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IoT-based Smart Electra Track with Web Dashboard

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ABSTRACT- The IoT-Enabled Smart Circuit Breaker system is designed to enhance safety and reduce electrical hazards, particularly for linemen performing maintenance work. Miscommunication between substations and workers often leads to fatal accidents. This project addresses the issue by integrating IoT technology for remote circuit control via a password-protected interface using Firebase. The system is powered by an ESP32 microcontroller with built-in WiFi and Bluetooth, ensuring reliable connectivity. A relay module enables fast load switching, while a Hall Effect sensor (ACS712) monitors current flow. An OLED display provides real-time system status, and a solid-state relay (SSR) ensures noise-free operation. The circuit is powered by a 12V adapter, regulated by an LM7805 voltage regulator. Users can control the system remotely via a mobile app, developed using MIT App Inventor, ensuring secure access with password authentication. This innovative approach significantly enhances industrial safety, prevents electric shocks, and enables efficient remote monitoring of electrical loads.

Keywords -IoT, smart energy monitoring, real-time electricity usage, ESP32, ACS712 sensor, Firebase, web dashboard, power consumption, energy alerts, electricity monitoring, cost saving, energy efficiency, remote monitoring

I. INTRODUCTION

The IoT-based Smart ElectraTrack with Web Dashboard is designed to help people monitor their electricity usage in real time. Many homes and businesses struggle with high electricity bills because they do not know how much power they are using until the bill arrives. This system solves that problem by allowing users to see their energy usage instantly and take steps to reduce unnecessary consumption.

The system works using a current sensor called ACS712 along with an ESP32 microcontroller. The sensor measures the electricity being used by different appliances, and the ESP32 sends this data through WiFi. Instead of just showing numbers on a meter, the information is sent to a web dashboard, which makes it easier for users to view and understand their power consumption.

One of the main benefits of this project is that it can alert users when the power usage crosses a safe or pre-set limit. This feature helps prevent sudden spikes in energy consumption and makes it possible to avoid unexpected high bills. Users can set their own usage limit, and the system will immediately notify them if the limit is exceeded.

The collected data is stored in Firebase, which acts as a database in the cloud. This means the information can be accessed at any time, from anywhere, using a computer or smartphone. The web dashboard is simple to use and provides clear visualizations so that even non-technical users can easily understand their electricity usage patterns.

Overall, the IoT-based Smart ElectraTrack is an efficient and user-friendly solution for managing electricity consumption. It encourages people to save energy, reduce costs, and create awareness about their power usage. With real-time tracking and smart alerts, this system makes homes and businesses more energy-conscious and better prepared to handle their electricity needs.

II. OVERVIEW

It is a system that helps people monitor their electricity usage in real time. It uses a current sensor and an ESP32 to measure power

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consumption and send the data over WiFi to a web dashboard. The information is stored in Firebase, so users can check their usage anytime and from anywhere. The system also alerts users when their electricity usage crosses a set limit, helping them avoid high bills and reduce unnecessary power consumption. This makes it a simple, effective, and user-friendly solution for saving energy and managing electricity better.

III. COMPONENTS

HARDWARE COMPONENTS :

1. **ESP32** - Microcontroller with built-in WiFi for data processing and transmission.
2. **ACS712 Current Sensor** - Measures real-time electrical current usage.
3. **WiFi Module** (Built into ESP32) Used for wireless data transfer.
4. **Power Supply** - Powers the entire system.
5. **Connecting Wires & Breadboard/PCB**-For circuit connections.

SOFTWARE COMPONENTS:

1. **Firebase Cloud** database for storing real-time data.
2. **Node.js** - Backend server to handle data flow.
3. **HTML/CSS/JavaScript** - For creating the web dashboard.
4. **Arduino IDE** - For programming the ESP32 microcontroller.

