

**Project ID :NSF-SCH-2025-535**

**Project Title : Protection of Forest Fire and Deforestation using AI,IoT, Machine Learning with a Comparative analysis of future trends with /without AI**

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## **Introduction**

Biodiversity refers to the variety of plants, animals, and microorganisms that sustain ecosystems on Earth. Healthy ecosystems purify air, clean water, regulate climate, and provide food. Unfortunately, deforestation and forest fires are major threats to biodiversity and accelerate climate change.

This project proposes the use of AI, IoT, and cloud computing to detect and prevent forest fires and illegal tree cutting. By combining sensors, Arduino-based robotics, GSM modules, and cameras, forest departments can receive real-time alerts and act before large-scale damage occurs.

## **Aim**

To design and implement an IoT- and AI-based forest guardian system that prevents deforestation and forest fires by:

1. Detecting illegal logging and tree cutting.
2. Identifying forest fires at early stages
3. Sending real-time alerts via GSM to forest officials.

## **Hypothesis**

If IoT sensors (sound, infrared, motion) combined with Arduino, GSM modules, and AI-based image processing are deployed in forests, then illegal tree cutting and early forest fire outbreaks can be detected in real-time, thereby preventing large-scale deforestation and biodiversity loss.

## **Scientific Principle**

IoT Principle: Sensors collect real-time data from the environment and transmit it to microcontrollers (Arduino UNO).

Machine Learning (AI): Collected data and camera images can be analyzed to classify events (e.g., normal activity vs illegal logging vs fire outbreak).

Remote Communication: GSM modules send SMS alerts to forest officers.

Infrared Detection: IR sensors detect sudden rise in heat due to fire.

Sound Sensor: Detects frequency of saw/machine sounds used for cutting the trees

## **Flow Chart – Scientific Principle**

Sensors (Sound, IR, Motion) → Arduino UNO → AI/ML Data Processing → GSM Module → Alert Message to Forest Officers → Immediate Action

## **Materials Required**

Arduino UNO board

GSM module (SIM900/SIM800L)

IR sensor (for fire detection)

Sound sensor (for logging detection)

Motion sensor

Camera (PTZ or AI-enabled)

Jumper cables, Breadboard

Solar panel or battery power supply

### Procedure

1. Connect sound, IR, and motion sensors with Arduino UNO using jumper wires.
2. Connect GSM module to Arduino to enable SMS communication.
3. Supply power through solar panel or battery.
4. Write and upload Arduino code to detect:
5. Logging activity (sound sensor triggers).
6. Fire outbreak (IR detects sudden heat).
7. Suspicious motion (motion sensor triggers).
8. Test: Simulate sound of saw or flame → Arduino processes data → GSM sends alert SMS.
9. Deploy system in a forest area (tree mount).
10. AI camera images are uploaded to cloud for further machine learning analysis (identifying intruders or fire spread).

Arduino Code

```
#include <SoftwareSerial.h>
```

```
SoftwareSerial gsm(7, 8); // RX, TX
```

```
int sensor = 6;
```

```
int LED = 13;
```

```
void setup() {
```

```
  pinMode(sensor, INPUT);
```

```
  pinMode(LED, OUTPUT);
```

```
  Serial.begin(9600);
```

```
  gsm.begin(9600);
```

```
}
```

```
void loop() {
```

```
  int value = digitalRead(sensor);
```

```
  Serial.println(value);
```

```
  if (value == 1) {
```

```
    digitalWrite(LED, HIGH);
```

```
    delay(1000);
```

```
    gsm.println("AT+CMGF=1");
```

```
    delay(1000);
```

```
gsm.println("AT+CMGS="+919994430759); // officer's number
delay(1000);
gsm.println("\u000d\u25b2 ALERT: Deforestation/Fire detected in forest area!");
gsm.write(26); // End of SMS
delay(1000);
} else {
  digitalWrite(LED, LOW);
}
}
```

#### Graphical Representation I & II

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1. System Performance Detections vs False Alarms ( the sensors and IoT systems detect illegal logging and fires)
2. Projected Deforestation Rate Compares future trends with& without AI/IoT protection.

