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JNANA SANGAMA, BELAGAVI – 590018

A Project Report

on

“FOREST ECOLOGY AND GREEN COVER MONITORING SYSTEM USING IOT”

Project report Submitted in partial fulfilment of the requirements for the Award of degree of

BACHELOR OF ENGINEERING IN INFORMATION SCIENCE AND ENGINEERING

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CERTIFICATE

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ABSTRACT

Forests are the dominant terrestrial ecosystem of Earth, and are distributed around the globe. Forests account for 75% of the gross primary production of the Earth's biosphere, and contain 80% of the Earth's plant biomass. Human society and forests influence each other in both positive and negative ways. Forests provide ecosystem services to humans and serve as tourist attractions. Forests can also affect people's health. Human activities, including harvesting forest resources, can negatively affect forest ecosystems. So preserving forest is the main goal and responsibility of each and every individual. The purpose of this project is to automate the forest management and reduce the human dependability to the maximum range. It has two modules, one is fire detection and alert and another module is green cover monitoring using image processing.

Forest fire (wildfire) is one of the common hazards that is occurs in the forest. In older days, manually fire detection approach is used. In current days, satellite-based surveillance system is used to detect forest fire but this works when fire is spread in the large area. So these techniques are not efficient. According to a survey, approximately 80% losses are accrued in the forest due to the late detection of fire. So to overcome this problem, we use the Internet of things technology which is quick and reliable.

Green cover monitoring is the process of managing the greenery level of the forest by analyzing health of trees and protecting it from tree theft. It includes constant monitoring of trees which is achieved in this project by image processing. The PI-camera captures the image with equal interval of time and analyzes it with the help of written algorithm and notifies the responsible person with results. The algorithm is used for analysis as the forest analyst cannot be available always. This result gives information about green level, forest health and other activities happening at the forest. The continuous monitoring is done by the camera sensor is transfered to alert the forest officers about any human interventions like, tree theft,animal pouching etc.This is done by human activity monitoring algorithm which gives human count and activity perception. .

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INTRODUCTION

1.1 Overview

For ages we have been worried by illegal activities like smuggling of precious and commercial trees such as Teakwood, Sandalwood, Sagwan etc., from the protected Forest areas. These trees are very expensive and have a lot of commercial demand in the world market. The trees are generally marked manually by some tags and considered as protected. This is not be useful and reliable since anyone can hamper it. Also during Natural calamities trees may somehow get damaged. In our country, the forest department monitors illegal cutting and smuggling of commercialtrees.But we all know this issue is not controlled are gone yet because we still receive news about it. The recent estimation done by Government of India says that the market price of sandalwood is estimated to be Rs 10,000 Crores annually. Government has taken various steps and measures to control these activities. In recent days,dogs are trained to monitor are detect tree theft. But it is not the efficient or best solution as it requires trained pet animals and lots of human efforts.

Apart from tree smuggling the main reason for forest destruction is forest fire or in general terms wildfire. It is uncontrollable which is harmful for natural and human resources. Once the fires starts it will spread quickly all over forest. The reasons for this disaster are lightening, severe drought,extreme dry and hot climate an human unawareness.Since the past decade there is an huge depletion in forest,which were caused by forest fire. Based on survey by Forest Survey of India's data it is determined that 50% of forest are in risk of forest fire Between January 1, 2019, and February 26, 2019, 556 forest fire occurred in India. These cases are example of how poor the forest ecology is monitored and forest fire is prevented.

The havoc due to forest fire has caused serious environmental problems and devastation of flora and fauna. Recently we have witnessed two major forest fires. One in Amazon forests and another one in Australia. Even though bush fires are common in Australia, this time it has crossed its threshold. In case of amazon wildfire, 40% of the forest was burnt. Within the current turbulent global economic, demographic, social and ecologic context, governments, local administrative authorities, researchers and commercial companies or even individuals have to recognize the importance of the resources contained in the forest environment - not only from the perspective of the biodiversity, but also from the point of view of the economic resources which forests enclose.

Therefore, any major threat posed to this essential component of the environment should be identified, studied and fought through the most efficient and modern economic policies and technological means. One of the most dangerous phenomena, which jeopardize forests, is represented by forest fires.A forest fire is any form of unrestrained fire that erupts in a forested area. Forest fires have proven to be a massive form of destruction for humankind, especially when not countered early.

Problem Definition

Monitoring is the most important step for the protection of forest.Any major threat posed to this essential component of the environment should be identified, studied and fought through the most efficient and modern economic policies and technological means.Apart from tree smuggling the main reason for forest destruction is forest fire or in general terms wildfire. Regular monitoring helps in reducing the risk of these havocs efficiently.

Problem Statement

1. To develop a all in one system which helps in monitoring the various conditions in the forest liketemperature,humidity and gas data.
2. The system will also be capable of detecting person and saw for higher level of monitoring.
3. The data generated by the system is simultaneously transmitted to the forest control office to the web page dedicated for it, and alerts are generated in case of wildfire.
4. This system will reduce human intervention in monitoring forest, because earlier humans had to travel to different parts of forest to know about the condition of that particular area.

LITERATURE REVIEW

2.1 Existing systems

There are various methods of detection of forest fire that are practiced in recent years. Video Surveillance System is generally used for detection of forest fire.It is classified in 4 groups: cameras that are sensitive enough to detect smoke in sunlight and fire blazes in dark night, which is accomplished by Infrared Thermal Imaging camera which detects warmness of fire, IR Spectrometer which says the difference between different smoke gases and LIDAR system which measures back scatterings of laser night by smoke particles.Even though they are highly advanced methods they are not accurate. The drawback of these methods is false alert due to various climatic reasons. Wild Fire Reconnaissance Framework which comprises of WSN was similarly proposed for identification of wild fires in South Korea. The WSN decides the temperature and dampness after which middleware program and web app examines the collected information. However in this method of identification of wild fire there was some loss of data amid correspondence.

2.1.1-Real Time Forest Anti-Smuggling Monitoring System based on IOT using GSM

Pushpalatha R, Darshini M.S

Outcome of the paper

The theory was completed to abstain from carrying of valuable trees in secured zone in woods. There are numerous approaches to secure trees yet here a brilliant technique for interfacing a few sensors around trees with a microcontroller was done. The most recent technique for distributed computing utilizing Amazon web administrations was executed which goes about as a server for acquiring the tree status remotely. That is to imply the Forest specialists about the trees' condition on 24x7 basis.This was conceivable in light of the fact that the inserted unit has GPRS.

Thought was to regard each tree as a smart tree (with a microcontroller, sensors and GPRS) and bringing numerous such trees under a system (Internet of Things). Anyway the Trees' condition is under ceaseless observing as a result of sensors. Subsequently it's an amalgamation of IoT, WSN and AWS to ensure the Nature.

2.1.2 FOREST MONITORING SYSTEM USING WIRELESS SENSOR NETWORK

B S Sudha,Yogitha H R,Sushma K M andPoojaBhat

Outcome of the paper

This paper presents design, development and prototype of wireless sensor network for forest and wildlife monitoring. This prototype system comprises of two modules namely the sensor and the sink module. Here we show the deployment of multi-sensors needed to cover the forest area. In addition to alerting of forest officials during forest fire accidents and animal monitoring, this system may also be implemented in wildlife sanctuaries and zoos. It can also be implemented as pet tracking system. It mainly targets animal health monitoring, alerting the forest officials during forest fire hazards, smuggling of valuable trees and poaching of endangered species. This system is also highly beneficial in preventing trespassing of wild animals into the living areas in the forest's vicinity. It also aims on animal location and tracking applications. This paper presents a low power consuming, less complex and an economic solution to the existing problem.

2.1.3 IOT ENABLED FOREST FIRE DETECTION AND ONLINE MONITORING SYSTEM

Abhinav Kumar Sharma, MdFaizRaza Ansari, MdFirozSiddiqui, MirzaAtaullahBaig

Outcome of the paper

Early warning and immediate response to a fire breakout are the only ways to avoid great losses and environmental and cultural heritage damages. Hence, the most important goals in fire surveillance are quick and reliable detection and localization ofthe fire. It is much easier to suppress a fire when the starting location is known, and while it is in its early stages. Information about the progress of fire is also highly valuable for managing the fire during all its stages. Based on this information, the firefighting staff can be guided on target to block the fire before it reaches cultural heritage sites and to suppress it quickly by utilizing the required firefighting equipment and vehicles.

2.1.4 AN IOT BASED FOREST FIRE DETECTION AND PREVENTION SYSTEM USING RASPBERRY PI 3

Outcome of the paper

We have designed a system for Forest Fire Detection which overcomes the limitation of the Existing technologies of Forest Fire Detection. In this work, we have developed a system which can reduce catastrophic events caused due to fire. This system detects the Wildfire as early as possible before the fire spreads over a large area and prevents poaching.The system is designed and executed. The inputs flame sensor, PIR sensor and Humidity sensor are used to detect fire, and intruder and measure temperature levels respectively. When abnormal situation occurs it will send alert message and the Web Camera is used to capture the picture and the captured picture is sent to email via Wi-Fi. Buzzer is activated when the fire is detected.

2.2 Proposed System

The System is mainly based on Arduino Uno andRaspberry Pi whichworks on C++ and python programming respectively. ArduinoUno controls sensors like Temperature and humidity sensor, proximity sensor and gas sensor while Raspberry Pi controls IR sensor and Pi camera. When it comes to green level monitoring, Image processing will do its task. For image processing purpose python programming is used. Image processing is coupled with Raspberry pi and forest fire detection is coupled with Arduino. The object detection is used for detecting humans and saw in order to prevent tree theft.

