

IoT Based Fire and Wild Animals Detection using Deep Learning

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Abstract— These days, a variety of outside circumstances induce forest fires to break out without warning. To increase rainfall, lessen wind attrition, reverse the trend of logging, and stop the encroachment of the desert, governments, especially in semi-arid regions of the world, designate tracts of wood as forest reserves. The legal system provides judicial and/or constitutional protection for rainforests in India and many other nations. Forests are the third most significant natural source after air and water. They effectively keep the radiative gaseous balanced by collecting carbon dioxide and releasing oxygen, which also helps to complete the hydrological cycle and produce rainfall. Food, medicine, timber, and many more goods can all be found in forests. They provide defense against things like radiation, drought, flooding, and soil erosion. The importance of forests in recreation, aesthetics, and as the shelter for a variety of wildlife are only a few of their additional roles. The designed methodology launches a novel framework that combines the combination of a few sensors that detect fires and will notify the closest communication center in order to identify and protect the plants and animals.

Keywords—Conservation of forest, wildlife, save wild animals, IoT

I. INTRODUCTION

Forestry is a sizable area where woods and wildlife predominate. It is an essential element of biodiversity. As a result, every significant risk to an important aspect of the ecosystem must be discovered, researched, and countered using the most effective and cutting-edge advanced technologies [18]. 4 billion hectares or about 30 percent of the globe's earth's surface are covered by forests. The profits we obtain from the forest are huge namely the medical materials, household requirements, and other huge profits. Forest fire is an evil disaster that affects a vast land field which in turn affects both flora and fauna. The fire might start for a variety of reasons, such as lightning (a natural vegetation fire triggered by the combustion of dry fuel like leaves), cigarettes, and other random behaviors. Forest Unmanaged fires that start in wild places and seriously harm both human and environmental resources are a common occurrence in Indian forests. The majority of forest fires are caused by ambient temperature and sporadic humidity, which provide favorable conditions for a fire to start. Thunder, individual irresponsibility, and exposing fuel to intense heat

and aridity are typical causes of forest fires. India's trees and ecosystems are more at risk and under a significant deal of threat. Up to \$1.48 billion in federal resources are needed annually to put out wildfires to start in forest areas, and ten to twenty firefighters lose their lives in the process. It is crucial to realise that early warning systems are necessary if you wish to control forest fires. In India, there still are typically customary practises to lessen the effects of forest fires. In India, new technology like water-based fire extinguishers and fire-breaks to contain the spread of a fire isn't always often used. To conserve these vast tracts of land and ecosystems, it is crucial to have strong detection and early warning systems so that a fire hazard may be controlled at an early stage and prevented from extending. Typically, there may also be a significant reliance on people so as to avoid accidents in the neighbourhood of a forest. Identifying the actual location, communication issues, mobility snags, weather conditions, climatic circumstances, and natural world state of affairs can be some of the only things preventing officials and accountable authorities from acting when a forest fire arises. For the benefit of officials and the woods involved authority, proper measures to prevent forested area fire may also be laid out more clearly.

Considering thousands of woods are destroyed annually by wildfires around the globe, they constitute one of the main factors contributing to deforestation. The cause of this is the hottest summers and milder winters. Fires result in significant forest degradation, whether they are started by people or by accident. In India, there were 520,861 intense wildfire occurrences between 2003 and 2017, most of which were concentrated in thick, evergreen, and deciduous forests of the eastern Himalayas and the lower Himalayan states (Impact, 2021). The primary intentional and unintentional providers of species diversity are wildfires. depletion, decrease in land ecosystem production, and woodland co Supplies, a decline in soil nutrients and associated reduction in major crops, growth in air pollutants, and a vulnerability to disasters that is becoming more severe. Deforestation has a negative effect on the atmosphere, increasing greenhouse gas emissions, soil depletion, flooding, endangered animals and habitat destruction, food shortages, and ecological imbalance (Causes, 2021).

