IOT Based Forest Saftey Alert System on Disasters with Intruder Detection

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Abstract -The most frequent danger in forests, forest fires seriously devastate the forest's richness, biodiversity, and natural environment. To safeguard forests from fires, early identification and preventive actions are required. There are two conventional ways of human surveillance that are most frequently utilised to accomplish early identification of these issues. Direct human monitoring is one method, while remote video surveillance is another. When doing distant observation, one can implement detection automation to achieve surveillance. This project's primary goal is to develop a real-time monitoring and warning system for fire detection, animal movement detection, and human infiltration detection in forest regions and along borders. The Raspberry Pi Pico microcontroller board, the ESP8266 WiFi module, and other components are used in this system. A 16x2 LCD display with an LCD I2C module, an infrared flame sensor, a MQ2 smoke sensor, a microphone sound sensor, a DHT11 temperature and humidity sensor, a NEO-6M GPS module, and a 5V mini buzzer.

The system also makes use of a camera and the object detection framework known as YOLO (You Only Look Once). The Personal computer will be used in the implementation as the main processing device. This board links a GPS module with serial data transmission to identify objects. By enabling wireless connectivity, the ESP8266 WIFI module enables the system to send the gathered data to a central server or cloud platform for additional analysis. To track forest conditions like fire breakouts and odd sounds, this module connects to a variety of sensors, including the infrared flame sensor, MQ2 smoke sensor, and microphone sound sensor. patterns. Environmental information is provided in real-time via the DHT11 temperature and humidity sensor. Accurate mapping and monitoring of forest regions are made possible by the NEO-6M GPS module, which gives exact position data. A camera that records pictures and movies of the forest is connected into the system to increase its capabilities. To analyses the visual data and identify various things of interest, such as animals or suspicious activity, the YOLO object identification framework is used. For the purpose of providing a user-friendly interface for real-time data visualisation, the LCD I2C module and 16x2 LCD display are used. The system shows crucial data on the LCD screen, such as temperature, humidity, identified objects, and GPS positions. The 5V tiny buzzer is activated in crucial circumstances, such as fire breakouts or possible threats. provide loud warnings that quickly alert authorities or forest rangers. A complete real-time monitoring, analysis, and alerting system is offered by the proposed IoT-based forest monitoring system.

Index Terms— **LCD, GPS, IoT, WIFI, Cloud, transfer learning, YOLO algorithm.**

I. INTRODUCTION

This chapter provides an overview of the report's state-of-the-art field. It also explains why this project is being done and briefly describes the report's format. A sophisticated technology called a forest monitoring system employs a variety of sensors, gadgets, and communication protocols to find and stop theft and illicit activity in forests. Forest managers will be able to identify theft and take swift action because to this system's ability to gather and analyse data in real-time. The system tracks animal and human activity in the forest using a variety of sensors, including cameras, GPS trackers, and sound sensors. To take pictures and keep tabs on the movements of people and vehicles, cameras and GPS trackers have been put in strategic locations across the forest. The sound is detected by the acoustic sensors.

The sound of weapons, chainsaws, and other unlawful activity in the forest. A central device or gateway that gathers and sends data to the cloud is linked to the system. Advanced analytics and machine learning algorithms are used to analyse and process the data in the cloud in order to spot suspicious activity and notify law enforcement and forest rangers. Drones may also be added to the system to enable real-time forest surveillance and help forest rangers deal with theft and other illicit activities. In order to offer a complete

