Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1 : 2024
ISSN : **1906-9685**

FOREST PROTECTION SYSTEM USING OPTIMIZED SOLAR

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ABSTRACT :

In response to the pressing need for forest conservation and protection, our project presents a wireless sensor network to build a smart forest fire, sound, smoke early detection sensory system. This system is meticulously designed to optimize sunlight absorption, thereby maximizing energy generation. The harvested energy is stored in solar panels to power an integrated sensor system. This system employs cutting-edge technology including motion sensors to detect unauthorized tree cutting activities, as well as smoke, fire, and sound sensors to swiftly identify and report forest fires. Upon detection, a buzzer is triggered, alerting forest officers for prompt intervention. The sensors attached to the Arduino Uno will monitor the fire, sound, and smoke level. If the sensed value is beyond the predefined value given in the program, an alert message would be send via SMS.

Keywords: Sound, smoke, Fire, Accelerometer sensors, ARDUINO UNO, Microcontroller, Mobile App.

1. INTRODUCTION :

Forest conservation and protection have emerged as critical global priorities in the face of escalating environmental challenges such as deforestation and forest fires. To address these pressing issues, innovative solutions that leverage renewable energy sources and advanced sensor technology are imperative. Our project introduces the Solar Panel Forest Protection System, a pioneering approach aimed at harnessing solar energy to safeguard forest ecosystems.

The Solar Panel Forest Protection System represents a significant advancement in the field of environmental conservation. By integrating dual-axis solar tracking technology with meticulously designed fan-shaped solar panels, our system optimizes sunlight absorption, ensuring maximum energy generation throughout the day. Four light dependent resistors (LDRs) are employed to identify the sun as the strongest light source [1]. The solar panel is moved by two servo motors working together to place it where the LDRs can detect the most light. This renewable energy is stored efficiently in solar panels providing a sustainable power source for the system's integrated sensor network[2].

Central to our system's effectiveness is its utilization of cutting-edge sensor technology[2]. Motion sensors are strategically deployed to detect and deter unauthorized tree cutting activities, enabling swift intervention to prevent further deforestation. Additionally, smoke and fire sensors are integrated into the system to detect forest fires in their early stages[3]. Upon detection, the system initiates a buzzer, promptly alerting forest officers for immediate response and intervention.

The integration of renewable energy sources with advanced sensor technology underscores our commitment to mitigating environmental threats and preserving precious forest ecosystems. By proactively monitoring and addressing potential risks such as illegal logging and forest fires, the Solar Panel Forest Protection System represents a significant step towards sustainable forest management and conservation[4-5].

1.1 Internet of things:

The Internet of Things is known as IoT. IoT is difficult to define accurately. Expert in digital innovation, Kevin Ashton, has exploited the theme of IoT. And then it was well-liked.

By integrating IoT-enabled sensors and actuators, the system gains real-time monitoring capabilities that are essential for detecting and responding to environmental threats with unparalleled speed and accuracy[1]. These sensors continuously collect data on various environmental parameters, such as motion, smoke, and fire, enabling the system to detect unauthorized activities like tree cutting and identify early signs of forest fires[2].

This real-time data is transmitted to forest management authorities, providing them with valuable insights for informed decision-making and swift intervention. The integration of IoT in the Solar Panel Forest Protection System significantly enhances its ability to safeguard forests, contributing to more sustainable and effective forest conservation efforts.

2. EXISTING METHODS & IT'S DRAWBACKS:

2.1 Manual Patrols:

Method: Forest rangers conduct regular patrols to monitor and prevent illegal activities.

Drawbacks:

1. **Inefficient coverage**: Large Forest areas make it challenging to patrol effectively, allowing illegal activities to go undetected in remote locations[2].
2. **Limited timeliness**: Manual patrols may not provide real-time information, resulting in delayed responses to threats.

2.2 Traditional Sensor Networks:

Method: Fixed sensors (e.g., cameras, motion detectors) are installed in the forest to detect specific activities.

Drawbacks:

Power constraints: Dependence on traditional power sources limits deployment in off-grid areas, hindering continuous monitoring**.**

2.3 UAVs (Unmanned Aerial Vehicles):

Method: Drones are used for aerial surveillance of forested areas.