The SDG's ambition is hampered by modern issues in species and ecosystems. Our ecosystem must undergo

modifications in order to conserve wildlife and support sustainable food producers and consumers. One should separate industrial prosperity from improper land use, consequent demand and supply habits, and destruction of ecosystems. Since almost 170,000 communities in India are close to forests, studies also measured the amount of wood, forage, small wood, and bamboo used by residents of those nearby woodland regions (P. D.N., Fuelwood studies in India: myth and reality, 2002). Additionally, it has been shown that the populations of such communities are heavily reliant upon the woodlands that provide the fuel wood, food, a tiny forestry, non-wood forest goods, and bamboo. An absence of the paucity of items offered in the woodland presented a problem for the decision-makers when formulating plans to improve the quality of life for those who live nearby. Nevertheless, the use of innovation will make it possible to create a framework which can deliver all of the land's digital information.

The Web and systems nowadays rely nearly entirely on people for their info. About every one of the approximately 50 petabytes (1 petabyte = 1,024 terabytes) of info that are currently accessible on the Web were initially developed and collected by humans through the use of keyboards, recorder buttons, webcams, and bar coding. If something was new or had passed its prime, one should recognize once it broke twice, fixing, or retrieving.

II. LITERATURE SURVEY

A. Smart Fire Detection and Surveillance System using IOT:

To predict the fire at home in this approach, a revolutionary concept is put forth. The spy network uses cutting-edge technology, is cost-effective, and is built to be installed in fire-sensitive areas to alert users to incidents. The use of sensors and an ESP thinker To discriminate between fire and smoke for tracking and alert generation based on visual intensity. To prevent the potentially dangerous scenario, It is advised to use an Internet-of-things fire detection system. The processor must process the surveillance data in order to an alarm based on the condition in the devices of interested parties via the cloud. The information is saved as info and is accessible anywhere at any time as a standard warning system.

B. A Privacy-Preserving IoT - Based Fire Detector:

We offered a privacy-protecting cloud-based fire detection system throughout the endeavor. Throughout this technique, an IoT device is frequently used to take footage of the environment first, then extract elements again from movies. The cloud is then used to evaluate these attributes further in order to detect fire and, if practical, convey alert message to the user requirements. Within that study, we use video descriptors to extract characteristics from videos. In particular, it has been determined how well seven distinct descriptors may capture information about the existence of a wildfire in movies. We have discovered that HOG and Shi-Tomasi perform better than the other six descriptions. With the CNN classifier, these two descriptors have been taken into account. As a result, we have the HOG+CNN and Shi-Tomasi+CNN fire detection architectures. A collection of films showing realistic wildfire and non-fire scenarios was used to test the systems..

C. Internet-of-Things Enabled Forest Fire Detection :

To address the issue of early detection of forest fires, this research emphasise the factor of wireless sensor networks (WSN). To complete the activity, the device uses a variety of sensors that are connected and wireless data transfer. These small s ellite receives the collected data and sends it to the ground station where it is processed. The suggested wireless sensor network-based approach aids in the earlier identification of any fire risk. Sensors are positioned at particular distances that maintain a clear view of the entire forested area in order to monitor the temp of the ignition

warning system, the level of co2 gas (Carbon dioxide), and smoke. The microcontroller will receive a signal or info from these sensors. In the case of an emergency, they will all immediately respond when they see changes in the surroundings. Here, we have a few benefits, including quick reaction times, one-time installations, and the ability to monitor the working environment at any time.

D. Monitoring the Movements of Wild Animals and Alert System Using Deep Learning:

In this article, we use DCNN to offer a trustworthy and reliable method for detecting animals in cluttered photos. Through the use of webcam networks, crowded images are obtained. The potential animal cluster centers made by multilevel graph cut cuts also shown in the photos in webcam image sequences. Into Determine whether the claimed region is actually an not, we have added a analysing stage in which the claimed area is divided to background or animal class. To improve speed, we added DCNN features to the machine learning algorithm. The test results reveal that such demonstrate reach is a trustworthy and efficient method for detecting wild animals both during the day and at night..