security solution, the forest monitoring system may also interact with already installed security systems, such as alarms and security cameras.
A well-known object identification technique used in computer vision applications, such as Internet of Things-based systems for monitoring forests. The YOLO framework is a great tool for tracking and analysing animal and human behaviours in forests since it can identify and categorise things in real-time. Object identification and categorization are two of the key applications of the YOLO framework in IoT-based forest monitoring systems. The YOLO algorithm can analyse the video or picture stream obtained by cameras or other sensors to recognise and categorise things, such as animals and humans, in real-time. This makes it possible for the system to deliver precise and timely information about the movements and activities of people and animals in the forest. Addressing the issue of forest crimes is the primary goal of developing an IoT-based forest monitoring system for the identification of unlawful activity, such as encroachment, poaching, and illegal logging.
In general, a forest monitoring system is a crucial tool for managing and conserving forests. In IoT-based forest monitoring systems, object detection primarily serves the function of identifying and tracking the movement of items like animals, people, and cars in the forest. Object detection is a crucial component of forest monitoring since it aids law enforcement and forest management in seeing possible risks to the environment and enabling quick response to unlawful activity. In order to gather information about the items in the forest, sensors like cameras and audio sensors are used in object detection. After that, the data is analysed to identify and categorise items using object detection algorithms like YOLO.

Real-time monitoring of the forest is made possible by object detection in IoT-based forest monitoring systems. This enables forest managers to take immediate action to address any dangers, such as illicit logging or poaching, and safeguard the environment. Using object detection, it is possible to keep tabs on animal populations, follow their migratory routes, and spot behavioural changes that could point to dangers to their survival.

II. PROBLEM STATEMENT

- High air temperatures, aridity (low humidity), and lightning all present favorable conditions for the onset of a forest fire.
- Wild animals that violate human habitat disrupt the human community; unwarranted human incursions into forests have encouraged smuggling operations, which in turn contribute to the degradation of forests.

III. OBJECTIVES

The objective of this adventure is to cultivate a Trap of Things (IoT)- based forest noticing structure that utilizes significant learning techniques to further develop boondocks the board and safeguarding tries. The structure expects to give continuous checking and assessment of various limits inside forested locales, enabling early area of woods fires, unlawful logging works out, and other environmental changes.

The basic pieces of the system include:

- Sensor Association: Send an association of IoT sensors generally through the forested area to assemble data on various natural limits, similar to temperature, sogginess, air quality, and sound levels. These sensors should be prepared for remotely sending data to a central server.
- Data Getting and Transmission: Encourage an overwhelming data acquiring structure that accumulates data from the conveyed sensors dynamically. This structure should ensure strong transmission of data to a central server for extra assessment.
- Significant Learning Models: Utilize significant learning systems, for instance, convolutional cerebrum associations (CNNs) and discontinuous mind associations (RNNs), to cultivate models for the examination of accumulated data. These models should be ready to recognize plans normal for forest flames, criminal tasks, or other environmental abnormalities.
- Steady Checking and Prepared Structure: Complete a continuous noticing system that reliably looks at the oncoming sensor data using the pre-arranged significant learning models. The system should be prepared for delivering alerts and admonitions in case of recognized anomalies, allowing forest area the board personnel to answer quickly.

- Portrayal and Uncovering: Cultivate a straightforward dashboard or impart to picture the accumulated data, including sensor readings, perceived idiosyncrasies, and undeniable examples. The structure should moreover deliver organized reports for examination and dynamic purposes.
- Flexibility and Backing: Plan the system to be versatile, taking into account straightforward improvement of the sensor association and joining of additional features from here onward. Ponder support essentials, similar to sensor arrangement, battery replacement, and accessibility issues.
- Security and Data Assurance: Complete strong wellbeing endeavors to defend the structure from unapproved access. Ensure that fragile data assembled by the system, for instance, region information, stays secure and goes along to pertinent assurance rules.

By encouraging an IoT-based boondocks checking structure that solidifies significant learning methodologies, the endeavor plans to update forest the leaders practices, work on early ID of biological risks, and support safeguarding tries.

IV. PROPOSED METHODOLOGY

The suggested approach seeks to develop a deep learning-based IOT-based forest monitoring system with the capabilities of gathering sensor data together with real-time item recognition and classification based on the algorithm employed.

The system usually comprises of a module with several sensor types interfaced with the microcontroller that is deployed across the forest area and collects and transmits the data to a centralised server or cloud platform. Deep learning algorithms are used to interpret and analyse the sensor data in order to generate insights and forecast the status of the forest. Large datasets of historical sensor data may be used to train the deep learning algorithms to discover patterns and connections between different environmental parameters the forest's state of health. This can assist in the detection and prediction of possible hazards to the forest environment, such as wildfires and unlawful human intrusion, and the implementation of preventative actions to lessen their effects.