SYSTEM REQUIREMENTS SPECIFICATION

3.1 Purpose

The objective of this system is to build all in one monitoring system that utilizes long range, low power consumption device LoRa for transmission of data acquired from different ecology monitoring sensors to the forest control room.It also uses object detection process for detecting saw machine which is used for tree theft.This device alerts the officer about forest fire or human intervention in forest as the device monitors continuously.This system helps in automating the monitoring system which was manually done earlier.

3.2 Hardware Requirements

- Raspberry Pi2
- Raspberry Pi Camera Module
- Micro SDCard.
- Arduino Uno
- Battery/ solar panel
- Breadboard
- LoRaWAN
- Proximity sensor
- Gas sensor
- Temperature and Humidity Sensor
- IR sensor
- ESP8266

Raspberry Pi 2 Model B

The **Raspberry Pi 2** Model B in an updated version with more RAM, a much better processor, more USB ports and a larger GPIO header.

Figure 1: Raspberry Pi 2 Model B

The specification of Raspberry Pi 2 are as follows

- Broadcom BCM2837 Arm7 Quad Core Processor powered Single Board Computer running at 900MHz
- 1GB RAM
- 40pin extended GPIO
- 4 x USB 2 ports
- 4 pole Stereo output and Composite video port
- Full size HDMI
- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- Micro SD port for loading your operating system and storing data
- Micro USB power source

Raspberry Pi Camera Module

Figure 2: Raspberry Pi Camera Module.

From its first launch the Raspberry Pi has had a connector on it to attach a camera to the GPU (the Video Core 4 Graphics Processing Unit on the Raspberry Pi) [9]. This connection uses the CSI -2 electrical protocol and is a standard used in most mobile phones. It is an extremely fast connection, which on the Raspberry Pi is capable of sending 1080p sized images (1920x1080 x10bpp) at 30 frames per second, or lower resolution at even higher frame rates.

Micro SD card

Figure 3: Micro SD card.

The micro SD card is a key part of the Raspberry Pi, provides the initial storage for the Operating System and files. Storage can be extended through many types of USB connected peripherals. 16 GB SD card is used for our Project.

Arduino Uno

The **Arduino UNO** is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.

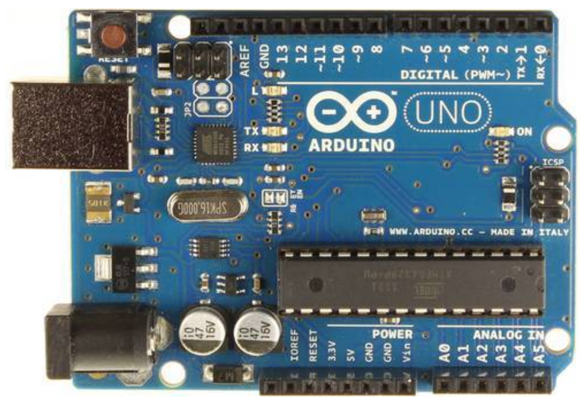

Figure 4: Arduino Uno

Features of the Arduino UNO:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

Solar panel

Powering your **Pi** using **solar power** will allow you to build green **Pi** projects **powered** by the sun. And with the right **solar panel** and battery, your project can also run continuously, forever.

Figure 5: solar panel

IR sensor

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion.These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor.

Figure 6: IR sensor

Temperature and Humidity Sensor

A Temperature and Humidity sensor senses, measures and reports both moisture and air temperature. DHT11 is used for the purpose. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed).

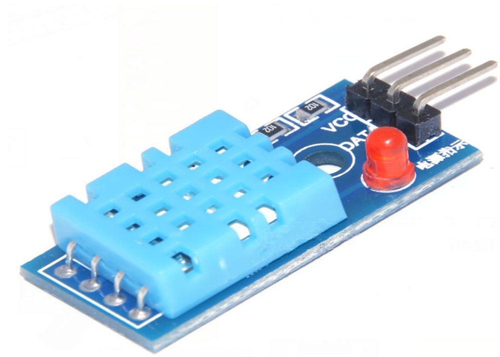

Figure 7: DHT11 sensor

Breadboard

A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate.

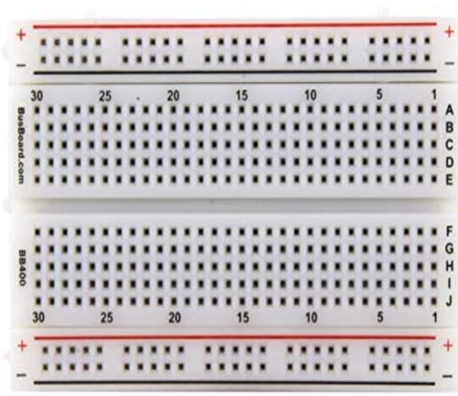

Figure 8: Bread board

LoRaWAN

LoRaWAN, also known as LPWAN, stands for low power, wide area network. It is the global de-factor standard for the Internet of Things (IoT). LoRaWAN is the foundation of the LoRa Alliance.

Figure 9: LoRa WAN

Proximity sensor

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal.

Figure 10: proximity sensor

Gas sensor

Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion.

Figure 11: Gas sensor

ESP8266

The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

Figure 12: ESP8266

3.3SoftwareRequirements

- Raspbian OS
- MQTT
- Tensor Flow
- Open CV
- Arduino Uno Language(C/C++)
- Python
- ThingSpeak

Raspbian OS

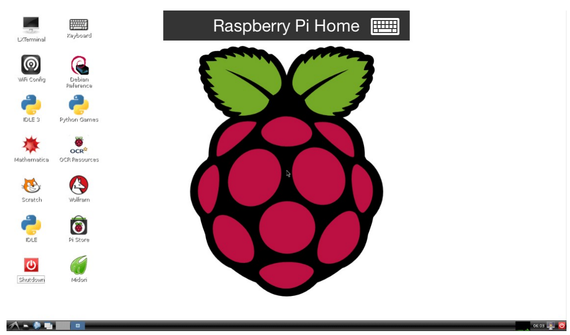

Figure 13: TheRaspbian Desktop

Although the Raspberry Pi's operating system is closer to the Mac than Windows, it's the latter that the desktop most closely resembles

It might seem a little alien at first glance but using Raspbian is hardly any different to using Windows (barring Windows 8 of course). There's a menu bar, a web browser, a file manager and no shortage of desktop shortcuts of pre-installed applications.

Raspbian is an unofficial port of Debian Wheezy arm with compilation settings adjusted to produce optimized "hard float" code that will run on the Raspberry Pi. This provides significantly faster performance for applications that make heavy use of floating point arithmetic operations.

All other applications will also gain some performance through the use of advanced instructions of the ARMv6 CPU in Raspberry Pi.

Although Raspbian is primarily the efforts of Mike Thompson (MP Thompson) and Peter Green (plug wash), it has also benefited greatly from the enthusiastic support of Raspberry Pi community members who wish to get the maximum performance from their device.

MQTT

Figure 14: MQTT

MQTT stands for MQ Telemetry Transport· It is a publish/subscribe, extremely simple and lightweight messaging protocol, designed for constrained devices and low-bandwidth, high-latency or unreliable networks. The design principles are to minimize network bandwidth and device resource requirements whilst also attempting to ensure reliability and some degree of assurance of delivery. These principles also turn out to make the protocol ideal of the emerging ―machine-to-machine‖ (M2M) or ―Internet of Things‖ world of connected devices, and for mobile applications where bandwidth and battery power are at a premium.

Tensor Flow

Figure 15: Tensor Flow and content.

Currently, the most famous deep learning library in the world is Google's Tensor Flow. Google product uses machine learning in all of its products to improve the search engine, translation, image captioning or recommendations.

To give a concrete example, Google users can experience a faster and more refined the search with AI. If the user types a keyword in the search bar, Google provides a recommendation about what could be the next word.

Google does not just have any data; they have the world's most massive computer, so Tensor Flow was built to scale. Tensor Flow is a library developed by the Google Brain Team to accelerate machine learning and deep neural network research.

It was built to run on multiple CPUs or GPUs and even mobile operating systems, and it has several wrappers in several languages like Python, C++ or Java.

OpenCV

Figure 16: OPENCV

OPENCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library ·OPENCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OPENCV makes it easy for businesses to utilize and modify the code.

The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms.

These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc.

OPENCV Structure and Content

OPENCV can be broadly structured into five primary components, four of which are shown in the figure 3.15. The CV component contains mainly the basic image processing and higher-level computer vision algorithms; MLL the machine learning library includes many statistical classifiers as well as clustering tools. High GUI component contains I/O routines with functions for storing, loading video & images, while CX Core contains all the basic data structures and content.

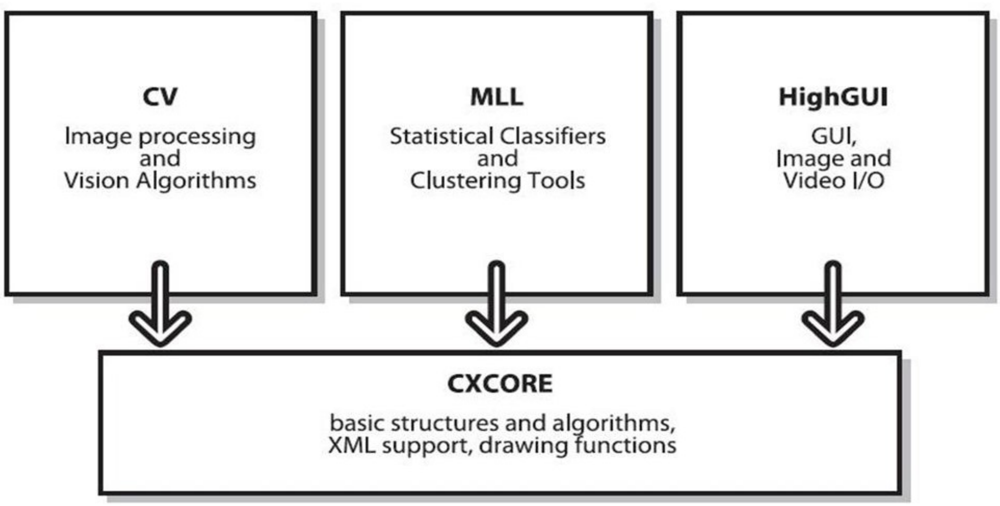

Figure 17: Structure of OPENCV and content.

