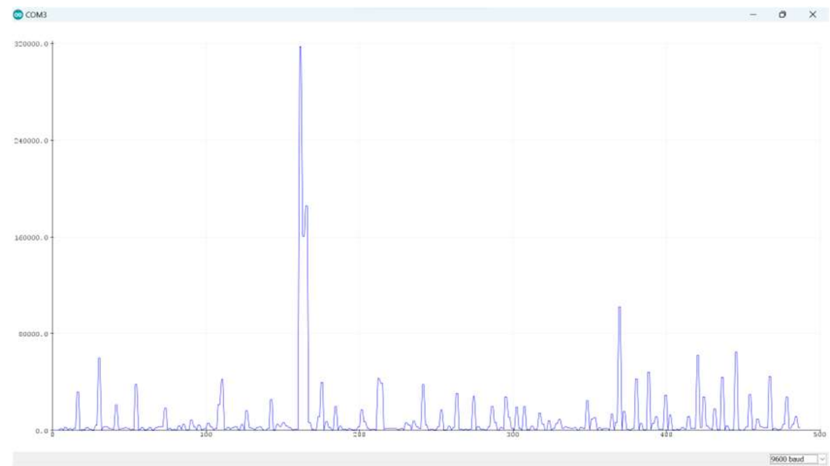


NODE MCU WITH VIBRATION SENSOR

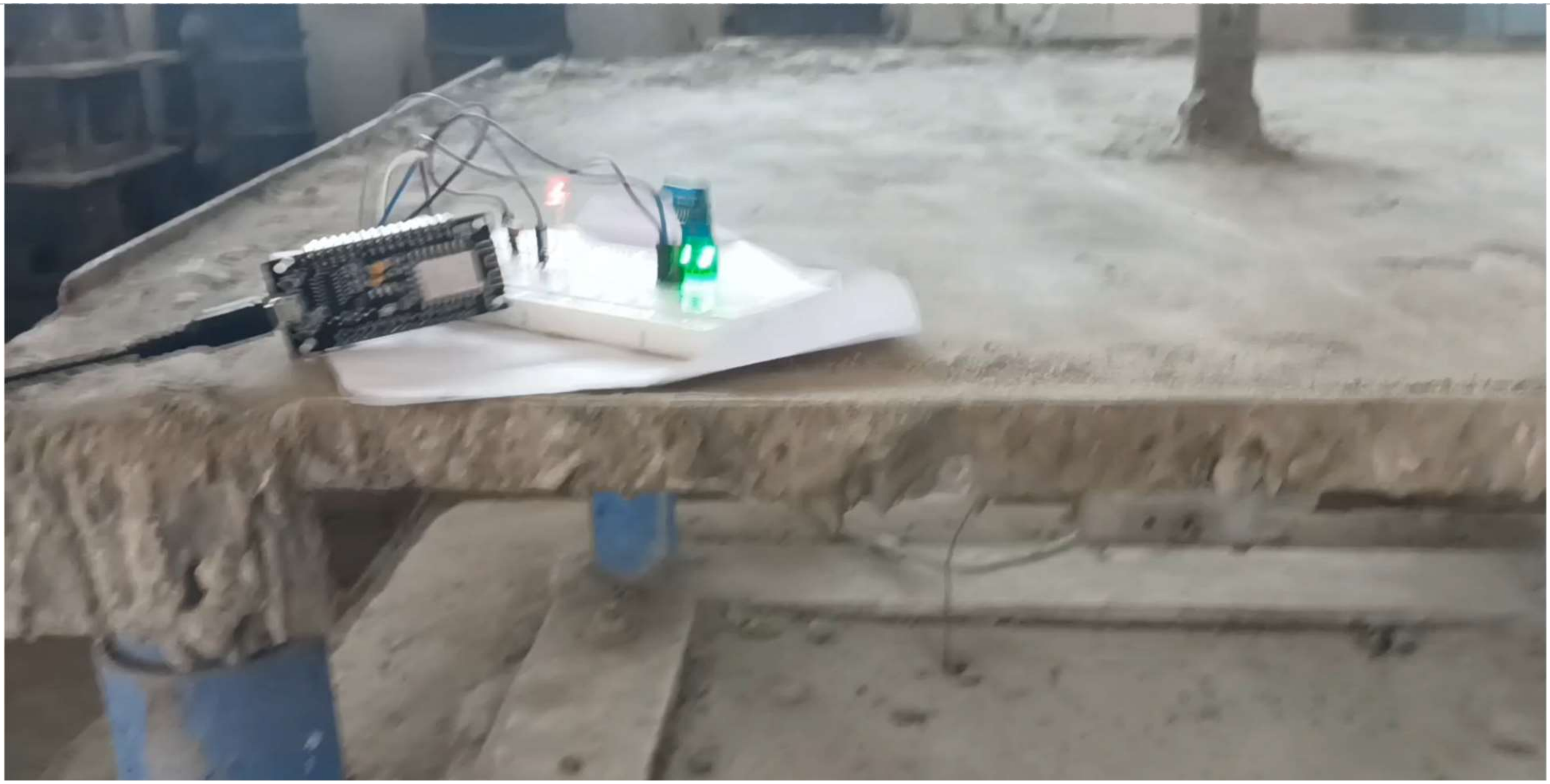
- A NodeMCU with a vibration sensor, begin by connecting the vibration sensor to the NodeMCU. Typically, vibration sensors have three pins: VCC, GND, and OUT. Connect the VCC pin to a 3.3V pin on the NodeMCU, the GND pin to a ground pin, and the OUT pin to any digital pin on the NodeMCU (such as D1).
- Next, write the code to read the sensor data. Use the Arduino IDE or any compatible platform to write the code. Begin by initializing the digital pin connected to the sensor as an input pin. Then, in the loop function, read the digital value of the pin using digitalRead().
- Based on the value read, you can determine if there's vibration detected. You might want to add some thresholding or filtering to make the detection more robust. Additionally, consider using interrupts if you need real-time responsiveness.
- Upload the code to the NodeMCU and power it up. Now, your NodeMCU should be able to detect vibrations through the sensor.




