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IOT BASED FOREST FIRE PREDICTION SYSTEM

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ABSTACT

The goal of the Forest Fire Detection System is to create a system that protects the forest by alerting forest officials by SMS as soon as a fire is spotted and calling for help. IoT and image processing technologies are applied to this. The main goal of the suggested system is to create a fire detection system using an ESP 32 Microcontroller coupled with an IR sensor, Neo 6m GPS Module, and Sim800L GSM Module. The GPS module will be used to pinpoint the location of the fire when it is initially discovered using a variety of sensors located throughout the forest. The fire detected location is delivered via an SMS in the form of a message using the GSM module.

Keywords: ESP 32, IR sensor, SMS, Neo 6m GPS Module, Sim800L GSM Module, Sobel EdgeAlgorithm.

I INTRODUCTION

Forest fire, also known as wildfire or wildland fire, is an uncontrolled fire that occurs in forest areas. It is essential to identify these types of fires as soon as possible to prevent harm to biological structures. Frequently, a large number of timberland sections are burned to the ground. When woods are cut down, it becomes extremely difficult to grow vegetation elsewhere Forest fire detection system is used to detect forest fire and to send the required amount of help to stop fire after processing of fire images captured by the drone. The drone images are processed on the Django Application using Sobel edge Algorithm. The entire process is divided into two modules 1.GPS module and 2. Drone Module

II LITERATURE REVIEW

Ignacio Bosch, Soledad Gomez, Luis Vergara et al. [1] have proposed a paper based on a schemeof infrared sensors. This scheme based on infrared image processing performs the immediate detection of any fire in the forest to determine the presence or absence of fire. Sensor networks are widely used and help the human capabilities to monitor large forest areas. This paper describes a scheme for automatic forest surveillance with the help of IR sensors. The paper describes only about detecting the fire and sending images of detected fire using image processing Yogesh Deshpande, Krishi Savla, Crispin Lobo,Jahnavi Patel & prof. Shivani Bhattacharjee et al. [2] has proposed a paper on Forest monitoring systems using sensors, wireless communication, and image processing. The forest monitoring system will keep a track of the conditions that are good for the fauna of the forest and collect data which includes temperature, humidity, entry and exit of animals and the various parts of the forest.

Diyana Kinaneva, Georgi Hristov, Jordan Raychev and Plamen Zahariev et al. in [3] has proposed a paper whose main objective is to fight against the forest fire and distinguish it which includes the earliest possible fire detection methods, the proper classification of fire and also the fast responses that could be from the forest officials. So they are using some modern technologies like Artificial intelligence (AI) and drones which constantly patrol over the fire area. In this they are using two types of drones to detect the fire as soon as possible, one is a fixedwing drone and the other one is a rotary- wing drone. The fixed-wing drone continually patrols the area and observes the forest land below. Since the fixed-wing drone will fly at the medium height (350m to 5500m), it might report false alarms because

of height or lack of an acute sight. If the fixed-wing detects the fire the rotary wing-drone becomes active and is sent to the location detected by the GPS for clear vision and observation. The reason for sending the rotary- wing drone is to minimise the false positive alarms sent to the forest officials.

Anphy Jose, Deepa Merlin Dixon K, Naiji Joseph & Silpa George E et al. in [5] has proposed a paper based on the study of the performance of edge detection operators. Image analysis technique includes its processing as postprocessing steps. The changes of intensity in an image is considered as an edge. This paper describes a comparative study among various operators such as Sobel, Prewitt, Roberts & and Canny based on its performance factors.

Miriyala, Trinath & Karthik, Ragipati & Mahitha, J & Reddy, V.et al. in [6] has proposed in his paper that 80% of fire crisis would have been avoided if the fire was detected immediately. The NodeMCU fire indicator and an observing structure based on IoT technology is the solution to this problem. This paper describes a system containing the Node Mcu which is connected to a temperature sensor, a smoke sensor, and a signal. The temperature sensor is used to detect the heat and the smoke sensor is used to detect any kinds of smoke produced because of the fire. When the fire is detected, the alarm is activated and an alert goes to the respective official. In addition to the alert, the LCD screen alsodisplays messages after the fire is detected. Later the clients or the forest officials can view the details on the Android Page which is very portable and user friendly and helps the clients in analyzing the minute details of the system.