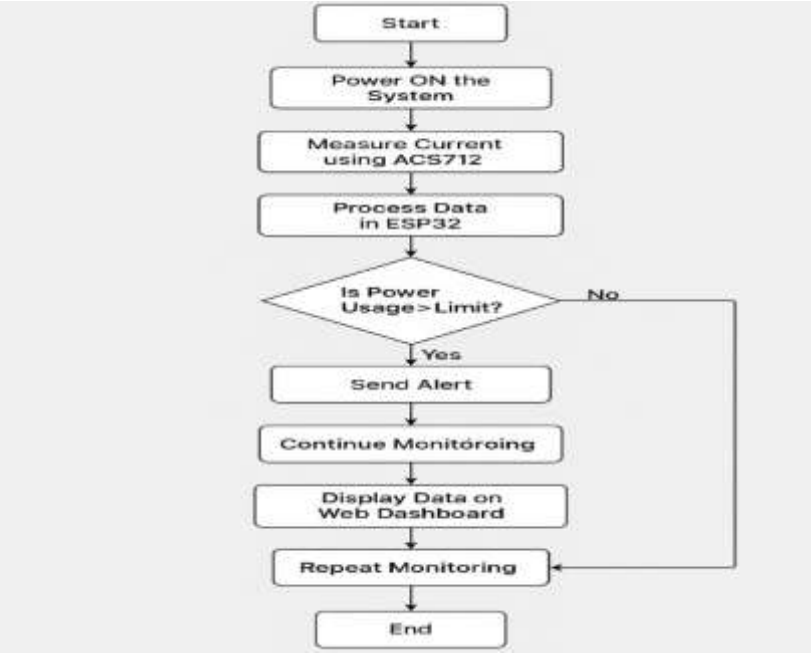

Fig 1: Flowchart

IV. EXISTING SYSTEM

The existing system for monitoring electricity usage mainly relies on traditional energy meters, which only show the total consumption at the end of the billing cycle. Users cannot track their power usage in real time, and there are no alerts when electricity consumption goes beyond safe or expected limits. This often leads to higher energy usage, wastage, and unexpected bills. Since people are not aware of their daily or hourly electricity consumption, they cannot take immediate steps to reduce unnecessary usage. As a result, the existing system lacks flexibility, instant monitoring, and user-friendly features for efficient energy management.

A. ABBREVIATIONS

- IoT – Internet of Things
- ESP – Embedded Serial Processor
- ESP32 – Espressif 32-bit Microcontroller
- ACS – Allegro Current Sensor
- WiFi – Wireless Fidelity
- DB – Database
- UI – User Interface
- LED – Light Emitting Diode
- API – Application Programming Interface

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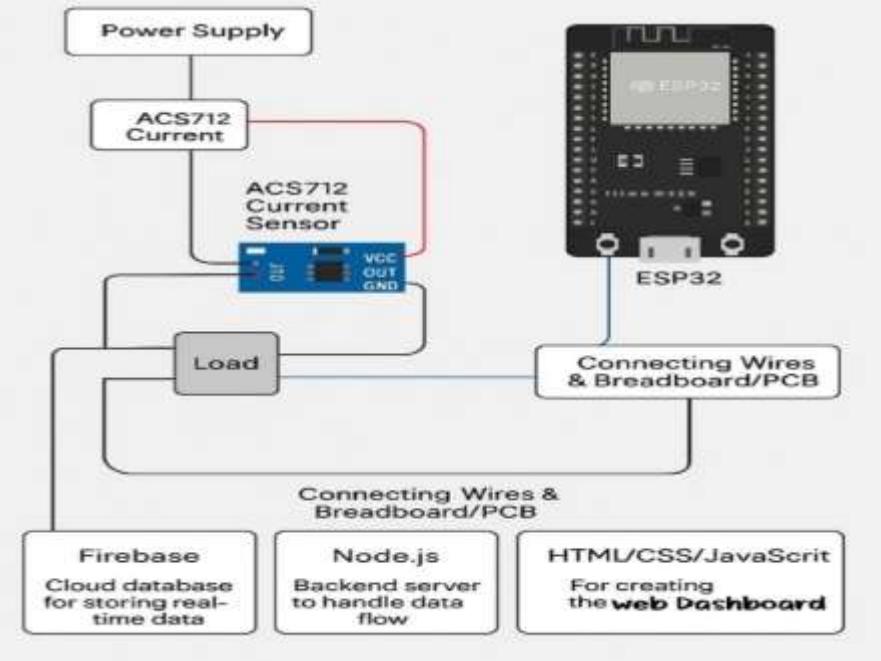

Fig 2: Block Diagram

B. METHODOLOGY

The system works by first using the ACS712 current sensor to measure the amount of electricity being consumed by the connected appliances. This data is then processed by the ESP32 microcontroller, which sends the information over WiFi to Firebase, a cloud database. From there, the stored data is displayed on a web dashboard where users can easily view their real-time electricity usage. The dashboard also checks if the usage crosses a set limit, and if it does, an alert is sent to notify the user. This step-by-step process makes it possible to monitor, store, and control energy usage efficiently.

V. IMPLEMENTATION OF PROJECT

The project is implemented using a current sensor (ACS712) connected to an ESP32 microcontroller, which measures the electricity usage of appliances. The ESP32 sends the collected data through WiFi to Firebase, where it is stored safely in the cloud. A web dashboard is created to display the data in an easy-to-understand way, allowing users to monitor their electricity usage in real time. The system also includes a feature to set a usage limit, and when the consumption goes beyond this limit, an alert is sent to the user. This makes the system practical, simple, and effective for tracking and managing power consumption.