Drawbacks:

Limited endurance: Short flight times restrict the coverage area and frequency of patrols.

3. PROPOSED METHOD:

By leveraging IoT-enabled sensors and actuators, the system gains invaluable real-time monitoring capabilities, enabling it to swiftly detect and respond to environmental threats such as unauthorized activities and forest fires. The ability to remotely access and control the system ensures that forest management authorities can intervene promptly, even in remote areas.

Moreover, the adaptive control features of IoT technology enable the system to optimize its operations based on changing conditions, enhancing its efficiency in both solar energy harnessing and forest protection.

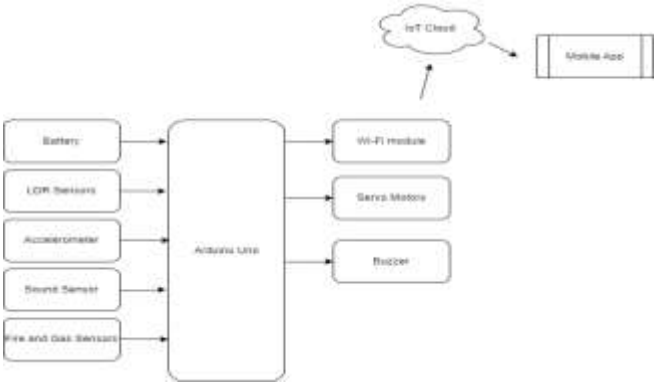

Fig 1. Block diagram

4. COMPONENTS USED:

4.1 Arduino:

With the Arduino platform, users may design and program their own electrical devices using microcontrollers. Arduino is an open-source physical processing system. The board has a variety of inputs and outputs that may be

utilized to communicate with the outside world, including digital and analog pins. A few inputs, like sensors, are fed into the Arduino, which then gives a few different outputs, like buzzer sounds. Unlike most microcontroller frameworks, which are limited to functioning on Windows, the Arduino application is compatible with Windows, Macintosh, and Linux operating systems.

Arduino is an instrument used to build a better version of a computer which can control, interact and sense more than a normal desktop computer. It's an open-source physical processing stage focused around a straightforward microcontroller board, and an environment for composing programs for the board.

Fig 2. Arduino symbol

4.2 Light dependent resistors (LDRs):

Light dependent resistors, LDRs or photo resistors are electronic components that are often used in electronic circuit designs where it is necessary to detect the presence or the level of light. LDRs are very different to other forms of resistor like the carbon film resistor, metal oxide film resistor, metal film resistor and the like that are widely used in other electronic designs[3]. They are specifically designed for their light sensitivity and the change in resistance this causes.

Fig 3. LDR Sensor

4.3 Multi-Sensor Network Monitoring System:

Integrated smoke, accelerometer, sound, fire sensors as well as a buzzer for instant notifications provide a sensor monitoring and alarm system that guarantees complete safety in a variety of settings. These sensors are strategically placed throughout the forest to continuously collect data on parameters such as motion, smoke, and sound[3]. After the buzzer promptly sounds, forest officers are alerted and an alert message would be send via SMS. So that forest officers can take immediate action to mitigate the situation[4]. The technology offers proactive security measures for enhanced security.

4.4 Centralized Monitoring System:

The centralized monitoring system facilitates remote accessibility, allowing personnel to monitor the forest and system operations from anywhere with internet connectivity.

A Centralized monitoring system serves as a centralized platform for real-time monitoring, data collection, and analysis of various parameters related to surrounding environments[4]. It monitors the real time data, which results in swift response. Cloud-based monitoring platform enables real-time data collection and analysis.

4.5 Power monitoring system:

A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through the photovoltaic effect[3]. Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge), and boron which provides the positive charge.

Fig 4. Solar panels

4.6 Servo motor :

Solar panels are often mounted on solar tracking systems that adjust their orientation throughout the day to maximize sunlight exposure. Servo Motor is a high-speed standard servo can rotate approximately 180 degrees. Solar tracking systems, powered by servo motors, enable solar panels to maintain an optimal angle relative to the sun, thereby maximizing energy production[5].