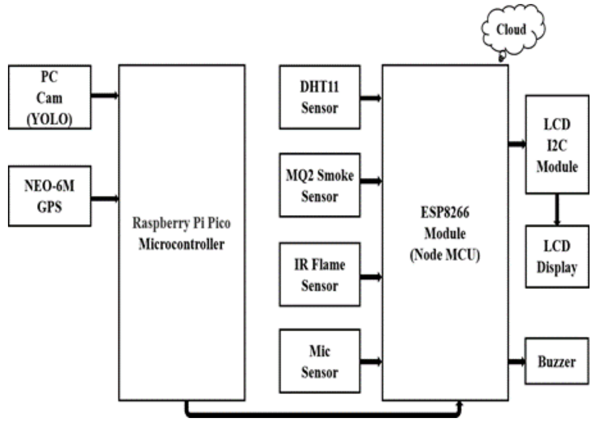

Fig 1: Block Diagram Representing Forest Monitoring System

As illustrated in fig. 1, the suggested system is based on a Raspberry Pi Pico microcontroller board and an ESP8266 WiFi module that have been interfaced with various parts needed to carry out the project's goal. The WIFI module is interfaced with the sensors, which include the Infrared Flame Sensor, MQ2 Smoke Sensor, DHT11 Sensor, and Mic Sensor. The MQ2 smoke sensor will detect flammable gases in the environment, the DHT11 sensor will provide digital signal output of temperature and humidity, and the Mic sensor will detect the intensity of sound. All of these data are provided as inputs to the ESP8266. The microcontroller is coupled to the Neo-6M GPS Module to offer precise the precise position of the region. To display all parameter data, an I2C module connects to the LCD. The WIFI module serves as the internet access point from which the microcontroller connects to the WiFi network. A buzzer is included into an alarm system to warn of any unwelcome activity. Every time the camera picks up a living item, it takes a picture for object recognition and classification using the developed algorithm, and then sends the information to the microcontroller. The Real Time Deep Learning (YOLO) method is used to distinguish between people and animals based on outward appearances and to recognise various objects. The gateway connects to a cloud server through a WIFI module, from which the user may extract data using the Blynk app. When any unauthorised activity is discovered, a message is issued to the user based on the data that has been retrieved, and the system will also reveal the precise location of the area, enabling prompt action by the authorities.

