

# Survey on Forest Misfortune Mitigation Systems: A Review

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## Abstract

One-third of the Earth's surface is covered by forests, which play a vital role in preserving biodiversity, regulating climate, reducing air pollution, providing habitat for various species, and supporting a livelihood for billions of people. Yet, despite our dependence on forests, we are still allowing them to disappear. This paper describes the various works in the field of forest misfortune mitigation systems such as prediction forest fire, animal poaching, and deforestation. The merits and demerits of various works has been reviewed and explored in this paper.

**Keywords:** Wireless Sensor Networks, Internet of Things, Digital Signal Processing

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## I. INTRODUCTION

The forest is an important ecosystem resource that is closely related to human survival. Forest purifies the air and reduces pollution as well as climate change, supports biodiversity, fights soil erosion, provides medicine, food, etc. With the increase in the human population and improvement in the people's living standards, the demand for forest resources are also increased. Although we are dependent on forests, we are allowing them to disappear. This paper discuss the three causes of the reduction of forest area and the methodologies used to mitigate the misfortune to the forest. The three main causes of the degradation of forests are forest fire, deforestation, and animal poaching.

Forest fires are one of the major causes of forest loss. Sometimes the forest land is set on fire to make the land is available for commercial purposes. Natural forest fires are also lead to the destruction of a huge area of forests. Natural and man-made forest fires have extreme consequences on local and global ecosystems. The forest fire threatens the lives of humans as well as animals. Also managing and controlling a large scale fire has become a very difficult and challenging task. Therefore fire detection and monitoring over large area is extremely important.

Wild animals are also the part of forests. The poaching of many wild animals, especially those protected in wildlife reserves and national parks, can pose a serious threat. Millions of wild animals were killed by every year due to poaching. Poaching usually occurs when an animal possesses something that is considered as valuable. There are different reasons for animal poaching.

Illegal wild life market is a multibillion dollar industry because some animal parts have high commercial value as they are used in food, jewelry, decor, or traditional medicine. Rhinos, for example, have been hunted because some believe their horns have medicinal value, and tigers are killed for their organs, pelts, and bones for medical and aesthetic purposes.

Industrialization has resulted in dramatic losses of trees due to a lack of raw materials and other reasons. With the fast rate of world's growth, the increasing need for land is becoming a major concern. The reason behind deforestation is due to the demand of land for agricultural, industrial, and urban needs to accommodate cities and their growing populations. Deforestation leads to several imbalances, both ecologically and environmentally, and leads to the loss of habitat for millions of wild animals.

For this reason, it is necessary to improve the effectiveness of monitoring wildfires, poaching and deforestation. On the other hand, on-site checking by patrol personnel and observatories is too costly and time-consuming to provide detailed and comprehensive observation due to the need of human assets, funds and other facilities. Hence, automatic detection of forest fire, deforestation and animal poaching is required.

From the literature surveys, it is found that many kinds of researches have been done in forest fire detection, animal poaching, and deforestation. Here focusing on performing survey different methodologies used to support forest misfortune mitigation as a whole. We believe that our proposed work can contribute more in view of safeguarding the forest.

This paper is organized into four sections. The introduction is followed by related works which include forest fire detection Systems followed by animal poaching detection systems which is followed by methodologies used to detect deforestation are discussed in section 2. In section 3, comparative study of different methodologies used to support forest misfortune mitigation. Discussions are described in section four.

## **II. RELATED WORKS**

The aim of this study is to familiarize different forest misfortune detection systems. Many solutions for the fire detection, animal poaching, and deforestation were discussed.

### **A. Mechanisms to detect forest fire**

#### **i. Fire detection methods using ML**

Yaqin Zhao et al[1] proposes an algorithm called CSAdaboost to detect smoke from forest fire videos. Using proper background model, motion regions of smoke are separated from two adjacent frames. It then uses the CSAdaboost algorithm to realize a smoke area using smoke ripple, picture vitality, and color data between the reference smoke color and the input smoke outline. Through this mechanism the system can able to detect smoke images early and can distinguish dense fog from smoke. Also this system can detect

the distractors such as blue sky and grey leaves. The main problem with this system is that there is no way to recognize candidate smoke areas in the smoke-like scene.