Fig 5. Servo motor

5. IMPLEMENTATION:

A prototype of our suggested method has been created and is tested in our lab to look at its architecture. There are primarily two sections to the implementation phase. The hardware component is one, while the software component is another. The following is a detailed description of the implementation phase:

5.1 Hardware Implementation:

In our project, the Arduino Uno acts as the central control unit, managing and coordinating the interactions among hardware components such as LDRs, smoke, fire, sound, Accelerometer sensors, Wi-fi module, servo motor, buzzer. Now the detailed usage of these components are given as follows. The LDR sensor continuously monitors ambient light levels, optimizing solar panel orientation and detecting sudden changes indicative of environmental disturbances[4]. MQ-02 Gas sensor/Smoke sensor provide early detection of harmful emissions, while accelerometers identify vibrations or movements associated with unauthorized activities like tree cutting and fire sensor detects changes in temperature or the presence of flames within the forest area. Servo motors enable precise control over the positioning of components, enhancing system functionality[5]. The Wi-Fi module facilitates real-time communication, transmitting critical data and alerts to forest authorities, while the LCD display device offers a user-friendly interface for on-site monitoring and status updates. Together, these hardware components form a comprehensive forest protection system, capable of proactive detection and timely response to potential threats, thereby contributing to the conservation and preservation of forest ecosystems. Upon detection, alerts are transmitted to forest officers via wireless communication, an alert message would be send via SMS and also that loud alarm may give alert to nearby individuals and wildlife[3]. A centralized control unit manages system operations, and weatherproof enclosures ensure durability in outdoor conditions. Finally The USB cable serves as a power supply and data connection interface for components that require it, such as the Arduino Uno and the Wi-Fi module (NodeMCU).

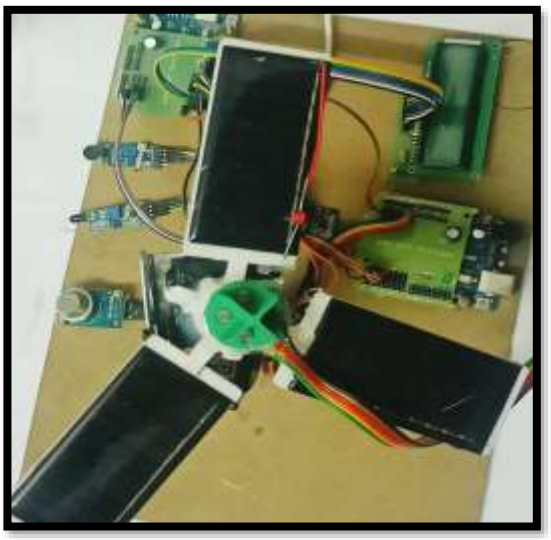

Fig 6. Circuit schematic for solar forest protection

5.2 Software Implementation:

Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Arduino IDE is a comprehensive software tool designed for programming Arduino microcontroller boards. Its key features cater to both beginners and experienced developers, offering a user-friendly environment for writing, compiling, and uploading code .

This Arduino code extends the software implementation by incorporating servo motors controlled by LDR sensors to dynamically adjust the position of a mechanism in response to changes in light intensity. The system initializes the servo motors and establishes serial communication for monitoring. Within

the main loop, analog readings from four LDR sensors are continuously sampled[5]. These readings determine the direction in which the servo motors should move to optimize the position of the mechanism. Each LDR sensor corresponds to a cardinal direction (East, North, West, South), and if the sensor reading surpasses a predefined threshold (set at 600), indicating brighter light in that direction, This Arduino code implements a software solution for monitoring environmental conditions and detecting potential incidents like falls, smoke, fire or gas presence[4]. Detected incidents trigger corresponding status flags, updating system status displayed on the LCD screen. If any incident is detected, such as a fall or smoke presence, the buzzer is activated briefly to alert users, and system status is transmitted serially for monitoring. This software implementation enables real-time monitoring of environmental conditions and swift response to potential threats, enhancing safety and security in the monitored area.