Ranjith E, Padmabalaji D, Sibisubramanian S, Radhika S et al. in [8] has proposed this paper whose purpose is to design an IoT based system which can be used to detect any forest fire at the earliest before the fire spreads over the large area. This system uses Raspberry pi which is connected to a camera and two sensors. If any kind of calamitous event occurs then the system will immediately get activated and it sends an alert message containing a picture of the region affected by the fire and the location of the device.

Vergin Raja Sarobin M, Simrandeep Singh, Abhay Khera, Lakshya Suri, Chhavi Gupta, Ayush Sharma, et al. in [9] told that Fire outbreak has been a common issue in forests and large buildings. In this research drone to detect forest and building fires which uses the techniques of image processing and video processing. Our research can be divided into three main modules. The first module focuses on the cloud service Thing Speak to perform data analysis. The Data collected by the drone, with the help of a flame sensor attached to the Arduino, is transferred to Thing Speak. With the help of an inbuilt camera module, the drone captures real-time images, and image processing is done on that image using google API. The algorithm uses content-based image retrieval and detects whether a fire is caught inside the image or not, along with its intensity. The algorithm also detects the objects present nearby the fire. The third module focuses on video processing. The algorithm detects fire based on the color of the pixels captured. The drone helps in capturing the live update on the area affected. All three modules boost up fire detection accuracy and can thus help in saving lives.

III. SYSTEM ANALYSIS AND DESIGN

A.GPS Module

1. IR Sensor

The IR sensor detects radiations from smoke, heat, infrared, or ultraviolet light. The idea behindthe IR sensor is to analyse IR signals. A fire or flame generates IR radiation when it is burning. The IR receiver on the fire sensor module then receives these IR signals in order to detect the flame or fire. Thissensor has a detection angle of 60° and a voltage range of 3 to 5.5 volts.

2. Temperature Sensor

When the temperature rises above 60 degrees Celsius, the temperature sensor (LM 35) most frequently detects fire. The measurement of the temperature is done directly in degrees Celsius (Centigrade). The most crucial aspect of this component in fire detection is that it has low self-heating. It is ideal for remote applications and operates between 4 and 30 Volts.

3. GPS Module

A complete GPS (Global Positioning System) receiver with a ceramic 25*25*4 mm antenna isthe Neo 6M GPS module.It is used to locate the fire's location.The microcontroller receives the longitudinal and latitudinal data, processes it, and then sends the coordinates to the person's pre-registered contact number.

4. SIM800L GSM Module

The most distinctive feature of the SIM800L GSM module is the use of the Serial Communication Method for Short Message Service (SMS).When the temperature rises as a result of a fire, this module aids in the automatic transmission of SMS messages.The URL of the detected fire's location will be included in the SMS.This module operates at a voltage range of 3.5 to 4.4 volts.This module has a SIM socket on the back and a helical antenna. To send an SMS to the person's pre-registerednumber, any activated 2G micro sim would work perfectly.

5. ESP8266 microcontroller

An IoT computer code with an integrated ESP-8266 Wi-Fi Module is the ESP 32 Microcontroller.It is the system's brain that communicates with all of the other parts.Data from both sensors is transferred to the base by this device.The Thingspeak Application is used to display the collected data.It is also controlled in such a way that it sends out the necessary notifications, which helpsorganize the monitoring process as a whole.

6. LCD

16 characters per line are used to display the messages on LCD (Liquid Crystal Display) screens. It is employed to display various messages regarding the actions being performed. throughout the wholedetection system. In order for the user to take further action, the messages are displayed to inform themof the system's state.