Why OPENCV?

1. Specific

OPENCV was designed for image processing. Every function and data structure has been designed with an Image Processing application in mind. Meanwhile, MATLAB, is quite generic. You can get almost everything in the world by means of toolboxes. It may be financial toolboxes or specialized DNA toolboxes.

2. Speedy

MATLAB is just way too slow. MATLAB itself was built upon Java. Also Java was built upon C. So when we run a MATLAB program, our computer gets busy trying to interpret and compile all that complicated MATLAB code. Then it is turned into Java, and finally executes the code.

If we use C/C++, we don’t waste all that time. We directly provide machine language code to the computer, and it gets executed. So ultimately we get more image processing, and not more interpreting.

After doing some real time image processing with both MATLAB and OPENCV, we usually got very low speeds, a maximum of about 4-5 frames being processed per second with MATLAB. With OPENCV however, we get actual real time processing at around 30 frames being processed per second.

Sure we pay the price for speed – a more cryptic language to deal with, but it’s definitely worth it. We can do a lot more, like perform some really complex mathematics on images using C and still get away with good enough speeds for your application.

3. Efficient

MATLAB uses just way too much system resources. With OPENCV, we can get away with as little as 10mb RAM for a real-time application. Although with today’s computers, the RAM factor isn’t a big thing to be worried about. Thus we can see how OPENCV is a better choice than MATLAB for a real-time system.

Python

Figure 18: Python

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossumand first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales.

Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object oriented, imperative, functional and procedural and has a large and comprehensive standard library.

Python interpreters are available for many operating systems.CPython, the referenceimplementationof Python, is open source software and has a community-based development model, as do nearly all of its variant implementations. CPython is managed by the non-profit Python SoftwareFoundation.

ThingSpeak

ThingSpeak is an open data platform for the Internet of Things. Your device or application can communicate with ThingSpeak using a RESTful API, and you can either keep your data private, or make it public. In addition, use ThingSpeak to analyze and act on your data.

3.4 Functional Requirements

- The Pi camera is mounted on the tree and it should be able to click pictures.
- The aurdinouno connected with sensors must be able to sense the data.
- The system should be subscribed to a topic to which the live stream video is published my MQTT.
- On receiving the image, the system will run the object detection algorithm
- The algorithm generates the Id, class and coordinates of the image.
- The aurdino Uno is subscribed to the server (thingspeak) which receives the string of sensor data published my MQTT.
- The web application must be connected to the thingspeak server in order to display live data through visualization.

3.5Use Cases

Forests are the precious natural resources which provide us wood, timber tree, human living essentials and it is the place where flora and fauna live. It helps in balancing the eco system.In order to retain the forest protection is important.The device being automatic which monitors the ecology of the forest and reports the variations and movements in the forest which are which is harmful to the forest. This helps the humans to continuously monitor the forest which cannot be done manually.

Acceptance Criteria

- Object is detected based on the images given to the trained model.
- Detected object is within a bounding box provided and should be tracked.
- Object Detected and Object Tracked should be continuously live streamed to the forest control room personnel.
- The green cover is monitored continuously by calculating green pixel count every minute.
- The temperature and gas sensor senses the data continuously and sends it through long rangewifi module.

Dependencies

Number of images provided for training the model to detect tree cutting machinery.

Risk/Suggestions

- During the design and programming stages,mechanical part failure is not always taken into account.
- Power sources that have communication to the device can be disrupted and lead to undesired actions.
- The camera maybe blocked by birds or other animals which leads to hindrance in image capturing.
- The wiring and connections made inside the device are not long lasting due to various forest conditions.

3.6 Non –Functional Requirements

Accuracy

The device should be able to sense ecology data accurately.The captured image must undergoprocessing and determine the objects that has to be detected correctly. The rate of accuracy must be high to reduce false alerts.

Look and Feel

The look and feel of the device should be simple and portable. All the components must be assembled neatly. The wiring and power supply has to be done efficiently as the device may undergounusual environmental conditions.

Security

As the commands are made through MQTT,Authentication is part of the transport and application level security in MQTT. With Transport Layer Security (TLS), the successful validation of a client certificate is used to authenticate the client to the server. On the application level, the MQTT protocol provides username and password for authentication.

Network

The requirement for proper network is essential for exchange of information and data transfer. As the device is deployed in forest, regular network and regular data transmission methods are useless and this leads to inefficiency in device analyzation.

3.7 User Characteristics

1. There is always a single user who is monitoring the information from the device.

2. The device will continuously sends the data accurately and the user can view different system at any point of time.

SYSTEM DESIGN

4.1Architecture

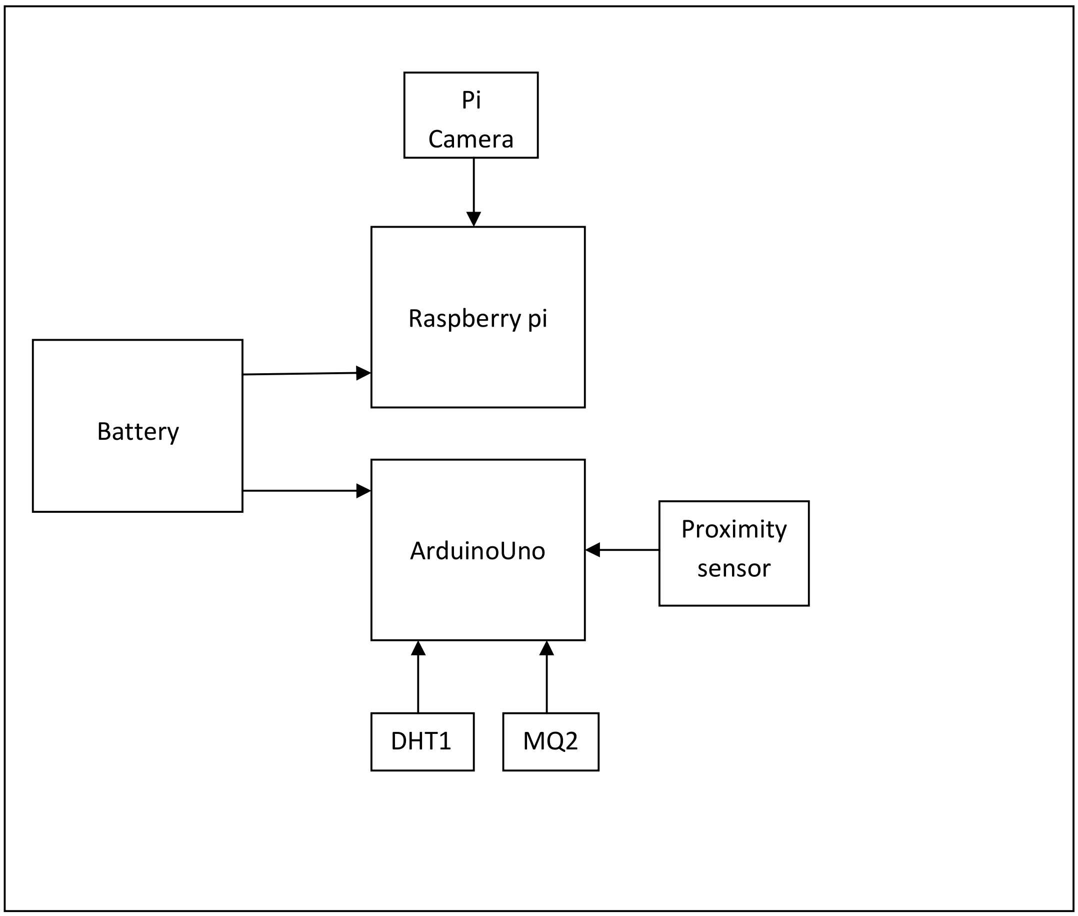

Figure 19: Architecture of proposed system

The device consists of Raspberry pi 2, ArduinoUno,MQ2sensor, DHT11 sensor, Pi Camera module and Proximity sensor and battery source. The temperature,humidity and gas data are collected from respective sensors through Arduino. The pi camera is used for capturing video feed for image processing to perform object detection.