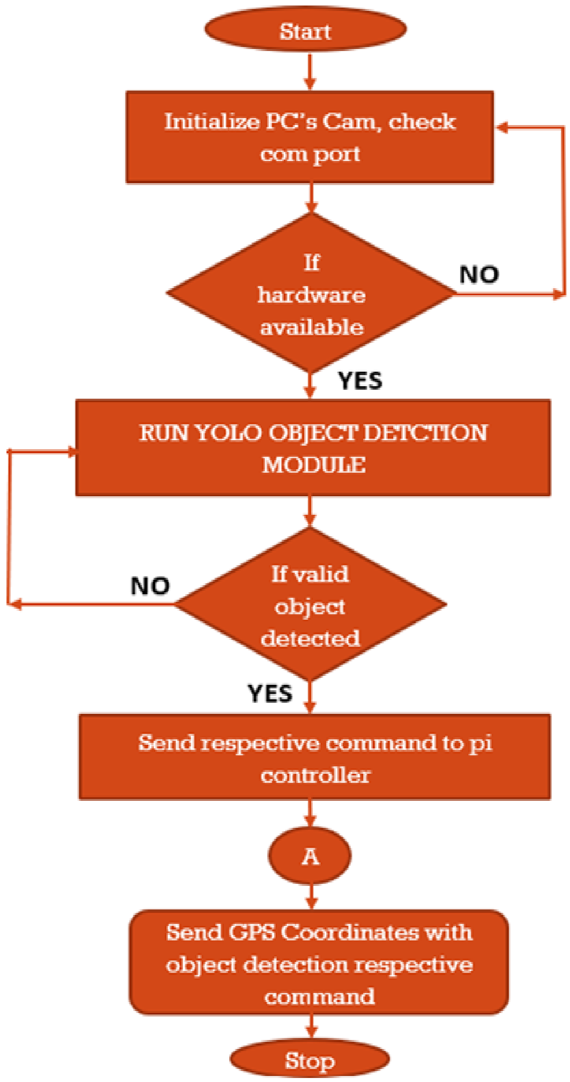

Fig 3: Flow Chart of The Object Detection

The system gets pictures taken by cameras and other IoT devices placed in the forest area. The YOLO algorithm is fed these photographs as input. To get the input photos ready for the YOLO method, preprocessing is applied. The photographs may need to be preprocessed by being resized to a specific size, the pixel values may need to be normalised, and any necessary image enhancing methods may be used. A number of convolutional layers are used by YOLOv3; these layers are in charge of extracting features from the input picture at various sizes and degrees of abstraction.

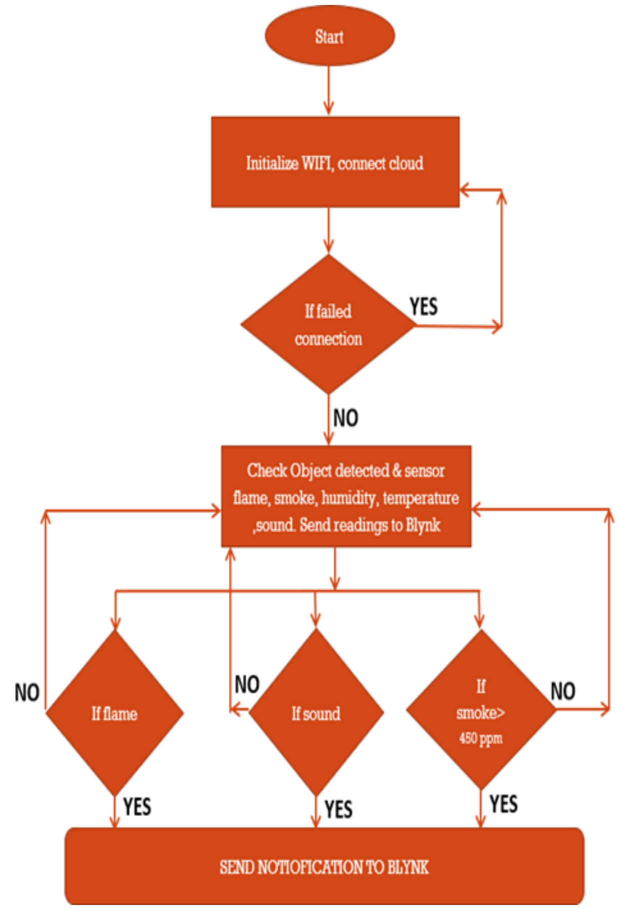

Fig 4: Flow Chart of Sensors and Cloud Integration

The Darknet-53 backbone, which consists of 53 convolutional layers, is used by the YOLOv3 architecture. This framework offers a comprehensive representation of the input picture and aids in the capture of complicated information. The YOLO model must first be trained on a labelled dataset that contains pictures of people and animals including elephants, bears, birds, giraffes, zebras, horses, and tigers, among others. By changing the network parameters during training, the YOLO model gains the ability to identify and classify these items. The preprocessed picture is run through the YOLO model to find items. A grid of lines divides the picture into scores reflecting how likely it is that an object will be found in each box. The bounding boxes are indicated by their (x, y, width, and height) coordinates in relation to the location of the cell. The YOLO algorithm distinguishes between the observed objects using the expected class probabilities. The method assigns the proper labels to the identified items by comparing the probability given to various classes. The system may see the findings after the items are identified and distinguished by superimposing bounding boxes and labels on the original image. The discovered items and their classifications are clearly displayed in this visualisation. The data may be further examined to learn more about the state of the forest, forest fires, or other dangers. Utilising the YOLO algorithm's capabilities, the system can successfully detect objects distinguish between various item classes in photos, and offer useful data for forest management and conservation initiatives.