6. ALERT VIA MOBILE APP:

Fig 7. Detection of forest threats through Mobile App

The IoT home app serves as a centralized interface, allowing users to access real-time data from these sensors, receive alerts, and remotely control IoT devices. Through the app, users can monitor the forest environment, receive instant notifications in case of anomalies or threats, and take immediate action by remotely controlling devices such as sprinkler systems for fire suppression or gate barriers for access control. By leveraging the power of IoT technology and mobile connectivity, the IoT_home app enables efficient and proactive management of the forest environment, ensuring its sustainability and protection for future generations**.**

Controlling the forest environment using the IoT_home app involves implementing a system that displays "1" if any change or anomaly is detected in the forest environment and gives a alert like “Abnormal Activity found”, and "0" otherwise. The system consists of various sensors deployed throughout the forest, continuously monitoring environmental parameters such as temperature, humidity, air quality, and detecting potential threats like fires or unauthorized activities. These sensors feed data to a centralized IoT platform accessible via the IoT_home app. If no changes or anomalies are detected, the system remains idle, and the IoT_home app displays "0" to indicate that the forest environment is stable. This simple binary display system allows users to quickly and easily monitor the status of the forest environment and respond promptly to any detected changes, thereby enhancing forest management and conservation efforts.

7. RESULTS:

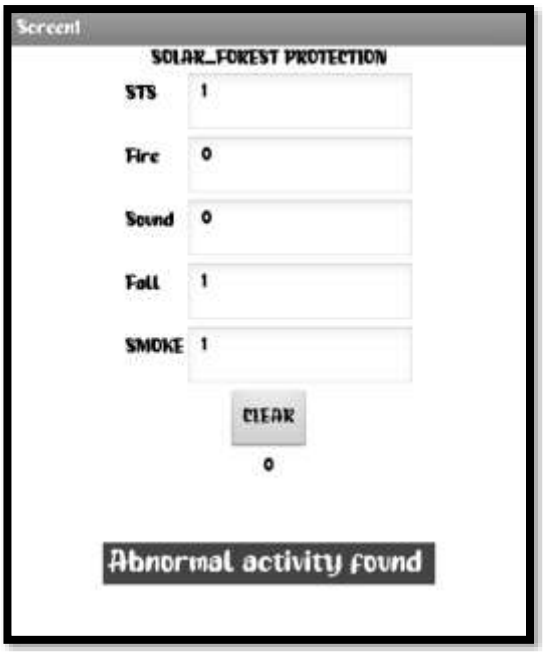

Fig 8. Results Monitoring on Mobile

In summary, implementing the forest environment control system using the

IoT_home app results in improved forest management and conservation through real-time monitoring, timely alerts, and community engagement. This proactive approach enhances response times to threats like forest fires and unauthorized activities, promoting the sustainability and resilience of forest ecosystems in the face of environmental challenges.

8. CONCLUSION

In conclusion, the project of controlling the forest environment using the IoT_home app represents a significant step forward in forest management and conservation efforts. By leveraging IoT technologies and mobile connectivity, the system enables real-time monitoring of environmental parameters and timely detection of anomalies or threats such as forest fires or unauthorized activities. Through community engagement features and proactive alerts, the project fosters collaboration among stakeholders and promotes a shared responsibility for forest conservation. Ultimately, this innovative approach holds great promise for enhancing the sustainability and resilience of forest ecosystems, safeguarding these invaluable natural resources for future generations.

9. FUTURE SCOPE :

The project of controlling the forest environment using the IoT_home app harbours vast potential for future innovation and impact on forest conservation endeavours.

Firstly, by advancing sensor integration, the system can incorporate cutting-edge technologies like LiDAR (Light Detection and Ranging) and hyperspectral imaging to capture detailed information about forest structure, biodiversity, and health. Moreover, integrating remote sensing capabilities from satellites or drones could enhance the system's coverage and provide insights into broader-scale forest trends and changes over time.

Secondly, leveraging the power of predictive analytics and artificial intelligence can revolutionize how forest management decisions are made. By analysing vast amounts of historical and real-time data, AI algorithms can identify emerging patterns and forecast potential threats like droughts, pest outbreaks, or wildfire risks with greater accuracy.

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