4.2 Design of the Proposed System

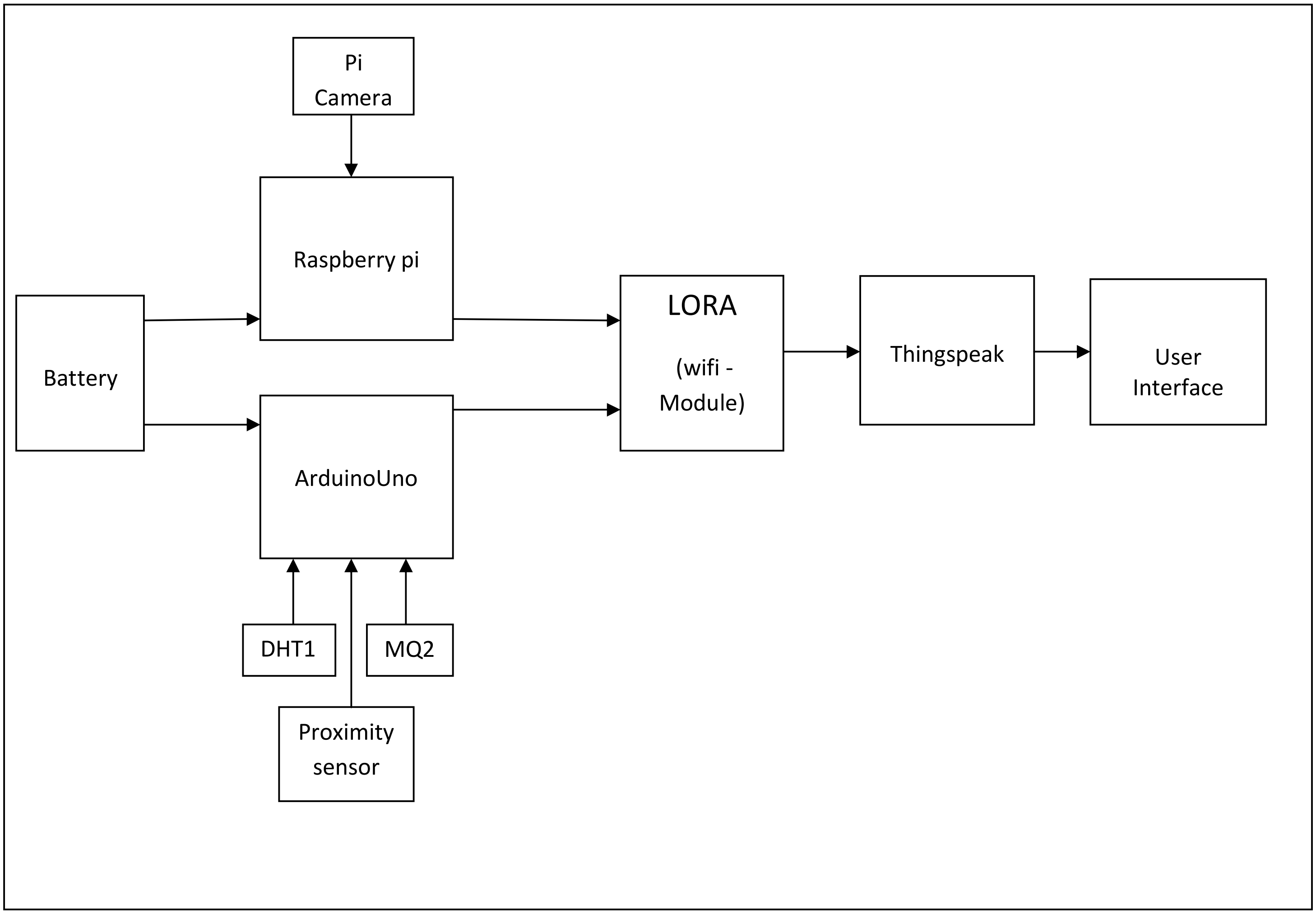

Figure 20: Design of proposed system

Figure 4.2 shows how the proposed system is designed.The data generated by the device is transferred through Lora Wifi module to the server i.ethingspeak.The channels in thingspeak are admin generated which is used for analyzation and visualization purpose.The date is interpreted in the webpage used by user for monitoring the forest.

4.3 Sequence Diagrams

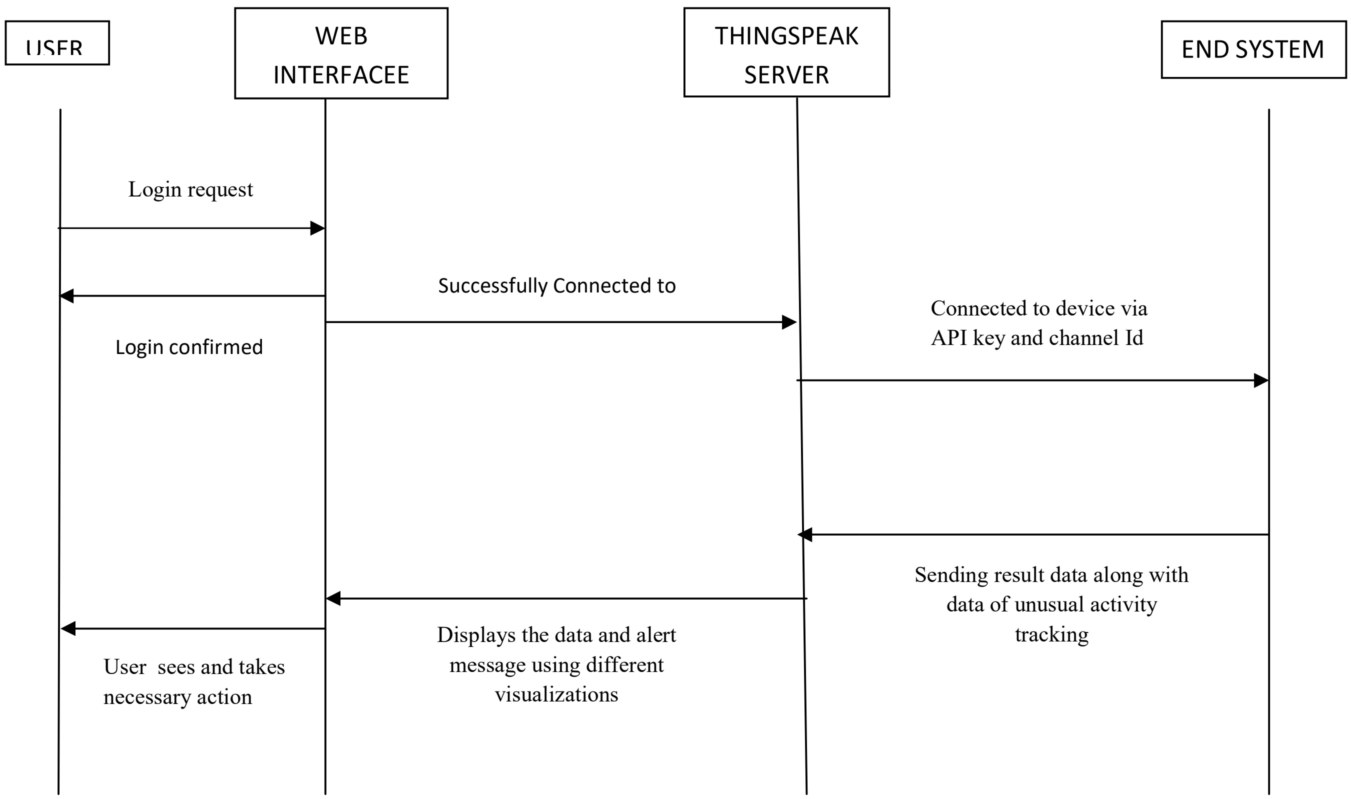

Figure 21: is the use sequence diagram of the user-web application

The above figure shows the data flow sequence of the following modules

- User
- Web application
- Thingspeak server
- End system

The first step is user login, after the successful login the use will be redirected to the home page of the web application where he can view the respective module details. The thingspeak server and the end system is connected with API keys and channel Id. The result data along with alert message are sent to the server which displays the data using different visualization in the web application page. The user sees the alert and perform necessary actions.

4.4 Use CaseDiagrams

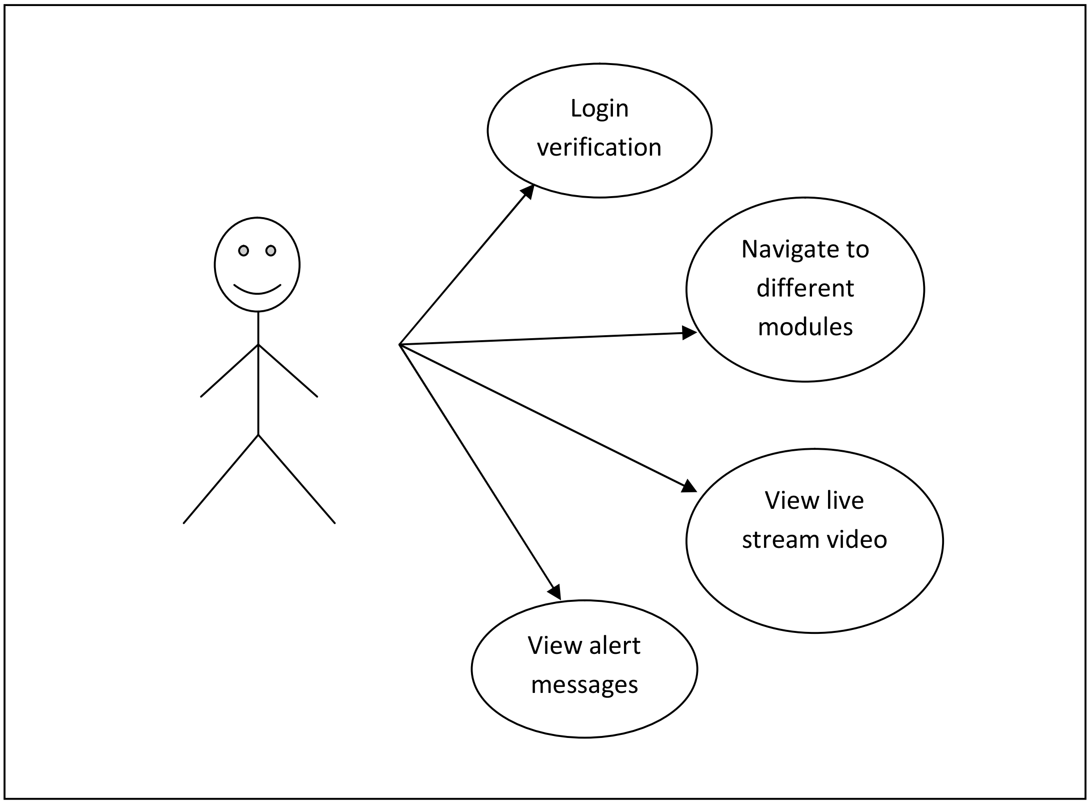

Figure 22: is the use case diagram of the user-web application

Figure 4.4 represents the use case diagram of the user using web application. The user can perform the following operation:

- User will use his credentials for logging in.
- User can navigate to specified devices or fields for results.
- User can view data from different sensors.
- User can opt for live streaming.
- User can view status and alert messages.