V. CIRCUIT DIAGRAM

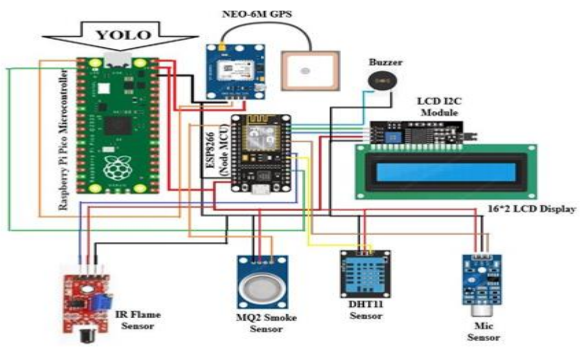

Fig 2: Circuit Diagram of Forest Monitoring System

The circuit architecture for the suggested system is shown in Fig. 3.2, where all sensors are linked to the ESP8266 Node MCU and the Raspberry Pi Pico microcontroller is used to operate GPS.

The +5V and GND pins of the ESP8266 controller are shorted to the VCC and GND pins of each sensor. The MQ2 smoke sensor's VIN is linked to the ESP8266's A0 pin since it provides analogue data. The D0 pin of the WIFI module is used as the buzzer's I/O pin, while the module's D1 and D2 pins are linked to the SDA and SCL pins of the I2C module, respectively. The D4 pin of the module and the D0 pin of the infrared flame are linked by the OUT pin of the MIC sensor.

Sensor is attached to the module's D5 pin. The DHT11 sensor's DATA pin is attached to the module's D6 pin. The VCC and GND pins of both the GPS module and the Pi Pico are shorted, and the TX pin of the GPS module is connected to the RX pin of the Raspberry Pi Pico controller. Additionally, the input is linked to the VIN pin of the ESP8266, and the TX pin of the Pi Pico controller is connected to the RX pin of the ESP8266 module. The WIFI module's built-in voltage supplies a 5V supply to all of the components.

VI. RESULT AND DISCUSSION

A. Human Intrusion Detection in Forest

Fig 5: Person Detected by the Camera

When a person is detected by the camera, it places the boundary box with name label and confidence value based on the algorithm implemented as shown in the fig 5. Then the object detected data can also b e seen in LCD display as shown in fig 6. And the data is stored in the cloud from where we can access it through the Blynk app with its location as shown in fig7. Therefore, the human intrusion detection can be monitored and supervised via Blynk app anywhere and anytime.