#### **ii. Firoxio- forest fire detection and alerting system**

Michael Owayjan et al.[2] proposes a novel method by combining the significant features of wireless sensor networks to detect forest fires in the early stage. The framework consists of different sensors, a solar charging instrument, and wireless information transmission mechanism to detect forest fires. The collected data is sent to the central unit, analyzed and after that uploaded to an online website that contacts the concerned authority if necessary. The website is controlled by certain specialists to take necessary measures in an emergency. The system is efficient and economical. But the system couldn't able to predict the fires. It can only detect the fires when it occurs. And there is a possibility that several surrounding trees and its branches may hide the solar panels in the forest which can diminish the yield voltage and current and thereby reducing the effectiveness of the system.

#### **iii. Forest Smoke Detection based on deep learning and background Modelling**

Smoke is a critical signal in the early stages of wildfire disaster prediction. Due to the presence of clouds in the sky, gray foliage, and the surface of the lake, all current video-based smoke detection systems are vulnerable to false alerts. Gouha Wang et al. [3] propose a strategy based on deep learning and dynamic background modeling to reduce false alerts. In this system, forest smoke detection is done in three steps. First, the single-shot multi-box detector deep learning network is chosen for the initial smoke discovery.

In the next step ViBe dynamic background modelling technology is utilized to gather the dynamic region in the video. In the last step dynamic region is used to diminish the wrong alerts. The system is remarkably reduce false detection of brown haze like target. The problem with this system is that due to the need of huge number of training datasets, the actual outdoor scenes are complicated and it may affect the accuracy.

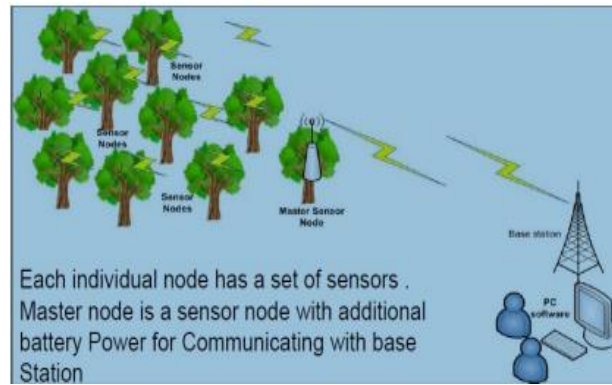
#### **iv. IoT based Forest fire Detection and Early warning system using Raspberry Pi and GSM**

A Vidya et al.[4] propose an early caution fire detection framework based on image processing on IoT platform. A Real time flame detection algorithm is used to distinguish the true fire occurrence. With this system the forest fire can be able to detect early and a quick action is taken before it spreads across a large area. Smoke sensors are associated with Raspberry Pi GSM module alert the forest fire monitoring control room. It can detect the forest fire at the early stages. Also the system is very efficient and economical. Encryption of information for security purpose need to be included as future work.

### **B. Mechanisms used to detect De forestation**

#### **v. Design WSN Node for Protection of Forest Trees Against Poaching based on ZigBee**

Smita Gaikwad et al[5]. Proposes a microcontroller-based poaching avoidance framework utilising WSN technology. It monitors the vibrations caused by logging trees and branches and can detect theft by sending a signal to a central server.



*Fig. 1 Proposed WSN System Architecture [5]*

The WSN consist of

**Sensor nodes:** Each sensor node collects the data from accelerometer and microphone as input which is placed at different places in the forest.

**Master Node:** Collect messages from all sensor hubs and send them to the base station. Moreover it processes messages from sensor nodes and raises alarm levels.

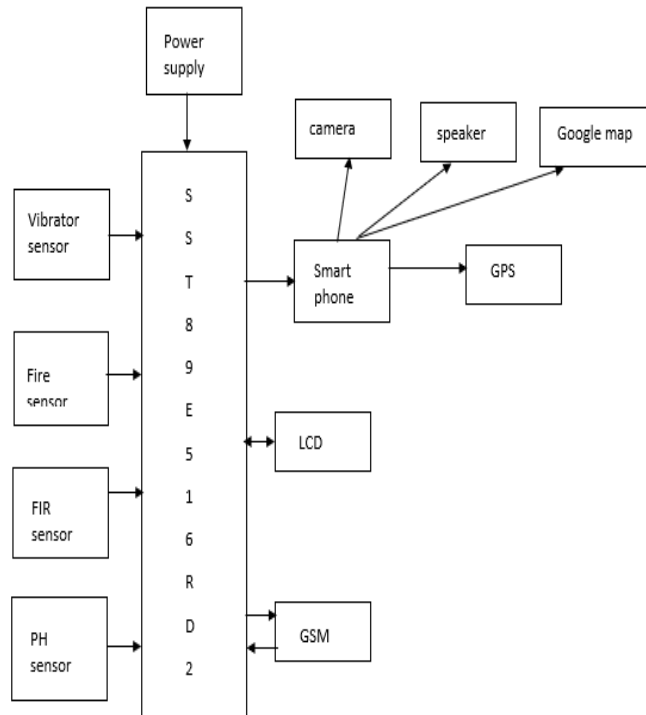
**Base Station:** Accept the messages from the master node and send the collected messages to the server.