VI. PROPOSED SOLUTION

The proposed solution is to develop a smart energy monitoring system that allows users to track their electricity usage in real time through a web dashboard. The system uses an ACS712 current sensor and an ESP32 microcontroller to measure and send data over WiFi, which is then stored in Firebase for easy access. Users can view their energy consumption on the dashboard and receive alerts when the usage crosses a set limit. This helps in reducing unnecessary power consumption, avoiding high electricity bills, and promoting efficient energy management in homes and businesses.

VII. SCOPE OF THE PROJECT

The scope of this project is to provide an easy and smart way for people to monitor and manage their electricity usage in real time. It can be used in homes, offices, and small businesses to track power consumption, set usage limits, and get alerts when those limits are crossed. The system helps reduce unexpected high bills, improves energy efficiency, and creates awareness about power usage. Since the data is stored in the cloud and shown on a web dashboard, it can be acessed from anywhere, making it flexible and user-friendly for everyday use.

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VIII. ADVANTAGES

- It helps to monitor electricity usage in real time.
- Users can set limits and get alerts when power crosses the limit.
- It reduces unexpected high electricity bills.
- Data can be checked anytime from anywhere using the web dashboard.
- It encourages energy saving and better electricity management.

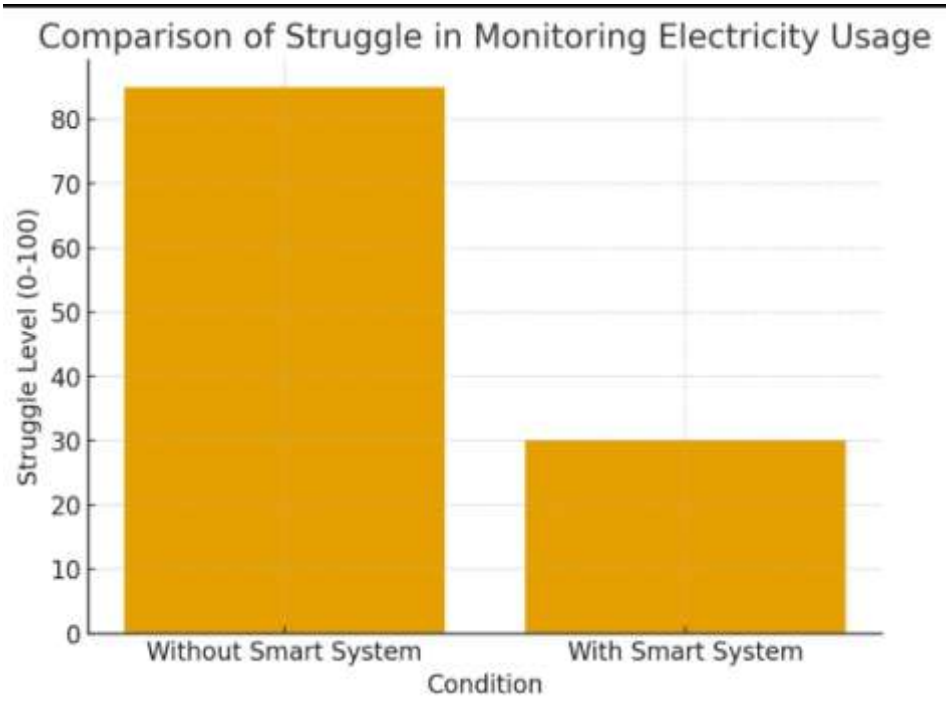

Fig 3: Comparison of struggle in Monitoring Electricity Usage

IX. FUTURE WORK

1.Add mobile app support so users can check electricity usage directly on their phones.
2. Use solar energy integration to track both consumption and renewable energy usage.
3. Add voice assistant support like Alexa or Google Assistant for easy control.
4. Improve the alert system by sending SMS or WhatsApp notifications.
5. Add automatic switching off of appliances when usage crosses the limit.
6. Provide detailed monthly and yearly reports of energy usage.
7. Use AI to predict future electricity usage based on past patterns.
8. Add multi-device support so users can track usage of each appliance separately.
9. Improve the dashboard design with more graphs and visuals for easy understanding.
10. Create a low-cost hardware version so more people can afford and use the system.

X. CONCLUSION

This project shows how IoT can be used in a smart way to monitor electricity and control energy usage. By using a current sensor, ESP32, Firebase, and a web dashboard, the system gives users real-time information about their power consumption. It also sends alerts when usage crosses the set limit, helping to prevent high bills and wastage of energy. The solution is simple, affordable, and useful for both homes and small businesses, making it easier for people to save electricity and manage their power usage more effectively.

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