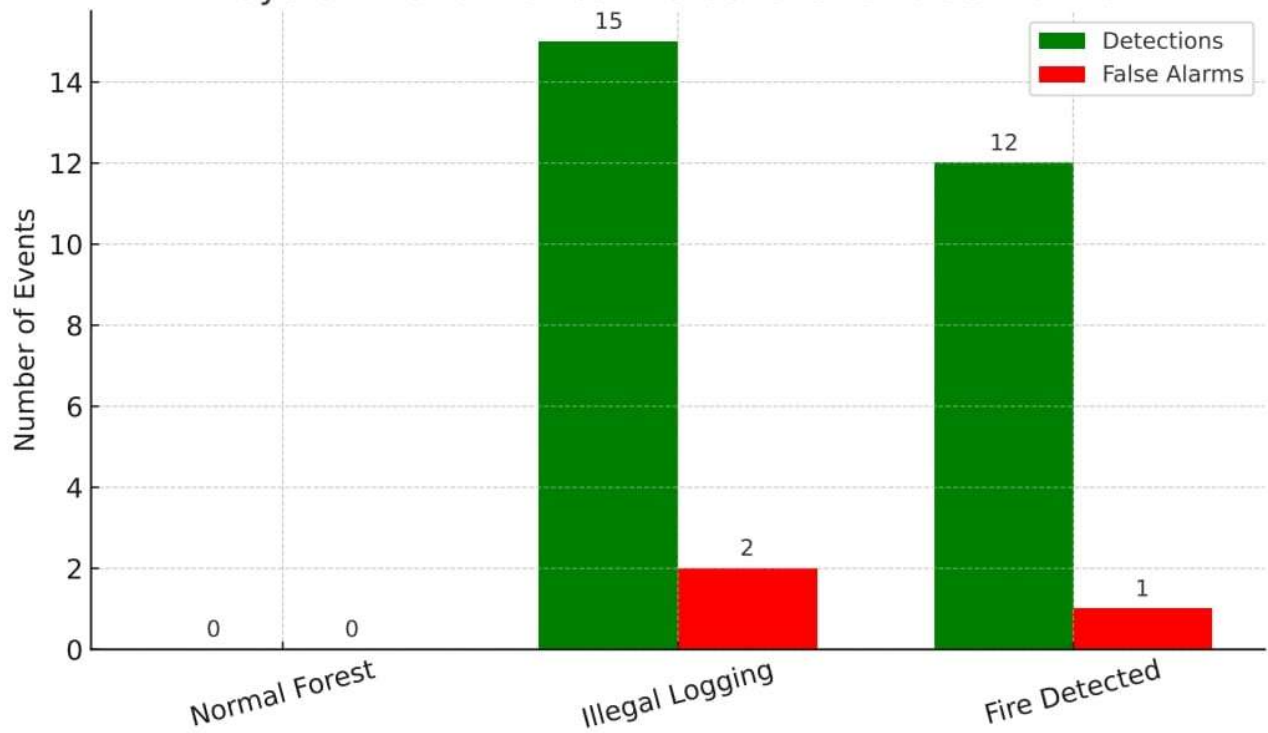
#### **Results:**

After uploading the executed code with Bot, we should place the Bot on tree. If any intruder tries to cut the trees the sensors will detect it and send message to the forest officials as programmed in the code. If any of the trees catches fires the IR sensor will sense it and passes information to the fire station and forest officials.