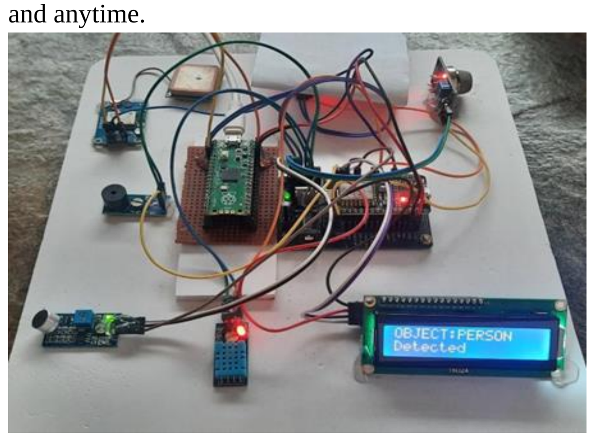

Fig 6: LCD Display of Person Detected

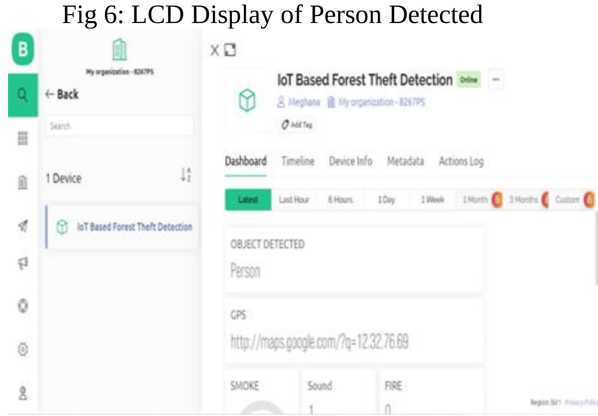

Fig 7 : Person Detected Data Monitored via Blynk App

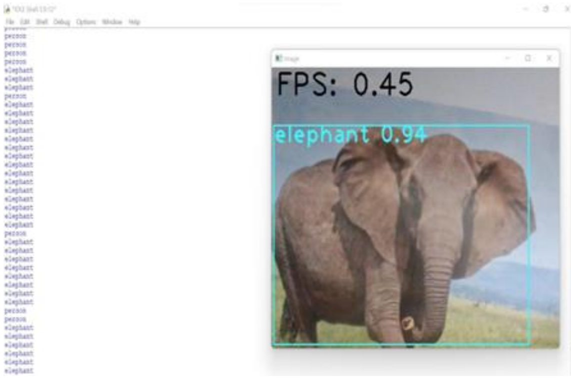

Fig 8: Elephant Detected by the Camera

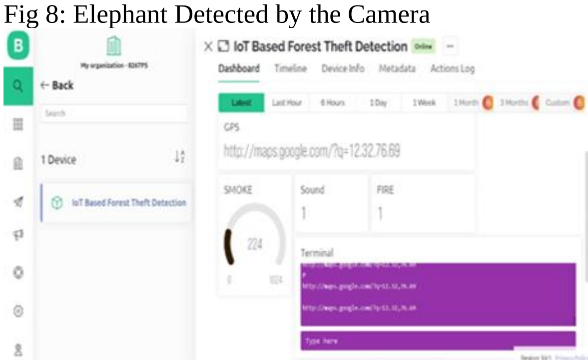

Fig 9: Fire Detected Data Monitored via Blynk App

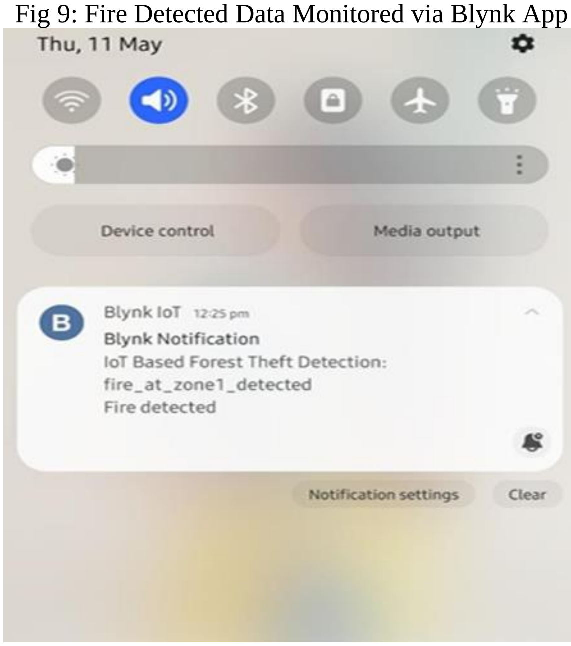

Fig 10: Blynk Notification of Fire Detected

When forest fire is detected by the Infrared Flame sensor, the data is stored in the cloud and it is accessed via Blynk app with its location as shown in the fig 9, '1' indicates that the fire has been detected by the sensor. Then the detected data can be seen in LCD display as shown in fig 10. And the notification is also sent to the respective authority's phone as shown in fig Therefore, the forest fire detection can be monitored and supervised via Blynk app anywhere and anytime. Similarly other notifications are illustrated below with fig 11 and fig 12