IMPLEMENTATION

5.1 Module 1– Device

5.1.1 Module 1a – Raspberry Pi

- The one part of the device is made up of raspberry pi2 model.

- The raspberry pi is connected with a camera module which is to capture image or video.The following are the tasks done by raspberry pi:

  1. The raspberry pi is used for image processing.Image processing is done to implement object detection.

  2. The raspberry pi is installed with required libraries and software.

  3. The code for object detection is uploaded.

  4. The code performs following actions.

     - The pi builds the authorized connection with the server i.ethingspeak.
     - The pi cam starts capturing video on boot.
     - The object detection module in raspberry pi detects different classes of objects like human,tree and saw.
     - The results and live video stream is transmitted through wifi to thingspeak through respective channel.

5.1.2Module 1b – ArduinoUno

- The one part of the device is made up of ArduinoUno model.

- The ArduinoUno is connected with a DHT11,MQ2 and Proximity sensor which is to sense temperature, humidity and gas molecules data respectively.The following are the tasks done by Arduino:

1. The ArduinoUno is used for sensing various parameters.

2. The ArduinoUno is installed with required libraries and software.

3. The code for sensing data is uploaded.

4. The code performs following actions.

   - The ArduinoUno builds the authorized connection with the server i.ethingspeak.
   - The Arduino starts to sense data on boot.
   - The sensed data is transferred to thingspeak with secured connection.
   - The data is analyzed for hazardous alerts.

5.2 ChallengesFaced

5.2.1 Device

- Managing to supply power continuously.

  The working of device requires continuous power supply. As using battery is inefficient because the device requires large amount of power supply, we used power bank which is rechargeable. But efficient solution for this issue is using of solar panel.

- Finding a efficient camera module for better quality.

  The tree theft and green cover monitoring requires image processing where the image is captured by raspberry pi. Good quality of picture is required for efficient and accurate calculation/detection. So we used 12mp pi camera module instead of 5mp.

- Organizing the sensors and extracting data from it through a single program.

  Running multiple program simultaneously for various functions and receiving data from each program and organizing is a complex task and its inappropriate. So integrating all function in a single program where each output is represented in order for neat presentation and easy access is a good option.

- Using efficient object detection module for accurate detection.

  As the project stresses on object detection we need a efficient and high power detection module for accurate detection.It shouldn't consume much space as raspberry pi is a micro controller. So we used mobilenetssd model which is light weight and efficient.

- Transferring the live stream video to remote device through long range networking.

  Live streaming of data increases efficiency.But raspberry pi can transfer data to another system which are in same network. We used socket programming for this process.But there is delay.But to transform the data to remote device which is not of network is a complex task.

- Keeping the device and the processing system in the same network.

  Raspberry pi 2 model doesn't have a onboard wifi model. And it can send wireless data only for the devices which are present in same network.So keeping the end device and the system in same network is difficult. We used wifi for testing device. For long range transmission we are using LoRa.

5.2.2 Mobile application

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- Creating multiple dynamic updating user interface module.

  The live data generated which is not only about single module. Different sensors and different image processing modules generates multiple output and each has to be accessed and represented separately. We used thingspeak module where each output can be sent to sever separately and represented in the web page.The updating process of data in web page is dynamic.

- Having stable internet connection to have flawless data visualization.

  Data connection is must because we are transferring and receiving data almost continuously.We were initially using wifi which is fast . But in forest we cannot access wifi so we are using LoRa.

- Implementation of web page that is accessible with various types of browser.

  Web application created for the data representation must be accessible through any device and browser. So in order to achieve this a web domain is hosted and suitable code is dumped to it. So that by using that url it is accessible through any device.

- Making secured connection to access data from thingspeak.

  The data is transferred and sometimes stored in thingspeak sever. But the data which is there in thingspeak must only be accessible for the respective forest department or control room. So the created channel must be password protected and it should be hidden for public view. Its only accessible by one person with proper credentials.

TESTING

6.1 UnitTesting

1. Unit testing is a software development process in which the smallest testable parts of an application, called units, are individually and independently scrutinized for proper operation.
2. Therefore the device is being tested and scrutinized with all its modules and units separately and has passed all tests well and fine.

6.2 IntegrationTesting

Integration testing (sometimes called integration and testing, abbreviated I&T) is the phase in software testing in which individual software modules are combined and tested as a group. Therefore the device is divided by interface, aurdino section and raspberry pi section. These sub systems when combined together works efficiently and with accuracy and is being tested well.

6.3 TestCases

TEST CASE NO: 01	**TEST CASE NAME:** Validation check
INPUT: Giving wrong credentials as input.	
OUTPUT: Wrong USERNAME of PASSWORD.	
RESULT: PASS	

TEST CASE NO: 02	TEST CASE NAME: Checking working of device.
INPUT: Circuit connection is broken to check if the device generates automatic alert about system/circuit failure.	
OUTPUT: System/circuit failure alert is not received.	
RESULT: FAIL	

TEST CASE NO: 03	TEST CASE NAME: Checking working of raspberry pi.
INPUT: Covering camera to observe dark or updated image.	
OUTPUT: Dark or blocked image is observed.	
RESULT: PASS	

TEST CASE NO: 04	TEST CASE NAME: Checking of working of Arduino and sensors.
INPUT: Lighting matches/burning a piece of paper.	
OUTPUT: Observed variation in temperature and gas data.	
RESULT: PASS	

TEST CASE NO: 05	**TEST CASE NAME:** Checking if the data is transferred to server /thinspeak.
INPUT: Lighting matches/burning a piece of paper.	
OUTPUT: Observed variation in temperature and gas data in thingspeak graph visualization.	
RESULT: PASS	

TEST CASE NO: 06	**TEST CASE NAME:** Connection to the device
INPUT: Giving various inputs to the device.	
OUTPUT: Variation in data graph and video streaming in web page is observed.	
RESULT: PASS	

RESULTS

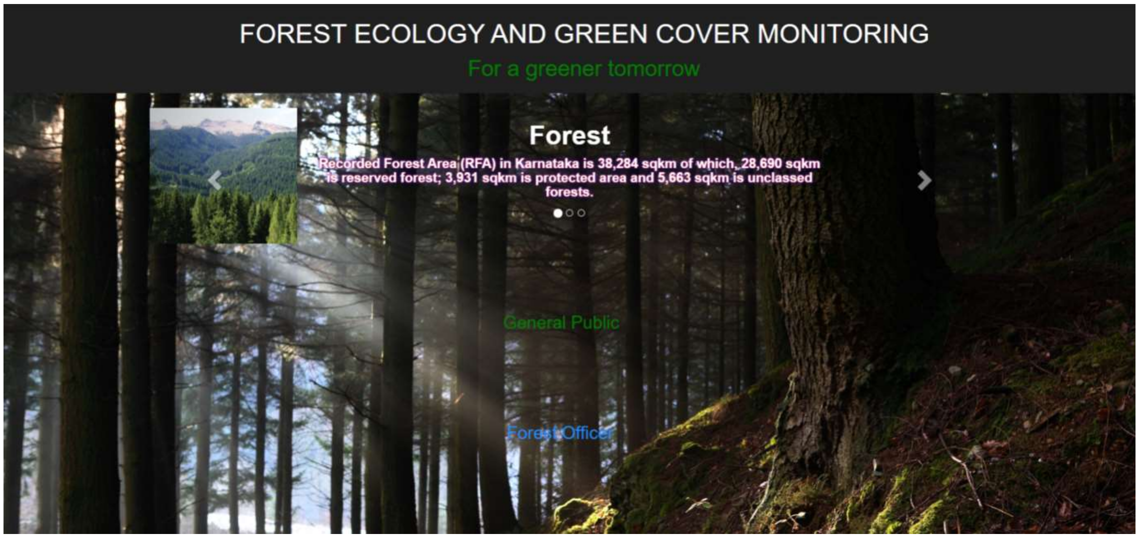

Figure 23 : This is the home page of web application we have made for this project.

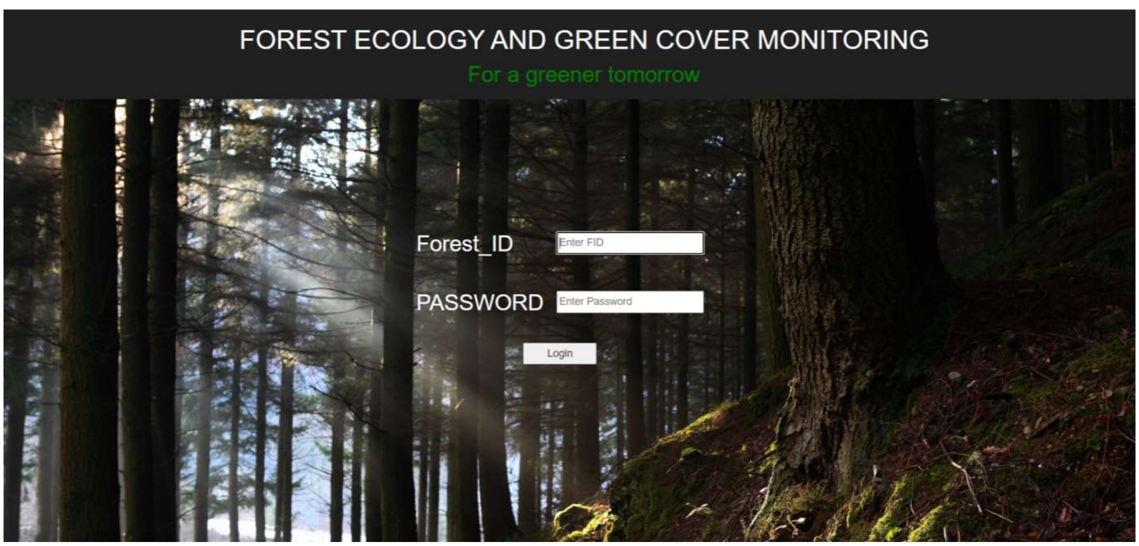

Figure 24 :The login page format for the forest officer to login for monitoring the results.