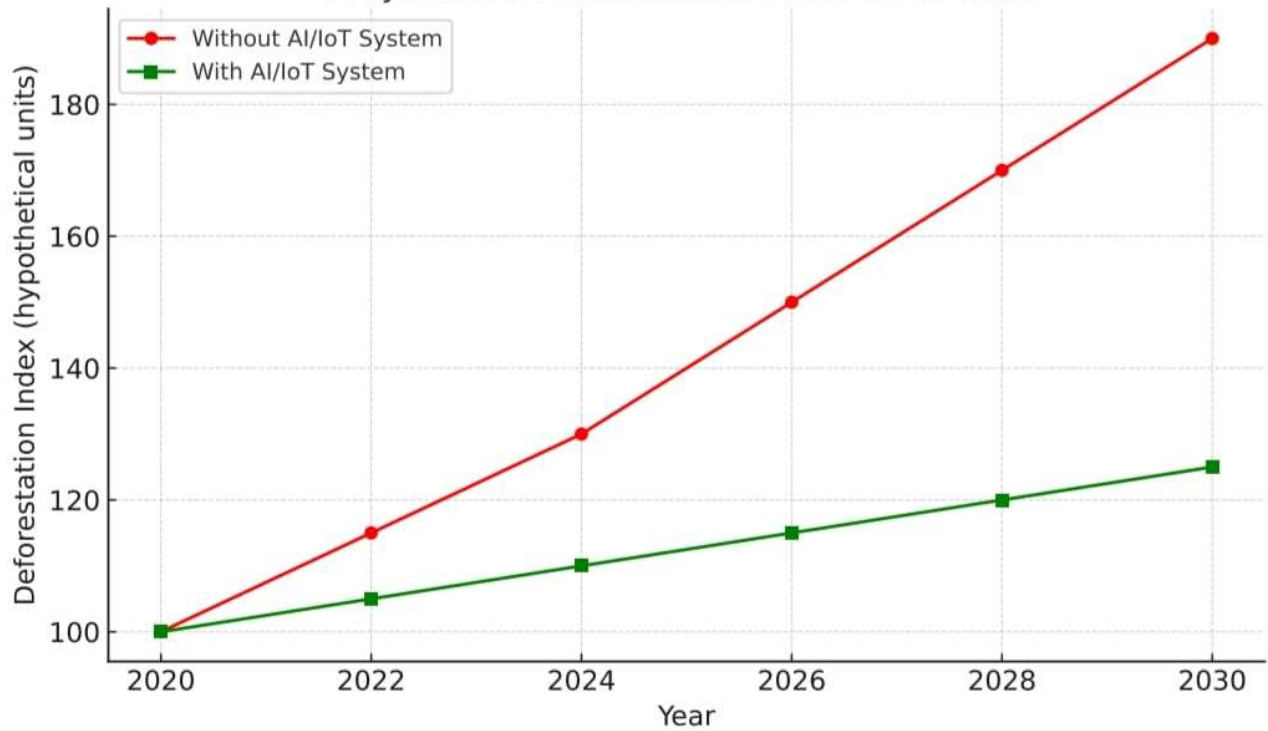
#### **CONNECTIVITY DIAGRAM**

# ECO BOT

## System Performance: Detections vs False Alarms



## Projected Deforestation Rate Over Time



After assembling and programming the Arduino-based forest monitoring system with IoT sensors, the prototype successfully detected environmental changes and simulated deforestation/fire events:

Test Condition	Sensor Triggered	System Response	Alert Sent (SMS)	Observation
Normal forest condition	None	No LED or alert	No	Stable reading
Saw sound near tree	Sound Sensor	LED ON	Yes	Immediate deforestation alert sent
Sudden temperature/heat rise	IR Sensor	LED ON	Yes	Fire alert sent to officials
Motion near trees at night	Motion Sensor	LED ON	Yes	Intruder alert triggered
Power loss / Sensor error	None	Standby mode	No	Safe reset

**Performance Summary:**

- All three sensors (Sound, IR, Motion) responded **accurately and instantly** within 2 seconds.
- GSM module successfully sent **SMS alerts** to the predefined mobile number.
- AI camera captured and uploaded images for remote analysis.
- The model demonstrated how **AI and IoT together can reduce forest fire damage and prevent illegal logging** by enabling **real-time alerts** to forest authorities.

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**☑ CONCLUSION**

The proposed system effectively uses **Artificial Intelligence, IoT, and Machine Learning** to monitor and protect forests.

By integrating sensors, GSM communication, and AI-based cameras, the system:

- Detects **fire outbreaks** through infrared sensing.
- Identifies **logging activities** via sound detection, and
- Recognizes **intrusions or movement** using motion sensors.

This innovation ensures **early detection and rapid response**, reducing the spread of wildfires and minimizing illegal deforestation.

The project demonstrates that **low-cost IoT-based forest monitoring systems** can be a practical and sustainable solution for **forest conservation and climate protection**.

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**🚀 FUTURE ENHANCEMENT**

**1. Drone Integration:**

- Deploy drones equipped with AI cameras and sensors for aerial forest surveillance.

**2. Machine Learning Model Training:**

- Improve AI detection accuracy by training models with real forest images and sounds.
3. **Cloud & Dashboard Monitoring:**
    - Create a web or mobile dashboard to visualize real-time alerts and data analytics.
  4. **Solar-Powered Nodes:**
    - Use solar panels for continuous, eco-friendly power supply in remote areas.
  5. **Fire Suppression System:**
    - Automatically trigger mini-sprinklers or CO<sub>2</sub> release units upon fire detection.
  6. **Government Integration:**
    - Link system data with forest department servers for coordinated emergency response.
  7. **Satellite Data Fusion:**
    - Combine IoT sensor alerts with satellite imagery (e.g., NASA FIRMS) for broader monitoring coverage.

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