**Server :** Used to provide audio and visual alerts.

The system runs on a rechargeable battery that can be recharged with a solar panel. The system is scalable too. As the system is wireless in nature, it is prone to hacking by hackers is the main drawback.

#### **vi. An automatic system for controlling Deforestation using IoT and GSM**

Shridevi. Soma et al.[6] proposes a system to monitor the forest by preventing tree cutting and forest fire. The system can also detect the presence of contaminated water in forests, whether safe or dangerous for animals, or the presence of people in forest areas. To prevent the cutting of trees, we have installed vibration sensors in forest areas with precious trees such as sandalwood. While an obscure person or thief attempt to cut the trees, the vibrator sensor vibrates, immediately send the tree cut message to microcontroller which can forward this message to GSM module and it send a cautioning message to the forest authority so that they can take appropriate actions. The system also provides location tracking facility. If the fire is caused by high temperature or man-made, the fire sensor detects this fire and sends a signal to the microcontroller. Which relays this signal to the GSM module and sends a forest fire alert to the forest authority.



*Fig.2 Block diagram of forest monitoring system [6]*

The forest fire observing framework comprises of Microcontroller and sensors such as Fire sensor, PIR Sensor, PH Sensor and Vibrator Sensor. In the Figure 2, The block diagram consists of a microcontroller which is used to process the data, and two warning alerts are generated as output. A warning message displayed on a liquid crystal display (LCD) and a warning message sent to forest officials about illegal activities such as logging and forest fire detection via GSM modules which is outside the forest. The microcontroller equipped with GSM to send alert messages to enlisted phone and the microcontroller can control all the operations of sensor nodes. The system can able to detect deforestation, forest fire and presence of contaminated water.

#### **vii. Monitoring Illegal Tree Cutting through Ultra-Low-Power Smart IoT Devices**

Alessandro Andreadis et al. [7] propose a novel technology to detect tree cutting based on audio event classification and wireless data transmission. The framework collect signals from remote sensors placed in the different areas in the forest and sends to a central server, which can collect alerts and forwards them to authorities for environmental protection and forest preservation. The proposed system uses lightweight neural network for detecting the tree cutting audio event. The proposed solution minimizes the amount of data transferred over the wireless network and subsequently diminishes the energy consumption of IoT devices.

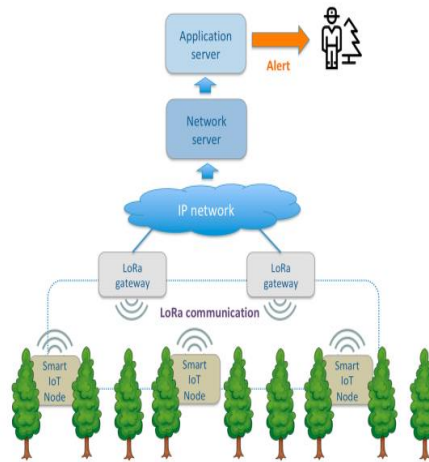


Figure 3. System architecture [7]

The proposed system architecture contains several IoT nodes which is spread across the forest for monitoring the sound of chainsaw or handsaw to detect the tree cutting activity. Nodes and LoRa gateways are placed on the trees or concealed pole. The system can also detect the forest fire from specific sound and send the signal to application server which send an alert message to the forest conservator. The feature extraction and audio classification can be implemented directly on the IoT node. But the realization of audio can only be performed based on recorded sound in the ESC dataset.

### C. Mechanisms to detect animal poaching

#### viii. Real Time Poaching Detection: A Design Approach

Tridip Sarma et al. [8] proposes the design of a framework to capture animal poaching activity in the forest. The system determines the intensity of sound from the guns which are used by the poachers in the forest. The system can able to identify the sound intensity of the guns above a particular threshold level by using acoustic sensors and then sends the output of the sensor to a computer system using a wireless technology. To identify the sound of gunshot and other sound from the forest, Digital image processing techniques are used. If the system detects a gunshot then an alarm is activated and forwards the alert signals to the forest security officials. The framework can moreover be able to identify the distance between the sensor position and the sound source. This will help to capture the poachers and can arrange medical assistance to the wounded animals. The proposed system will help the forest authorities to access the exact spot in the forest at the right time.