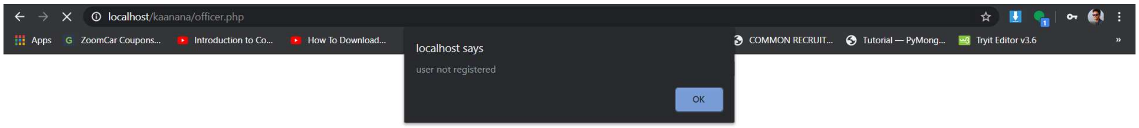

Figure 25 : After successful login we get a login successful or confirmation message.

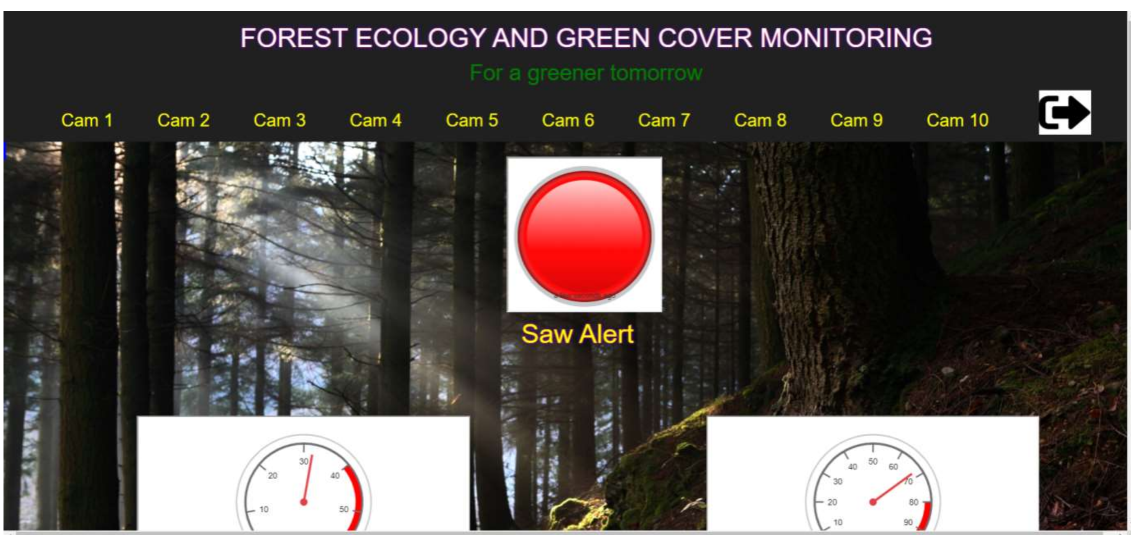

Figure 26: The alert lamp visualization which glows for 15 seconds whenever saw is detected.The camera module is used for continuous monitoring to avoid tree theft. This includes detection of person and tree cutting tools like saw.The object detection module detects saw and send alert message. This alert message is represented by lamp in our web page.

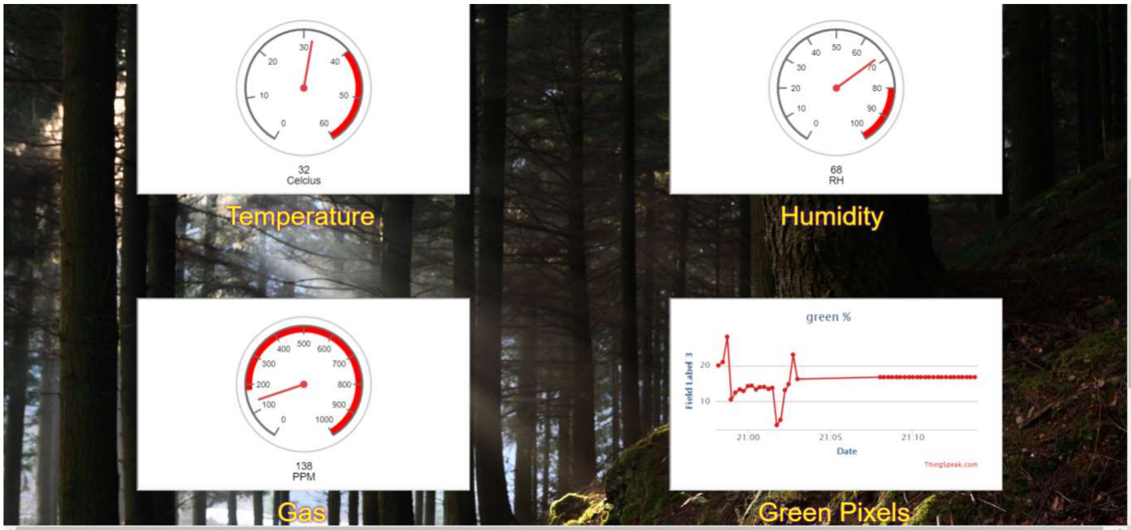

Figure 27: The first 3 visuals is the results of temperature and humidity sensor read by DHT11 sensor and gas data read by MQ2 sensor respectively.The 4th visual that is green pixel graph represents green level in the forest which is acquired every minute. The data is read and transmitted with equal interval of time. The red zone in the first 3 visuals represents the risk values which requires immediate attention. All risk values are computed based on the regional environment conditions.

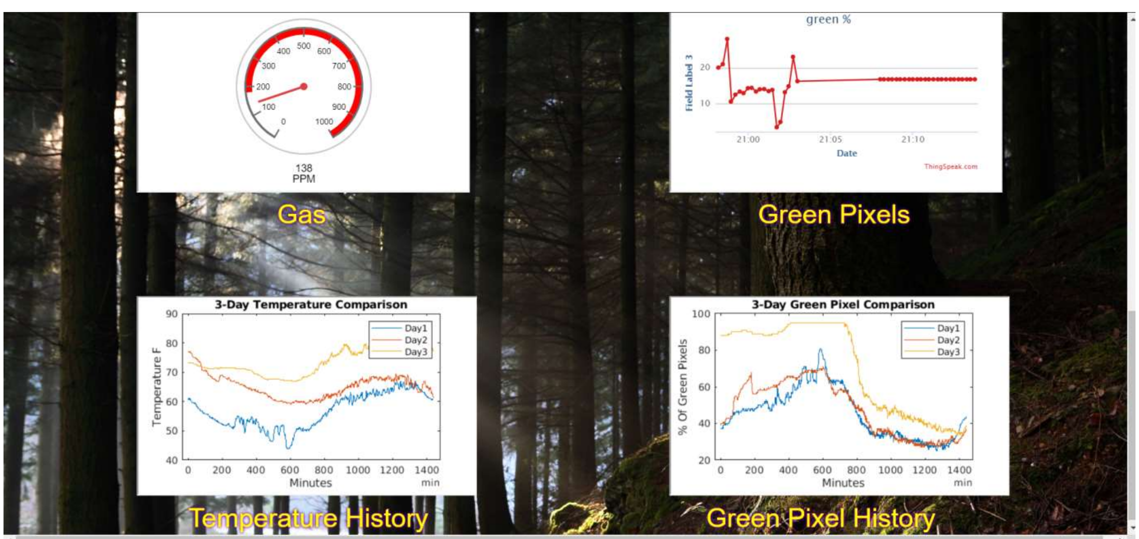

Figure 28: In order to keep track of temperature and green cover history, regular comparison graph is generated. This graph automatically compares data of previous days in order to

depict variations. This is helpful to analyze depletion or improvement in green cover over the days.

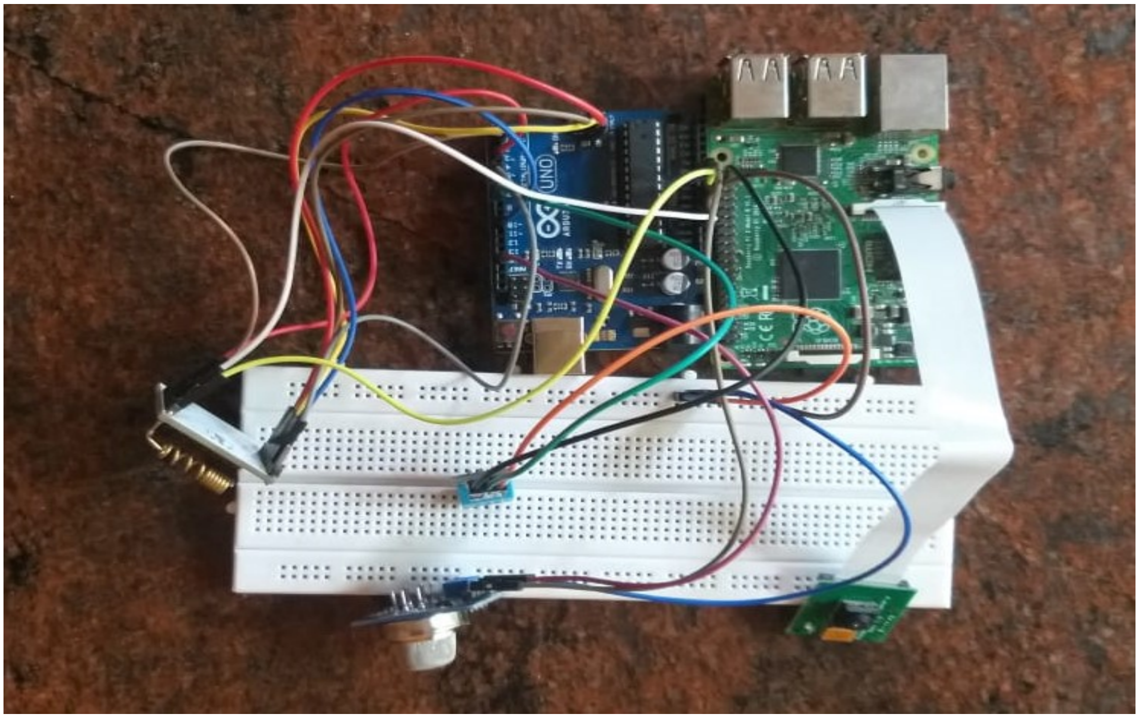

Figure 29 : Circuit connection of device. The device consists of Arduino Uno,DHT11,MQ2,Raspberry pi, Pi camera and jumper wires.