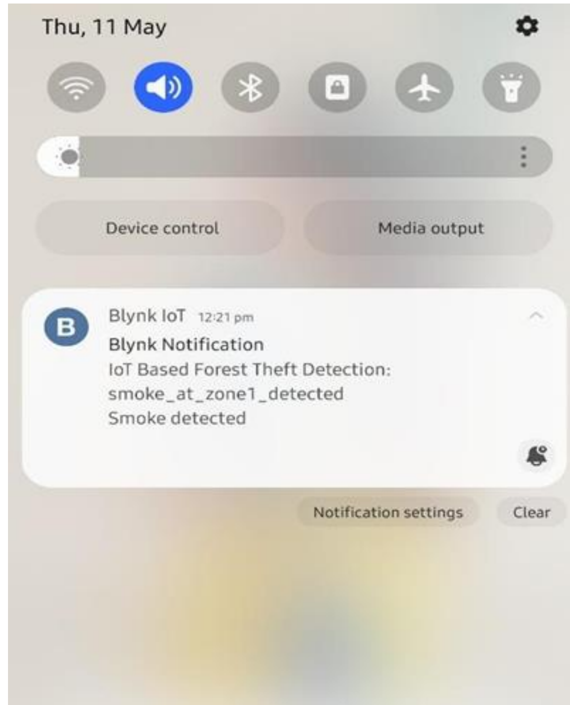

Fig 11: Blynk Notification of Smoke Detected

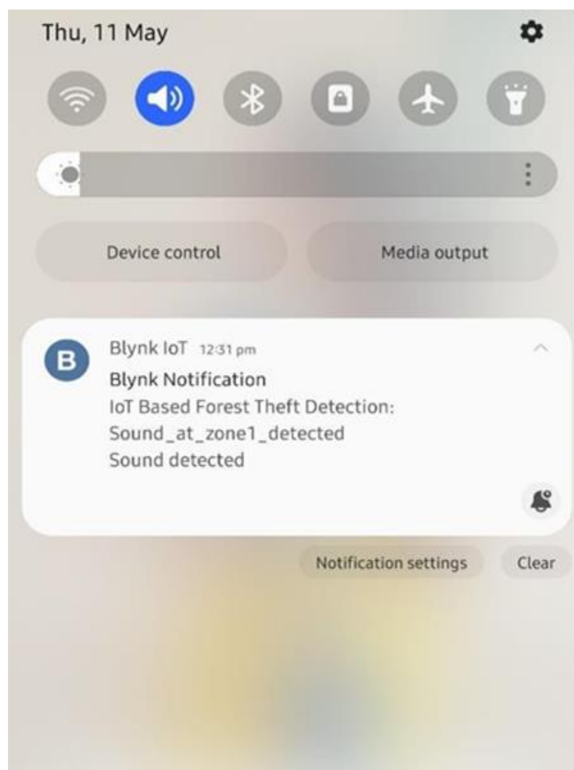

Fig 12: Blynk Notification of Sound Detected

VII. CONCLUSION AND FUTURE SCOPE

CONCLUSION:

Forest monitoring and object detection methods based on deep learning combine them into end-to-end feature extraction, which has a wide range of development prospects and great potential, as opposed to traditional image processing methods, which handle these tasks in a number of steps and links.

The suggested system is capable of spotting changes in the forest ecosystem that might be signs of a forest fire, human incursion, or animal activity, and it can inform authorities to take action before the situation deteriorates. Overall, by providing precise and timely information on the forest environment and spotting possible risks to the ecosystem, the system aids in improving the management and conservation of forests.

FUTURE SCOPE:

This framework involves a few sensor components and constant profound learning for object discovery and characterization which can possibly further develop woods the board rehearses, monitor biodiversity, and decrease the effect of human exercises on backwoods biological systems. By integrating these components into an IoT-based timberland observing framework, we can improve our capacity to screen and ration woods all the more really, forestall out of control fires, and pursue informed choices to guarantee practical backwoods the executives for people in the future.

Later on extent of IoT-based backwoods observing frameworks, the establishment of web cameras and the reconciliation of Just go for it (You Just Look Once) can give huge advantages. By consolidating web cameras with Just go for it object identification in these sorts of frameworks, we can upgrade reconnaissance capacities, further develop information assortment and examination, and reinforce protection endeavors. This coordinated methodology considers proactive administration and assurance of backwoods, adding to their drawn out supportability and the conservation of biodiversity.

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