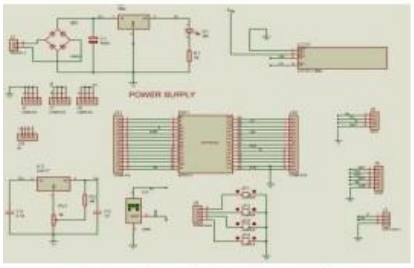

Fig. 1. Schematic Pin Diagram of GPS Module

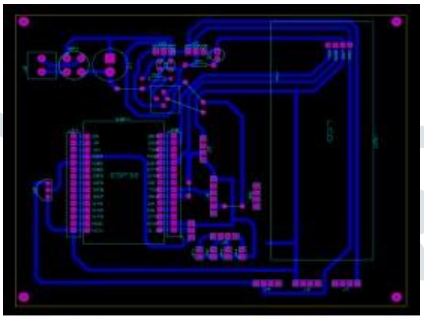

Fig. 2. Layout Design of GPS Module

B. Drone Module

Unmanned aerial vehicles, or drones, are flying robots that can be remotely controlled or madeto fly at will using computer code. To take pictures, a drone is flown to the area where a fire has been spotted. These photographs are kept in the dataset folder on the forest officer's PC, where they will be processed and utilised to determine the fire's intensity and direction using the Sobel Edge Detection Algorithm.

IV. SYSTEM ARCHITECTURE

The System Architecture of the entire system is as follows in Fig.3.

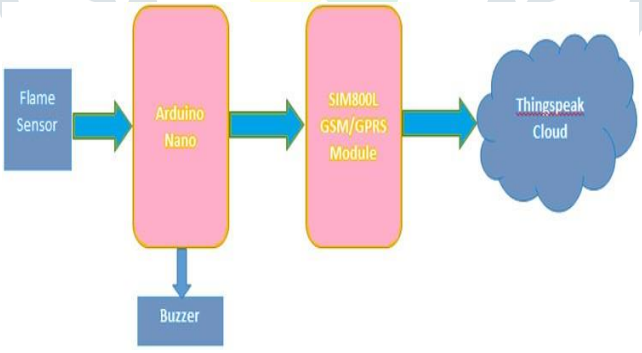

Fig.3 System Architecture

An overview of the forest fire detection system may be seen in the system architecture diagram above. IoT and image processing technology are the two technologies used in its creation.

The entire proposed system is divided into two parts:

- Module-1: GPS (using IoT Technology) ● Module-2: Drone (using Image Processing)

The hardware documentation needed to complete all operations is contained in the first module.First, any fire, hot gases, or flames in the forest are discovered using the temperature and IR sensors. Anytime a fire is discovered, the ESP 32 microcontroller receives the information and activates the GPS module to locate the fire.

Once the location has been determined, the GPS Module will transfer this data to the ESP32 Microcontroller, which will convert it into a URL. Using the Sim800L GSM Module, this URL will be communicated via SMS to the designated forest officials. The forest officials can register, log in as users, obtain this data, and study the changes in temperature occurring at the location where the fire was identified thanks to the cloud backup system Thingspeak Application, which also stores this information. The LM 35 Temperature

sensor is interfaced with the Thingspeak Application, making this analysis possible.

The screen will open with maps that display the location of the fire that was identified as soon as the forest officer clicks the link. The officer will benefit from having a clear understanding of the location of the fire thanks to this. The forest officer will send the drone to this place once they are aware of the location to take photographs of the fire so they can determine its severity and direction.

After the photos are taken, the second module, which makes use of image processing technology, enters the picture. This enables the forest officials to register, log in as users, upload the images, and process them. This gives the forest officials a clear idea about how intense the fire is, how quickly it is spreading, and also its direction. It also helps in processing the images captured by the droneusing the Sobel edge algorithm on the Django web-app.

This will enable the forest officials to dispatch the appropriate personnel and equipment to contain the fire and put it out.

V. WORKFLOW

The workflow diagram of the Django application for processing the fire images in Fig 4.