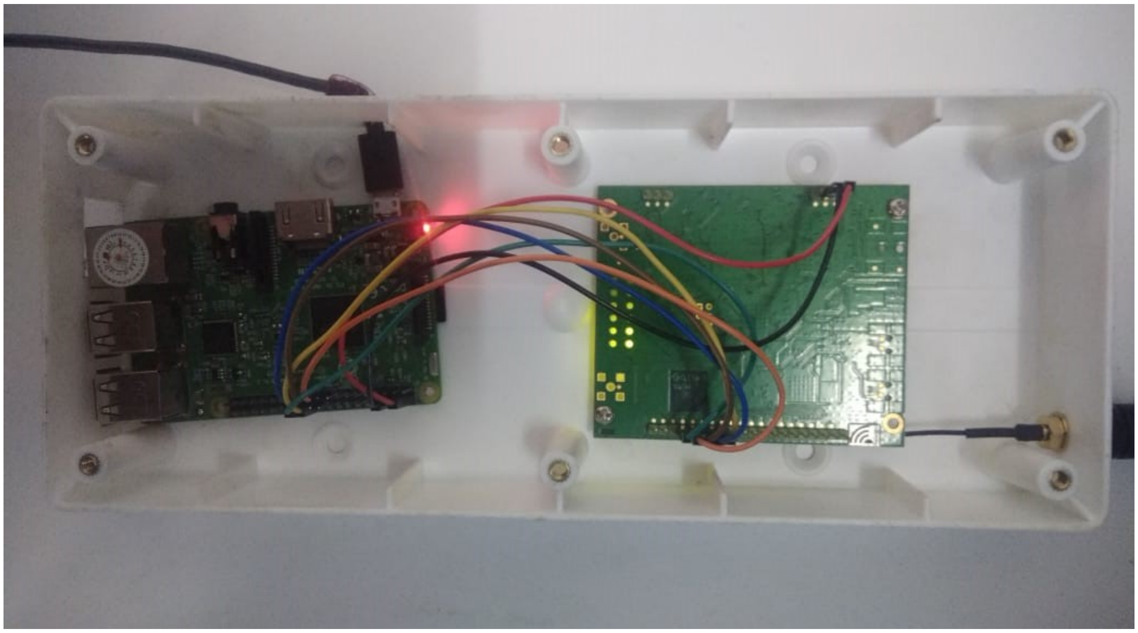

Figure 30 :The LoRa Module circuit connection

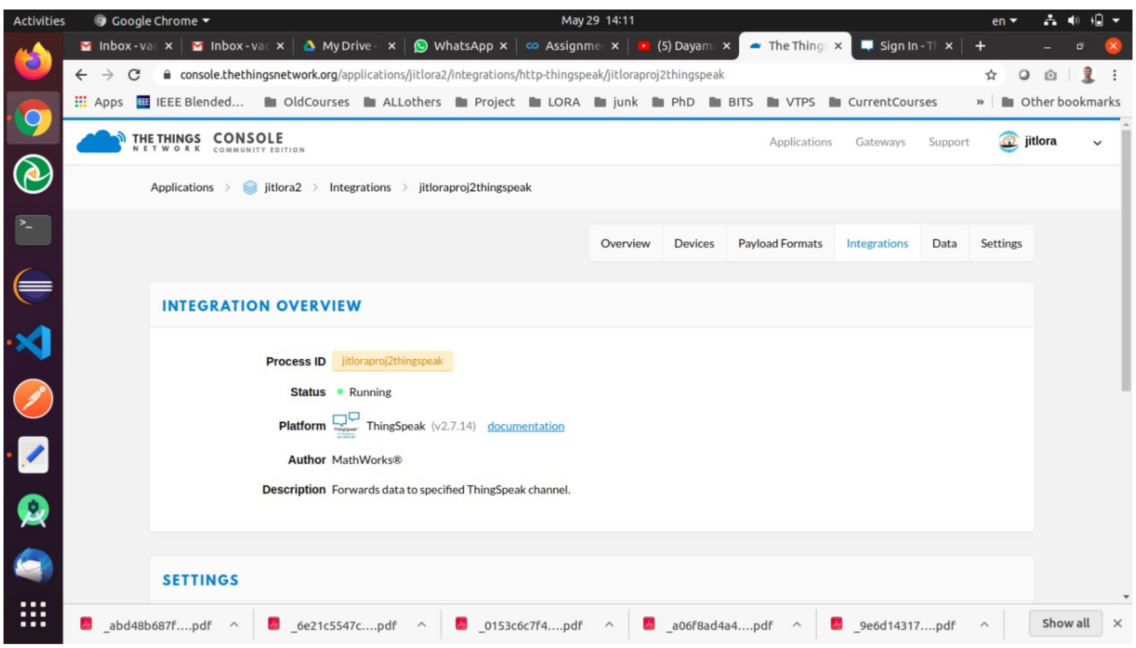

Figure 31 :Integration overview represents the connection to external transformation of data to external platform. Inour case it is Thingspeak. The status will show if the transmission is active or not.

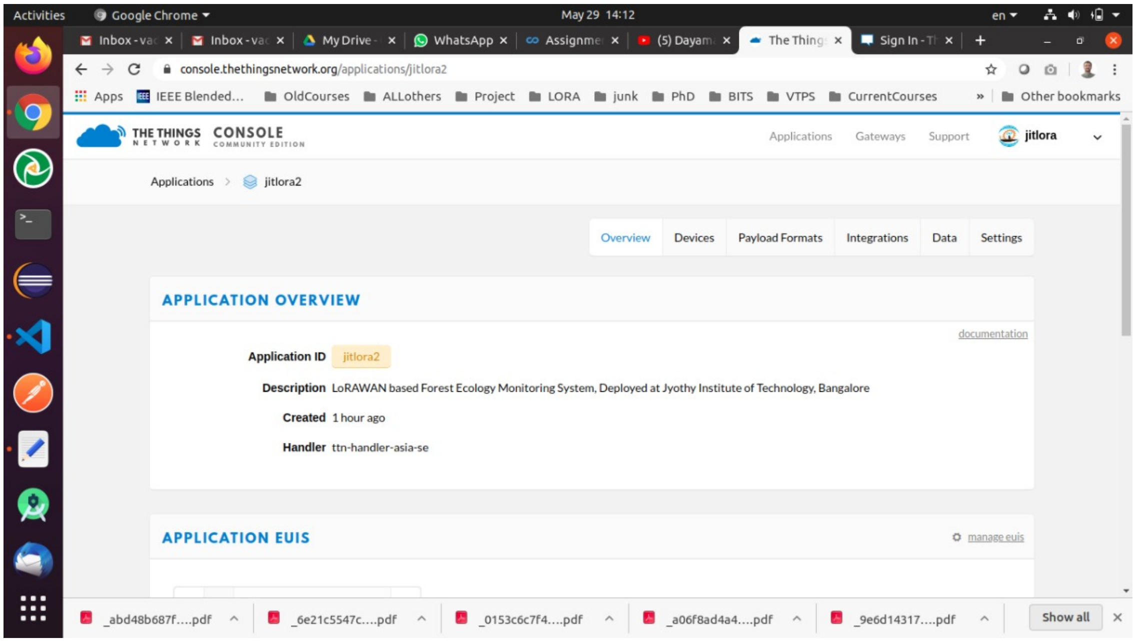

Figure 32 :The application overview represents the system that is using lora network, creation of the channel and the handler.

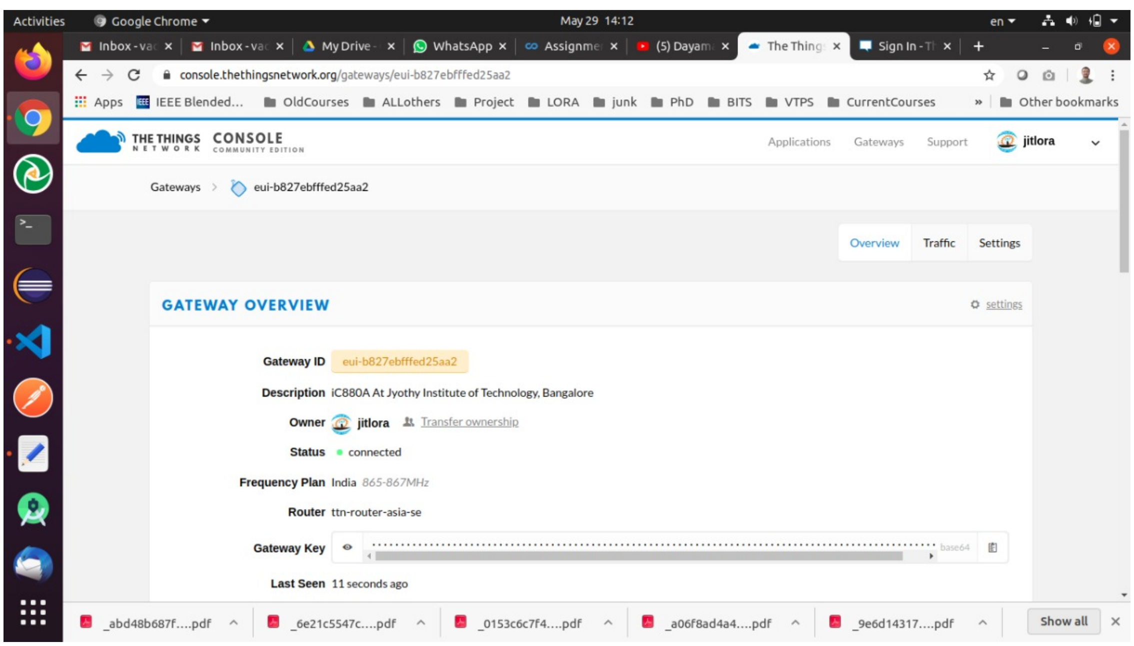

Figure 33 :The gateway overview give the necessary credentials like gateway id, gateway key which is used in code for data transmission.