E. Real-Time Automatic Investigation of Roadway Animals by 3D Reconstruction Detection Using Deep Learning for R-3D-YOLOv3 ImageClassification and Filtering:

Convolutional neural networks (CNN) and deep learning (DL) methods in general are dominating the computer vision field. In ODT, there is a lot of research being done on computer vision (CV) for things like home appliances, medical imaging, industrial automation, defense and surveillance footage. By the end of the fiscal year 2020, it is anticipated that the CV market would have grown by 50 billion USD. A high-performance cloud-based infrastructure is used to run CV. The use of smart objects is quite similar to that of sensors that provide raw data comparable to that of the cloud. This DL genuine 3D motion-based YOLOv3 model also assaults CV-based Internet of Things (IoT) devices. Sight is a crucial function for both humans and homeless and feral animals. We can always rely on our vision as a reliable resource. Users choose an object while driving the car through a simulation of smart city streets, woodlands, and other locations. However, neither of these environments conducts simple on-the-road investigations nor can they identify the faces of objects.

III. PROPOSED SYSTEM

Typically Depending on camera-trap photos, the suggested system uses the CNN algorithm to identify wildlife animals. Evaluation from image sequences requires the segmentation of objects and their separation from the background depending on their motion. Because the proposed system uses the Internet of Things, it can identify and warn about wildfires and other early-stage threats. Raspberry Pi is combined with a few sensors and a camera in the solution we've suggested. Our unit is composed of a fire sensor, that is used to detect fire, a pi camera, and an ultrasonic sensor, which uses image processing to detect intruders. The system will quickly send an alarm message with a picture of the impacted area and the location of the device if any catastrophic occurrence takes place.

The goals of this study are to create and put into use an IOT-based system that can detect and identify animals in the forest as well as identify forest fires and send an emergency SMS to the appropriate person. A 24/7 on-site forest fire tracking and detection service are what the IOT system hopes to offer. Deep learning will also be used in this study to identify different animal species. Develop reliable and strong animal detection from chaotic and dynamic camera-trap network image streams.

A. System Architecture

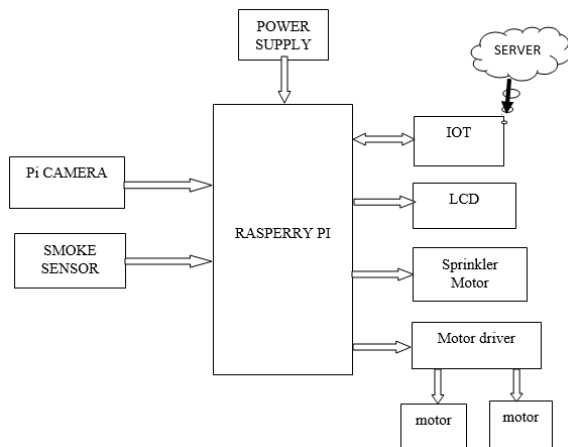


Fig. 1 System architecture for fire detection

Before the wildfire develops across a wide area, the Raspberry Pi Iot application recognizes the raging wildfire as quickly as feasible and acts quickly. Raspberry Pi is linked to detectors like flame sensors. The Raspberry Pi-connected GSM modem notifies the security system for remote sensing applications. Automatic SMS alerts are sent by the GSM module to the control..