#### ix. CAPTURE: A New Predictive Anti-Poaching Tool for Wildlife Protection

Thanh H. Nguyen et al.[9] propose an anti-poaching device, named CAPTURE which is Comprehensive Anti-Poaching tool with Temporal and observation Uncertainty REasoning. In each time frame, forest rangers conduct patrols inside the forest range to avoid poachers from capturing animals either by catching the poachers or by expelling animals traps placed by the poachers. While patrolling forest rangers collected the poaching signs and is used in conjunction with other domain features to forecast the behaviour of the animal poachers. Compared to other models CAPTURE's prediction accuracy is better.

#### x. Demonstrating Low-Cost Unmanned Aerial Vehicle for anti-Poaching

Joseph K. Paul et al.[10] proposes a system towards the minimization of animal poaching by using Unmanned Aerial Vehicles. These UAVs are capable of performing multiple tasks in various fields. Mainly there are seven steps involved to detect animal poaching using drones. There are 7 steps involved in the working of our model.

- Using ArduPilot, GPS location and area of surveillance is detected.
- Object detection is done using RaspberryPi on the drone.
- The system uses YOLO(You Only Look Once) an object detection algorithm to detect each frame of the video which is captured by the drone.
- If any suspicious activity is detected then an alert message is sent to the base station.
- Alert message contains the GPS location and captures images.
- The alert message is sent as an encrypted form.
- After the surveillance is completed or battery charge falls below ten percentage, the drone is programmed to return back to the base station.

The framework can automatically identify poachers as well as the animals even in the low intensity light areas using infrared sensors, the drone being equipped with IR sensors helps in night vision imaging and the system is of low cost. As the image clarity in Captures is low the accuracy of the system is less

### III. COMPARISON STUDY

The following table will illustrate the comparison study of different technologies used to predict the forest misfortune mitigation advantages and disadvantages

**TABLE1. COMPARISON STUDY OF DIFFERENT FOREST MISFORTUNE MITIGATION SYSTEMS.**

| Forest Misfortune Mitigation Systems | Technology                                          | Merits                                                                                                            | Demerits                                                                                                      |
|--------------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Forest fire detection                | CS Adaboost algorithm to detect early smoke of fire | -Detect smoke image early<br>- Distinguish smoke image early<br>-Detect distractors like blue sky and grey leaves | -No option to detect candidate smoke region from smoke like scene<br>-haven' studied smoke feature extraction |

|  |                                        |                                                    |                                                                                                        |
|--|----------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|  | Wireless Sensor Networks               | -Efficient and green                               | -Can't predict the fire<br>- Surrounding object can block the solar panel there by reducing efficiency |
|  | Deep learning and background modelling | -Reduces the false detection of smog-like objects. | -the accuracy of the system is less due to the lack of enough training data.                           |
|  | IoT with Raspberry Pi and GSM          | -Detect fire at early stages<br>- Prompt and cheap | -Data transmission not secure                                                                          |

| <b>Forest Misfortune Mitigation Systems</b> | <b>Technology</b>                   | <b>Merits</b>                                                   | <b>Demerits</b>   |
|---------------------------------------------|-------------------------------------|-----------------------------------------------------------------|-------------------|
| <b>Detection of Animal Poaching</b>         | Wireless Sensor network with Zigbee | -scalable<br>-Can work with rechargeable batteries              | -prone to hacking |
|                                             | IoT and GSM                         | -can able detect deforestation, forest fire and the presence of | -Prone to failure |

|                        |                           |                                                                                         |                                                                     |
|------------------------|---------------------------|-----------------------------------------------------------------------------------------|---------------------------------------------------------------------|
|                        |                           | contaminated water.                                                                     |                                                                     |
|                        | IoT with LoRa gateway     | -Feature extraction and audio classification can be performed directly on the IoT node. | -The audio recognition test has performed based on recorded sounds. |
| <b>Animal Poaching</b> | Digital Signal Processing | -Forest officials can able to access the correct area in right time                     | -system is not compact                                              |
|                        | CAPTURE                   | - Accuracy high                                                                         | -Actual actions of the poachers are hidden from rangers.            |
|                        | Unmanned Aerial Vehicle   | -Can detect poachers and animals automatically<br>--Night vision<br>-Low cost           | -Captured image clarity low.                                        |

#### IV CONCLUSION

In this paper, we have made a review on different forest misfortune systems such as mechanisms used to detect forest fires, animal poaching , and de forestation. A comparison study is performed on different forest misfortune mitigation systems. This paper not arguing that here is a perfect collection of all methods in the detection of forest fire, animal poaching

and de forestation . A combination of the techniques for the detection of the above three misfortunes to the forests will make a significant impact on the well -being of the forests.