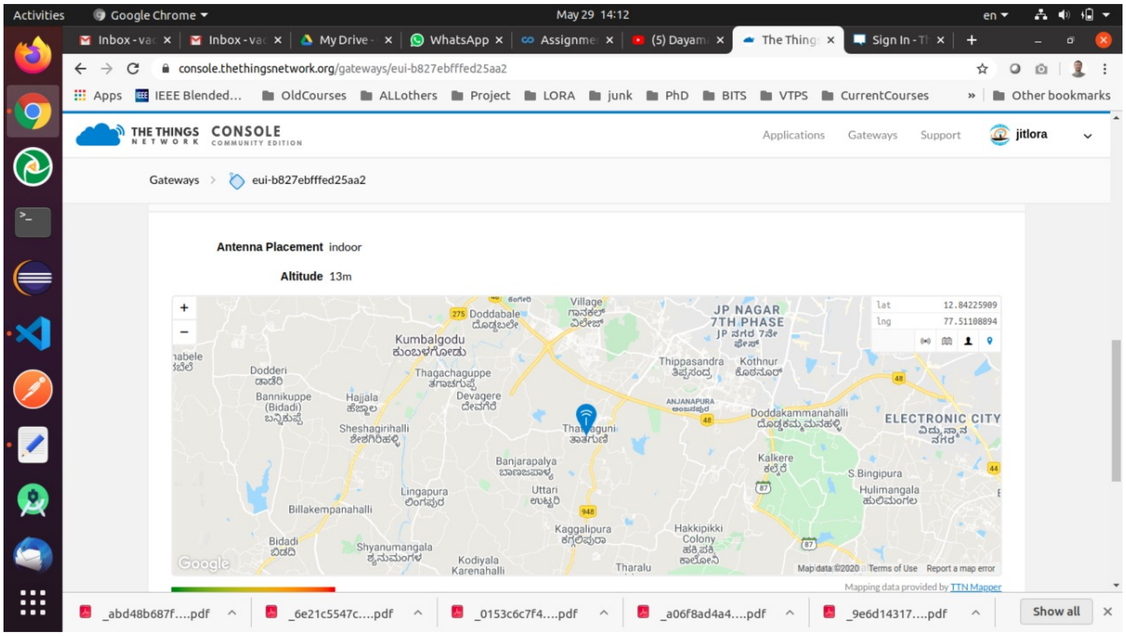

Figure 34 :The antenna placement location description.

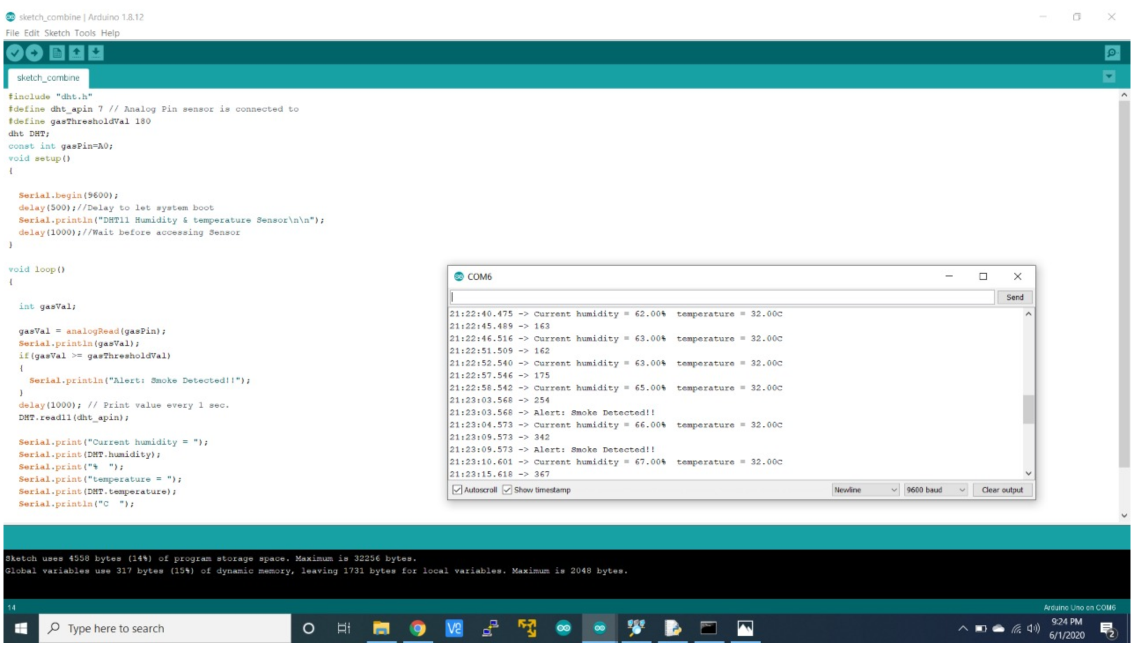

Figure 35 :The temperature, humidity and gas data printed on console. The alert gas is detected comes up when the value crosses threshold value.In here the alert is obtained when we tried to burn paper to check sensor working.

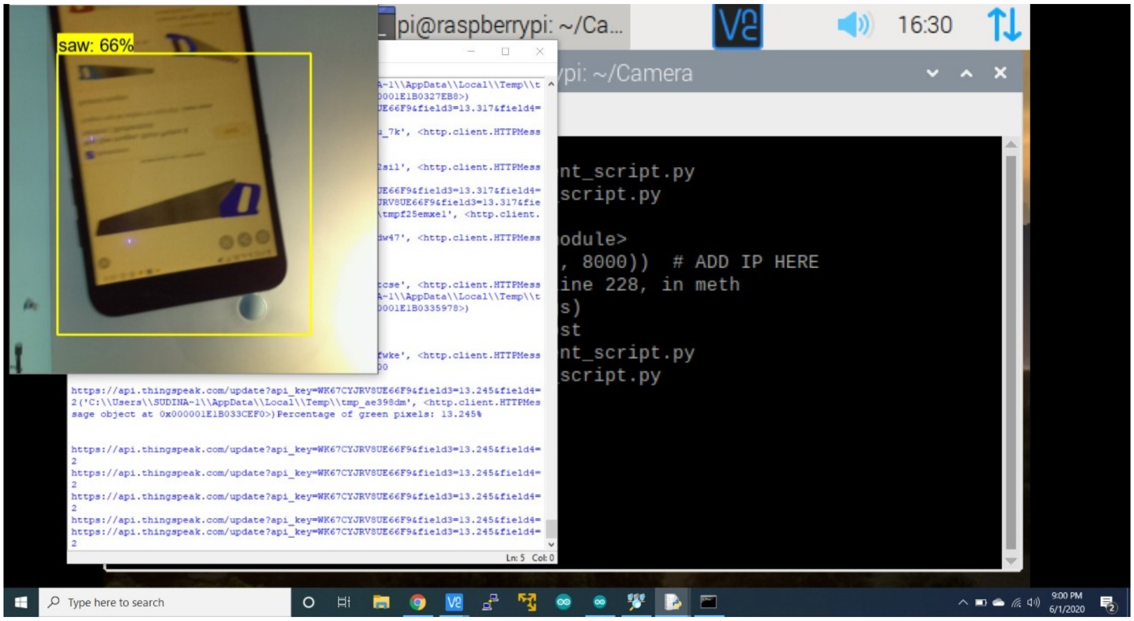

Figure 36 :This image represents the results of object detection. We trained a model to detect basic tree cutting machine saw. This is the result when we showed a saw image to camera.

FUTURE ENHANCEMENTS

Though the claim has been made that a Smart module has been developed to protect trees, future enhancements are required to make the system more rugged.

- The Units / Hardware / Sensors have to be rugged.
- To use solar panel for regular power supply.
- Creating an alert if the system components/circuit fails.
- Suitable enclosure has to be made.
- The Module should be placed in untraceable place on trees, not easily accessible to tree-destructors.
- Forest Authorities has to be suitably educated.

CONCLUSION

We have designed a system, an IOT based forest fire detection which is implemented using Raspberry pi and Aurdniouno. So when the temperature and the flame gets increased alarm will be activated. We have designed a system for Forest Fire Detection which overcomes the limitation of the Existing technologies of Forest Fire Detection.

In this work, we have developed a system which can reduce catastrophic events caused due to fire. This system detects the Wildfire as early as possible before the fire spreads over a large area and prevents poaching. We also proposed IOT based forest green level monitoring using image processing which is also implemented by Raspberry pi.

Continuous monitoring of green level tells us about the health of the forest. It is also also used to alert the forest officers about any human interventions like, tree theft, animal pouching etc. This is done by human activity monitoring algorithm which gives human count and activity perception.

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