14:30:31.067 -> 6934
14:30:31.162 -> 1302
14:30:31.162 -> 1302
14:30:31.257 -> 701
14:30:31.353 -> 307
14:30:31.448 -> 815
14:30:31.544 -> 5214
14:30:31.544 -> 5214
14:30:31.689 -> 17308
14:30:31.689 -> 17308
14:30:31.736 -> 4627
14:30:31.736 -> 4627
14:30:31.832 -> 117
14:30:31.927 -> 38
14:30:32.023 -> 541
14:30:32.166 -> 91
14:30:32.261 -> 5651
14:30:32.261 -> 5651
14:30:32.356 -> 796
14:30:32.452 -> 1320
14:30:32.452 -> 1320
14:30:32.548 -> 3047
14:30:32.548 -> 3047
14:30:32.644 -> 805

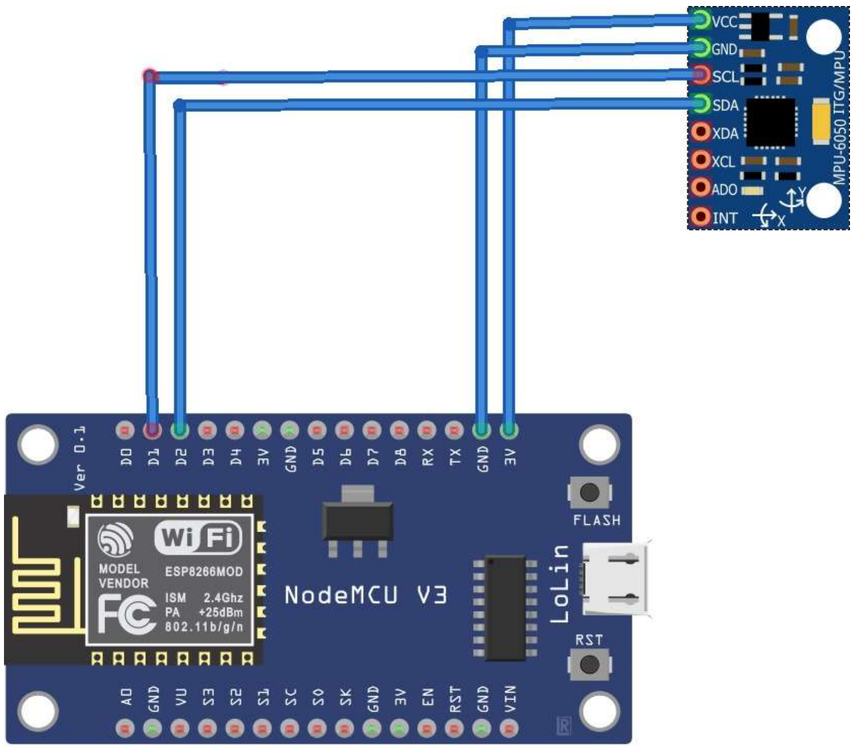


VIBRATION SENSOR TESTING



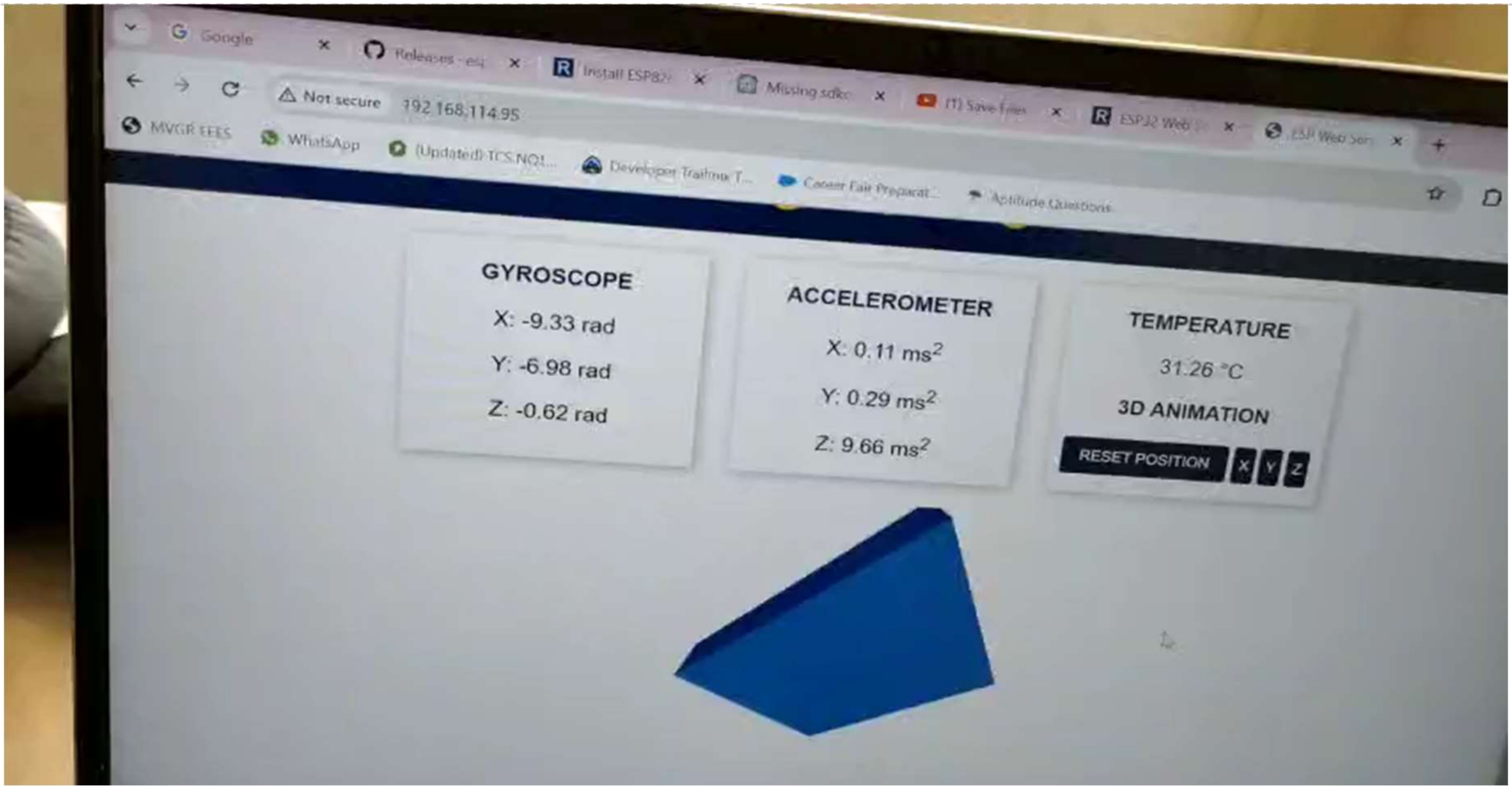
NODE MCU WITH ACCELEROMETER AND GYROSCOPE SENSOR

- To use an accelerometer with a NodeMCU, you'll need to connect the accelerometer module to the NodeMCU and write code to read data from the accelerometer. The accelerometer typically communicates over protocols like I2C or SPI. Begin by connecting the accelerometer to the NodeMCU using the appropriate communication protocol.
- For instance, if you're using an accelerometer with an I2C interface, connect the SDA pin to the NodeMCU's D2 pin and the SCL pin to the D1 pin. Once connected, write code to initialize the I2C communication and configure the accelerometer. These libraries like Wire. h for I2C communication and the specific library for your accelerometer model. In your code, read the accelerometer data, which typically includes acceleration values in three axes (X, Y, Z).
- Processing this data according to your application needs, such as detecting changes in orientation or motion. Finally, upload the code to the NodeMCU and power it up. Now, your NodeMCU can utilize the accelerometer to detect and respond to changes in acceleration.