## REFERENCES

1. Yaqin Zhao, Qiuji Li, Zhou Gu College of Mechanical and Electronic Engineering, Nanjing Forestry University,” Early smoke detection of forest fire video using CS Adaboost algorithm”, Volume 126,issue:19,Page:2121-2124,Publication year :2015,ISSN:0030-4026.
2. Michel Owayjan, George Freiha, Roger Achkar, Elie Abdo, Samy Mallah,” Firoxio-forest fire detection and alerting system” , 17th IEEE Mediterranean Electrotechnical Conference, Beirut, Lebanon, 13-16 April 2014.
3. M. S. Kiran and P. Yunusova, “Tree-Seed Programming for Modelling of Turkey Electricity Energy Demand”, Int J Intell Syst Appl Eng, vol. 10, no. 1, pp. 142–152, Mar. 2022.
4. Guohua Wang, Juncong Li, Yongsan Zheng,” Forest smoke detection based on deep learning and background modeling”, 2020 IEEE International Conference on Power, Intelligent Computing and Systems (ICPICS).
5. A.Vidya, P.Malini, S.Sathiya, “IOT Based Forest Fire Detection And Early Warning System Using Raspberry Pi And GSM”, International Journal of Future Generation Communication and Networking Vol. 13, No. 1, (2020), pp. 1430-1435.
6. Smita Gaikwad, Prof. Rajesh Patil, Ajay Khandare, Anshuman Rai ,” Design WSN Node For Protection Of Forest Trees Against Poaching based on ZigBee”,978-1-4799-9985-9/15/ ©2015 IEEE.
7. Agarwal, D. A. . (2022). Advancing Privacy and Security of Internet of Things to Find Integrated Solutions. International Journal on Future Revolution in Computer Science & Communication Engineering, 8(2), 05–08. <https://doi.org/10.17762/ijfrcsce.v8i2.2067>
8. Shridevi. Soma and Swamy Sudha,” An Automatic System for Controlling Deforestation Using Iot And Gsm”, International Conference on Recent Trends In Computational Engineering and Technologies (ICTRCET). ISBN: 978-93-88775-00-7.
9. Alessandro Andreadis , Giovanni Giambene and Riccardo Zambon ,” Monitoring Illegal Tree Cutting through Ultra Low Power Smart IoT Devices”, Sensors 2021, 21, 7593. <https://doi.org/10.3390/s21227593>
10. Tridip Sarma, Vivek Baruah,” Real Time Poaching Detection: A Design Approach”, 2015 International Conference on Industrial Instrumentation and Control (ICIC) College of Engineering Pune, India. May 28-30, 2015.
11. Ananthakrishnan, B., V. . Padmaja, S. . Nayagi, and V. . M. “Deep Neural Network Based Anomaly Detection for Real Time Video Surveillance”. International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 4, Apr. 2022, pp. 54-64, doi:10.17762/ijritcc.v10i4.5534.
12. Thanh H. Nguyen , Arunesh Sinha , Shahrzad Gholami , Andrew Plumptre , Lucas Joppa , Milind Tambe , Margaret Driciru , Fred Wanyama , Aggrey Rwetsiba , Rob Critchlow and Colin M. Beale,” CAPTURE: A New Predictive Anti-Poaching Tool

for Wildlife Protection”, Proceedings of the 15th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2016).

13. Nouby M. Ghazaly, A. H. H. . (2022). A Review of Using Natural Gas in Internal Combustion Engines. International Journal on Recent Technologies in Mechanical and Electrical Engineering, 9(2), 07–12. <https://doi.org/10.17762/ijrmee.v9i2.365>
14. Joseph K. Paul, Tankala Yuvaraj and Karthikay Gundepudi ,” Demonstrating Low-Cost Unmanned Aerial Vehicle for anti-Poaching”, 2020 IEEE 17th India Council International Conference (INDICON)|DOI:10.1109/INDICON49873.2020.9342131.