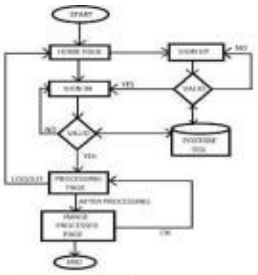

Fig. 4. Flowchart of Django web-app for processing

1. The homepage of the application offers three links: home, login, and sign up.
2. If an officer is brand-new to the forest department, he will go to the signup page to create a new account by providing all the information (username, password, confirm password, etc.), and those details are saved in the PostgreSQL database. If the officer types a different password and confirm password, it displays a warning message that the passwords do not match and reroutesto the same page.
3. After the forest officer successfully creates the account, he can login in by providing a legitimate username and password, which are then verified in the database. It will lead you to the processing page if the provided information is accurate. If the officer enters an invalid usernameor password, a warning notice stating "invalid credentials" appears and they are redirected to the same page.
4. An officer who logs in will be taken to the processing page, where he can submit an image andnavigate through the image dataset folder to select the image for processing.
5. He can examine the processed image in the image processed page after the image has been processed.
6. An image processed page will redirect to the processing page for any additional imageprocessing on fire images once you click the "OK" button.
7. He can log out after his job is finished by clicking the logout button on the processing page, which will take him to the home page.

The Sobel Edge Detection Algorithm workflow diagram in Fig 5

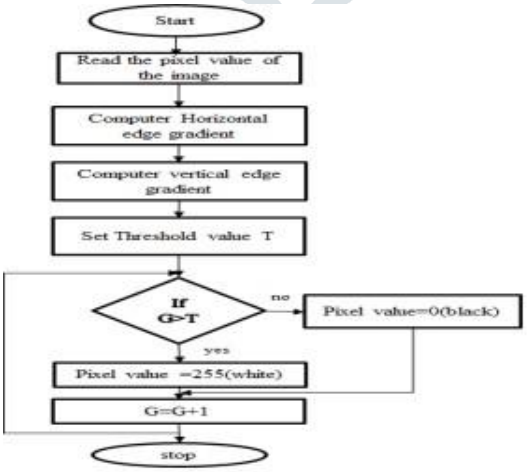

Fig. 5. Flowchart of the Sobel Edge detector algorithm

The Sobel Edge Detection technique turns the input image into pixels. The absolute gradient is created by individually applying Gx and Gy masks to the pixels. The output pixel turns white if the absolute gradient exceeds the conditioned threshold value; else, it turns black.

VI. DATA ANALYSIS AND RESULTS

Data Analysis occurs in the main station. It consists of the following:

A. Thing Speak

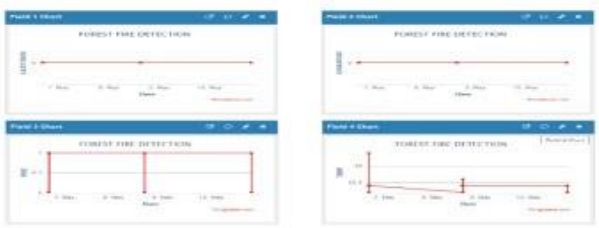

Fig. 6. Thingspeak graphical analysis

Field 1 & Field 2: This channel uses GPS to record a device's latitude and longitude information from a specific place.

Field 3: 0 and 1 are used to hold the value in this channel. Where 0 denotes the absence ofadjacent fire detections and 1 denotes the presence of nearby fire detections.

Field 4: This channel records the local temperature, and its variation aids in our analysis of thecircumstance.

B. Image Processing

To analyze the intensity and direction of the fire, real-time photos captured by the drone's camera are acquired and analyzed using OpenCV in Python on a Django web application. The visual analysis of the photograph determined how much assistance was needed from the forest authority.

Fig. 7. The processed image on the Django web-app after applying the Sobel edge detection algorithm.

VIII CONCLUSION

Forest fires only harm the ecosystem when they are not discovered right away. Analysis of the issue and prompt notification of the forest officials will help to prevent significant harm to theenvironment and cultural heritage. Therefore, the primary objectives of this kind of system are that the entire procedure be very speedy and that the detection be accurate in pinpointing the fire's location. When a fire has barely started to spread and its known origin is recognized, it is simpler to distinguish it from other fires. For the forest officials to effectively manage the fire during each of its stages, they need to know how the fire is progressing, including its intensity and direction.

The speed of the forest fire detection system is its most crucial component since it will enable forest officials to learn about fires as soon as possible to stop them from spreading over a vast area.

Some of the system's drawbacks include the inability to send images directly to the Django Web application for processing and the lack of an onboard computer on the drone that would allow for the development of AI to classify the image's components.

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