VCC
GND
SCL
SDA
XDA
XCL
ADO
INT
MPU-6050 ITG/MPU
D0 D1 D2 D3 D4 3V GND D5 D6 D7 D8 RX TX GND 3V
Ver 0.1
FLASH
NodeMCU V3
LoLin
RST
A0 GND VU S3 S2 S1 SC S0 SK GND 3V EN RST GND VIN


GYROSCOPE
X: -10.94 rad
Y: -7.53 rad
Z: -0.05 rad
ACCELEROMETER
X: 0.00 ms2
Y: 0.00 ms2
Z: 0.00 ms2
TEMPERATURE
35.96 °C
3D ANIMATION
RESET POSITION
X
Y
Z

ACCELEROMETER SENSOR TESTING



INTEGRATION OF SENSORS

- The integration of GPS (Global Positioning System) and vibration/acceleration sensors with a NodeMCU (ESP8266) microcontroller for tracking illegal forest activities involves the following steps. general procedure for integrating these components are:

Understanding the Sensor Interfaces:

1. Familiarize yourself with the pin configurations and communication protocols of each sensor module.
2. The GPS module typically communicates via UART (Serial).
3. Vibration and accelerometer sensors may use analogue or digital output signals, depending on the module.

Wiring the Components:

1. Connect the GPS module to the NodeMCU using UART communication. Usually, this involves connecting the GPS module's TX pin to a GPIO pin on the NodeMCU for receiving data.
2. Connect the vibration and accelerometer sensors to the appropriate GPIO pins on the NodeMCU. Ensure proper power (VCC) and ground (GND) connections.
3. Refer to the datasheets or documentation of each sensor module for the exact pin connections.

Programming the NodeMCU:

1. Write a firmware program for the NodeMCU using an Arduino IDE or a suitable programming environment.
2. Utilize libraries or code examples available for interfacing with the GPS module (e.g., TinyGPS++) and the vibration/acceleration sensors.
3. Initialize the serial communication for both the GPS module and the NodeMCU.

4. Read GPS data (latitude, longitude, altitude, etc.) from the GPS module periodically.
5. Implement logic to detect vibrations and changes in acceleration using the vibration and accelerometer sensors.
6. Define thresholds or patterns that indicate illegal activities (e.g., sudden movement, prolonged vibration).
7. Integrate GPS data and sensor readings to create a comprehensive tracking and monitoring system.

Testing and Optimization:

1. Test the integrated system in simulated or real-world forest environments to evaluate its performance and accuracy.
2. Optimize the firmware and sensor configurations based on test results to improve reliability and efficiency.
3. Address any issues or challenges encountered during testing, such as signal interference or power consumption.

Deployment and Monitoring:

1. Deploy the integrated smart devices in strategic locations within forested areas where illegal activities are prevalent.
2. Monitor the system remotely or periodically to ensure proper functioning and reliability.
3. Maintain and update the firmware as needed to address any issues or incorporate new features or improvements.

- The integration of GPS and vibration/acceleration sensors with a NodeMCU microcontroller to create a smart device for tracking illegal forest activities. This integrated system can provide valuable data for forest monitoring and enforcement efforts, helping to protect natural ecosystems and biodiversity.

RESULTS

- The results demonstrate the effectiveness of the smart device in monitoring and combating illegal forest activities. The integration of GPS, accelerometer, and vibration sensors with the NodeMCU microcontroller provided a comprehensive and cost-effective solution for forest monitoring and enforcement, ultimately contributing to the preservation of precious ecosystems and biodiversity.