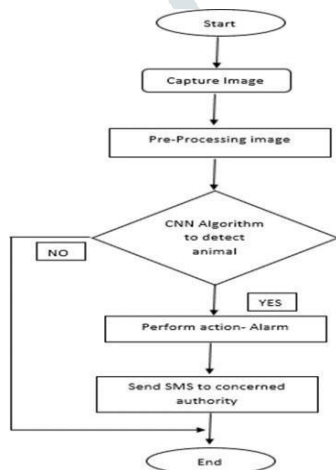


Fig. 2 System architecture for animal detection

B. Basic operational requirements

1. Raspberry pi

In essence, the Raspberry Pi is a minicomputer on a single board. A unique processor, memory, graphics driver, and I/O are included. Its motherboards use a customized version of the Linux operating system. The Raspberry Pi is an affordable computing device. The Raspberry Pi Foundation does computing available to everyone in the world so that they can learn how to program. The Raspberry Pi has undergone a several improvements since it was first introduced in 2012, including increases in RAM capacity, CPU speed, device compatibility, and connectivity protocol support. In February 2016, the Raspberry Pi 3—the most recent iteration—was unveiled. It has a quad-core 1.2GHz 64-bit ARMv8 CPU, 1GB RAM, built-in Bluetooth, and many other features.

2. Fire sensor
3. Pi camera
4. Arduino

Arduino is a microcontroller electrical platform that combines hardware and software. It is simple to use and manage, and it accepts inputs and outputs from other devices. produces the output. You too can give instructions to its processor is vast. [8] This Arduino Depending on wthe iring,

programming languages are employed, and the IDE, a piece of software based on the processing. The Arduino board offers sets of analog and analogue pins for analogue input and output. To load the guidance onto the board, where the software and the USB connection are employed attached to the board. Both Windows and Linux support it.

5. Sprinkler

6. Motor

C. System Design

a. Input

Input system is a key component of the project process, and programmers must attach importance to it. The approach is to provide the program with the most relevant data. Therefore, inputs are created in a way that minimises feeding-related faults.

The embedded device and the client are connected through the coding phase. It entails creating processes and standards for text processing, which are important to convert exchange information into a set that can be processed. This can be done either by allowing individuals crucial the information directly through into structure or by getting the desktop receive data from a handwritten file. The entry methodology is supposed with an eye toward minimising the quantity of input necessary, minimising risk, minimising delays, minimising unnecessary stages, and maintaining a straightforward workflow. The entry is built in a manner which it maintains privacy while offering safety and usability. These factors were taken into account by Input Design:

- Whatever information must be provided as input?
- How will the info be organised or programmed?
- The conversation to direct the working staff's input-giving.
- Techniques for creating input verifications and actions to take in the event of a failure.

The purpose of input plan is to ensure that information is rational and error-free. The app was designed with simplicity in mind. In some circumstances, the client is also offered the chance to choose a suitable originate from a variety of choices relating to the field..

b. Output

A quality product is one that provides the results effectively and complies with the end client's needs. Each program's outcomes are how computing outcomes are transmitted to clients and also other systems. It is the customer's foremost crucial and primary resource. The interaction between the technology and aiding user judgement is improved by effective and accurate design process..

IV. IMPLEMENTATION

A. Modules

There are various modules used in our project. They are as below

a. Input module

Wildlife in the surroundings of environment are photographed with high-fidelity cameras. Signals are sent to the hardware system along with the collected images.

b. Raspberry Pi3

The raspberry pi is a low-cost, compact system that connects to a display and makes use of a regular touchpad. And it has a

microcontroller with a 1.2 GHz BCM2837 64-bit Armv7 processor.

The Raspberry Pi is a tiny, low-powered, single-board computer which has been designed to use less power than a typical PC. The Raspberry Pi is equipped with a tiny USB connector, a display port, a miniature SD card slot, an HDMI port, an audio video jack, a Central processing unit, and GPIO pins. The Raspberry Pi is given flexible power via the miniature size USB power. The SD card is used to help it maintain bulk amassing. The improved wireless device's SD card, which is used for digitalization and can be incorporated.



