|| Volume 8 || Issue 2 || February 2024 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
AND ENGINEERING TRENDS

IoT-Based Electrical Device Surveillance and Control System

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Abstract: With the increasing integration of smart technologies into daily life, the need for an efficient, automated, and remote-controlled electrical device surveillance system has become imperative. The Internet of Things (IoT) provides a robust platform for developing intelligent systems that allow users to monitor and control electrical devices from anywhere using internet-connected devices. Traditional electrical control mechanisms rely on manual operation, which limits flexibility and efficiency. This paper proposes an IoT-based electrical device surveillance and control system that enhances energy efficiency, security, and user convenience. The system consists of smart sensors, microcontrollers, and cloud-based platforms to facilitate real-time monitoring and control. Data collected from sensors are processed and analyzed to optimize power consumption while ensuring the safety of electrical appliances. The proposed system integrates machine learning techniques for predictive maintenance, anomaly detection, and automated decision-making. By leveraging IoT-based automation, this system minimizes human intervention, reduces energy waste, and provides a cost-effective solution for home automation and industrial applications. This paper explores the existing challenges, proposed methodology, system architecture, and experimental results that validate the effectiveness of the developed system.

I.Introduction:

The evolution of IoT has transformed various industries by enabling real-time monitoring, data-driven decision-making, and automation. One of the most impactful applications of IoT is in the field of electrical device surveillance and control, where intelligent systems can remotely manage appliances, optimize energy consumption, and enhance security. In traditional electrical systems, human intervention is required to operate appliances, leading to inefficiencies and higher energy consumption. Moreover, electrical failures, device malfunctions, and security risks are often undetected until significant damage occurs.

An IoT-enabled electrical device control system mitigates these challenges by integrating smart sensors, cloud-based data storage, and mobile applications for remote access. By using Wi-Fi, Zigbee, or LoRa communication protocols, electrical devices can be interconnected and controlled via a centralized system. Additionally, advanced algorithms for predictive maintenance help in identifying potential failures before they occur, reducing downtime and maintenance costs.

This paper discusses the necessity of IoT-based automation in electrical surveillance, presents an in-depth analysis of the proposed system, and evaluates its effectiveness in improving operational efficiency, security, and energy savings. The research also compares existing solutions with the developed system to highlight its advantages and potential applications.

II.Objective

The primary objectives of this research are:

1. Remote Monitoring and Control: Enable users to control electrical devices from anywhere using a web-based or mobile application.
2. Energy Efficiency: Optimize power consumption by monitoring device usage patterns and automating operations.
3. Fault Detection and Predictive Maintenance: Identify electrical failures using AI-based predictive analytics to prevent unexpected breakdowns.
4. Security Enhancement: Detect unauthorized usage and potential hazards through real-time surveillance mechanisms.
5. User Convenience: Provide an intuitive and user-friendly interface for easy management of home and industrial electrical appliances.
6. Cost Reduction: Reduce electricity bills and operational costs by automating device control and reducing energy wastage.

III.Existing System

Current electrical device control methods primarily rely on manual operation or rudimentary automation. These systems suffer from several limitations:

1. Lack of Remote Access: Traditional systems require physical presence for device operation, reducing flexibility.
2. High Energy Consumption: Inefficient device usage leads to unnecessary power consumption, increasing electricity costs.
3. Limited Security Measures: Existing systems do not provide real-time alerts for unauthorized access or device malfunctions.

4. Absence of Predictive Maintenance: Electrical failures are only addressed after they occur, resulting in costly repairs and downtime.
5. Non-Integrated Systems: Different appliances operate independently without centralized control, leading to inefficient management.

Block Diagram

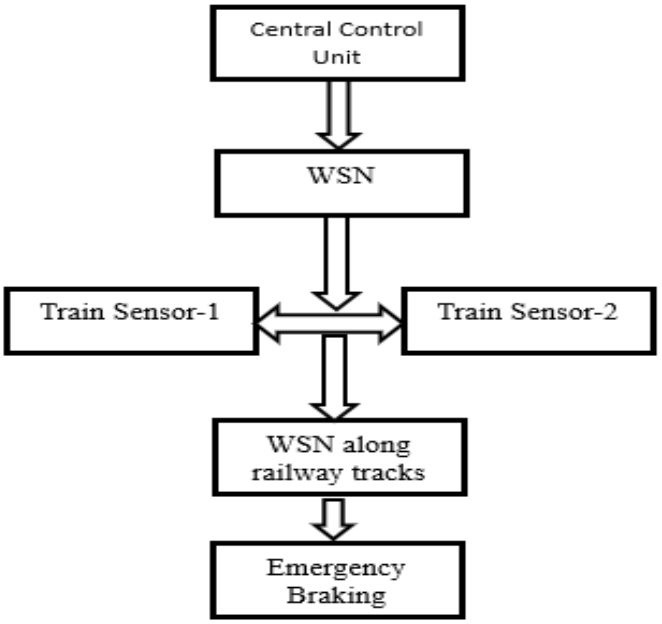

Fig 2. Block Diagram

IV.Proposed System

To overcome the limitations of existing systems, this research proposes an IoT-based electrical device surveillance and control system with the following features:

1. Smart Sensors: Monitor parameters like voltage, current, temperature, and device status in real-time.
2. Microcontroller Unit (MCU): Acts as a central processing hub, interfacing with sensors and communication modules.
3. Cloud Connectivity: Data collected from sensors are transmitted to a cloud platform for remote access and analysis.
4. Mobile/Web Application: Provides a user-friendly interface for monitoring and controlling devices remotely.
5. Artificial Intelligence Integration: AI algorithms analyze usage patterns to optimize energy consumption and detect anomalies.
6. Automated Alerts and Notifications: Sends real-time alerts in case of abnormal power usage, device failures, or security breaches.

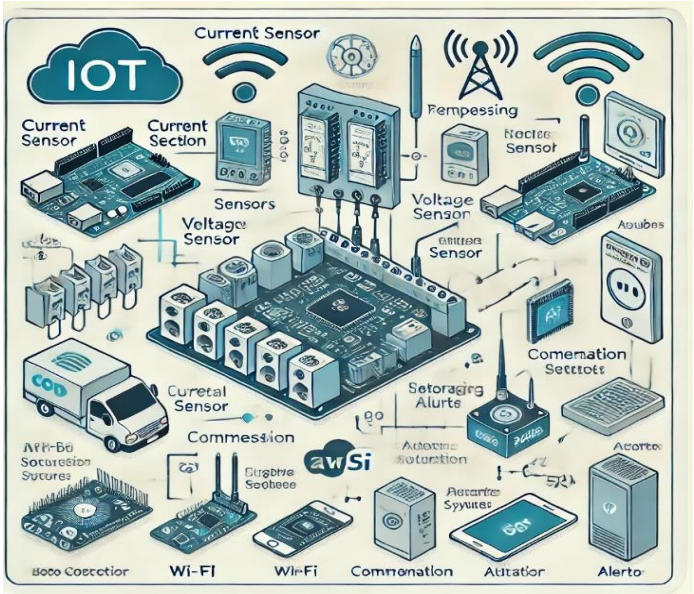

Fig 1. Proposed system

V.Methodology

The implementation of the proposed system follows these key steps:

1. Hardware Selection and Setup: Includes microcontrollers (such as ESP8266/ESP32), sensors, relays, and communication modules.
2. Sensor Data Acquisition: Sensors collect real-time data on electrical parameters and transmit it to the microcontroller.
3. Cloud Storage and Processing: Data is uploaded to a cloud server (e.g., Firebase, AWS IoT) for storage and processing.
4. User Interface Development: A web-based dashboard and mobile application allow users to control and monitor devices remotely.
5. AI-Based Analysis: Machine learning algorithms detect anomalies, optimize energy consumption, and predict potential failures.
6. Automated Control and Alerts: The system autonomously turns off unused devices and sends alerts for abnormal activities.

VI.Applications

1. Smart Homes: Enables remote control of home appliances for convenience and energy efficiency.
2. Industrial Automation: Enhances monitoring and management of factory equipment.
3. Office Spaces: Optimizes power usage by automating lighting, air conditioning, and other electrical systems.
4. Healthcare Facilities: Ensures critical medical devices operate efficiently without power failures.
5. Educational Institutions: Provides centralized monitoring of electrical usage in schools and universities.

Advantages

1. Enhanced Energy Efficiency: Reduces unnecessary power usage and lowers electricity costs.
2. Improved Security: Detects unauthorized access and prevents electrical hazards.
3. Remote Accessibility: Allows users to control devices from anywhere in the world.
4. Predictive Maintenance: Prevents device failures through AI-driven analytics.
5. User-Friendly Interface: Simplifies device management for users of all technical backgrounds.

VII.Conclusion

The IoT-based electrical device surveillance and control system provides an innovative and practical solution to modern electrical management challenges. By integrating smart sensors, AI analytics, and cloud-based control mechanisms, the system enhances energy efficiency, security, and user convenience. The proposed system addresses the limitations of traditional control mechanisms, making electrical monitoring more intelligent, automated, and cost-effective. Future work will focus on expanding AI capabilities, integrating voice control, and improving security features to further enhance the system's performance.

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