NEO-6M GPS and Vibration Readings

Latitude	18.060768
Longitude	83.406265
Date	18/3/2024
Time	11:6:3
Vibration Measurement	1561

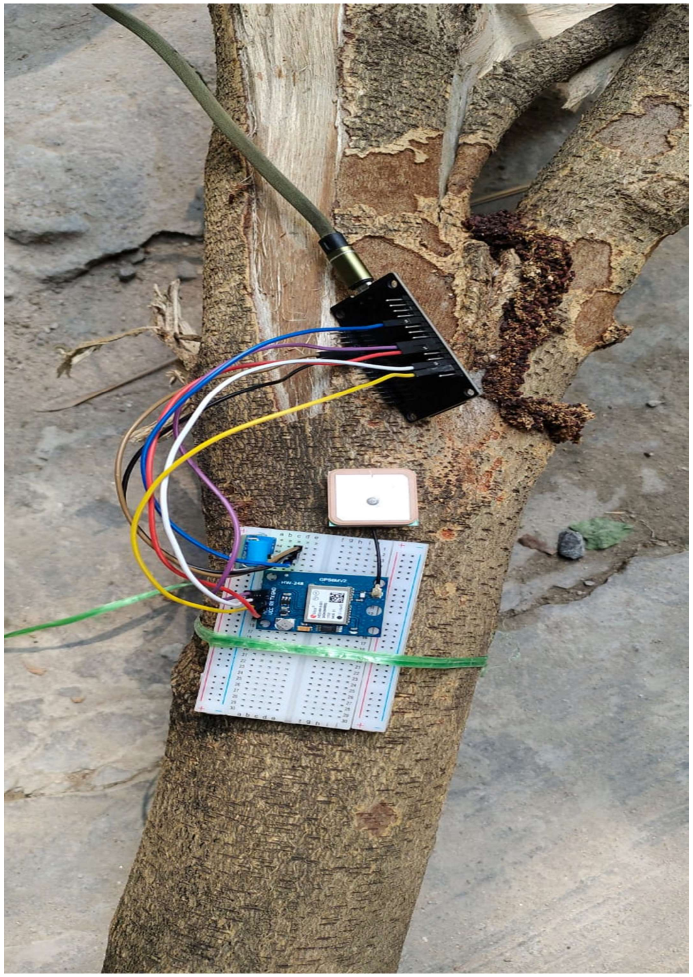
High Vibration Detected!

Vibration History

Index	Measurement
1	65
2	7146
3	3000
4	1561
5	1561
6	1561
7	1561
8	519
9	1561
10	1276

Open Google Maps


MBA & MCA
Mvgr bus stand
MVGR Data
ngineering Block
MVGR CIVIL
ENGINEERING...
Pond
Water Tank
Canara Bank
Chemistry Laboratory
EEE Department
Workshop Labortary
Maharaj Vijayaram
Gajapathi Raj College...
Mvgr ECE Block
ECE
Administration Block
MVGR.Engg
College Main Gate
College
Ground
Mvgr Cse Block
MVGR cse
MVGR Sports Complex
Layers
Google



ANALYSIS

- The proposed smart device holds significant potential to enhance forest monitoring and enforcement efforts. From the results of testing any illegal activities can be detected. While an unauthorized person in the forest tries to log the trees, firstly the vibration sensor gets alerted and shows the threshold of vibration if the threshold crosses 2500hz, then immediately the GPS sensor gets alerted and shows us the location of the target.
- However, its effectiveness depends on factors such as the reliability of sensor data, the robustness of wireless communication infrastructure, and the integration of data analysis into decision-making processes. Further research and field testing is necessary to evaluate the practical implementation and impact of the device in addressing illegal forest activities.

FUTURE SCOPE

- The proposed smart device represents a promising advancement in the field of forest monitoring and enforcement, but its potential for further development and application is vast.
- Integration of additional sensors, such as cameras or environmental sensors for detecting changes in temperature, humidity, or sound levels, could provide detection of a wider range of illegal activities. Furthermore, advancements in wireless communication technologies could improve data transmission efficiency and enable real-time analysis of collected data, allowing for an even swifter response to detected incidents.
- Additionally, the development of machine learning algorithms to analyze the collected data could enhance the device's ability to differentiate between natural phenomena and illegal activities, reducing false alarms and increasing overall effectiveness

- Moreover, scaling up the deployment of these smart devices in collaboration with governments, NGOs, and local communities could lead to a networked system of forest monitoring and enforcement, further bolstering conservation efforts and promoting sustainable forest management practices.

- Overall, the future scope of the proposed smart device holds great potential for revolutionizing forest protection efforts and mitigating the impacts of illegal activities on global biodiversity and ecosystem health.


THANK
YOU