Fig 3: Raspberry Pi 3 Model B

c. Pi camera

It is an inexpensive, compact webcam that works with the Raspberry Pi. The most widely used webcams are those that use MIPI connectors to establish connection to Raspberry Pi. This type of technology has the benefit of very quick transferring data here between the webcam and Raspberry Pi. And to interface also with a camera, there is a straightforward Python Raspberry Camera API.

d. Processing module

The computer receives the photos the webcam sends and classifies the animals using them. A dB is constructed and filled with the collection of reference photographs.

e. Output module

When a creature is deemed a risk, the appropriate steps are followed, and a Text message with the organism's position and kind is sent to a forestry authority.

f. Smoke sensor module

To use a MQ2 smoke sensor, which can sense a variety of chemicalgas including methane, butane, and LPG, we have developed a fire smoke detection system parameters of the proposed characteristic of smoke. The functionality of the sensing nodes is to detect fire. Therefore, there should be a good selection of the sensors for detecting it. Whenever fire occurs there will be a change in temperature of the surrounding, increase in the concentration of certain gases change in humidity percentage and the presence of flame in the environment, so there should be sensors that are sensitive to each of the mentioned parameters. In general, the selection of each sensor in our system was based on the sensitivity to fire parameters. Liquor, hydrocarbons, and carbon are all detectable by MQ-5. The sensors works in accordance with its sensitivities by converting electricity into approximations of concentration of gas that used a equation. Since the readout is dependent on mathematically converting voltage into a %, it is difficult to determine the sensor's reliability. Even when no referring source is used, accuracy can still be defended as being adequate.

g. Sprinkler module

The system performance of the gas detector is used to evaluate the time delay. The pressure regulator is attached to a relay switch, and when a flame is spotted, the relay is turned on, turning on the water tank. Light waves with a shorter wavelength than 100 nm are detected by the flame sensor. The relay switches on when a

fire is detected. Water from the tank was sucked in by the water pump, which then released it into the sprayer. How long it takes the switch to turn on once a fire was discovered is the section that was being evaluated. When a fire is detected, the spray motor sprays water to stop it from spreading to the nearby area.

STEPS INVOLVED IN IDENTIFYING ANIMALS

1. The webcam is used to take the picture.
2. Raspberry Pi 3 physical board's microcontroller is used to analyze the collected picture.
3. The captured image is examined for numerous feature descriptors that correspond to any wildlife in the generated data set.
4. Next, it recognises and categorises the wildlife that the webcam has taken.
5. Depending on the proportion of related items, the method computes the reliability in %.

B. Technologies used

a. CNN

Convets, also known as convolution neural networks, are neural networks with shared parameters. Think of having an image. Now when we think of a neural network we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution. Now in mathematics **convolution** is a mathematical operation on two functions that produces a third function that expresses how the shape of one is modified by the other.

b. Python

Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language. It was created by Guido van Rossum during 1985- 1990. Like Perl, Python source code is also available under the GNU General Public License (GPL).

Python Features:

- Easy learning
- Easy reading
- can be maintained easily
- A wide standard library
- Interactive Mode
- Portable
- Extendable
- Databases
- GUI Programming
- Scalable

V. RESULTS

Test data are inputs which have been detect the behavior within it during the failure modes within the software is kindly generally not feasible because of the process of software testing , multiple inputs are taken and each test data are considered and they are verified, and rather test cases are written for both successful ones as well as failure ones and generally most feasible data is taken, the overall software testing is taken into those considering within the both of the process in which they need to satisfy both of the process verification and validation. When the fire is detected, water sprinkler is switched on automatically.



Fig 4. The above figure shows the model of the proposed system.



Fig 5. The above figure shows the image of the giraffe detected.

CONCLUSION

The proposed system is an IoT based smart device to detect and identify the animals present in the forest and also detect fire in forest using Raspberry pi and Arduino. The CNN algorithm classifies animals efficiently with a good number of accuracy and also the image of the detected animal is displayed for a better result so that it can be used for other purpose such as detecting wild animals entering into human habitat and to prevent wildlife poaching and even human animal conflicts. We have proposed a reliable and robust method for animal detection in highly cluttered images using CNN. The cluttered images are obtained using camera trap networks we applied CNN features to machine learning algorithm to achieve better performances.

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