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IOT BASED POWER MONITORING SYSTEM WITH THE HELP OF ESP8266 AND PZEM 004T SENSOR

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ABSTRACT

The Internet of Things (IoT)-based Power Monitoring System offers a smart solution for real-time Monitoring and efficient management of electrical power consumption across diverse applications, ranging from residential buildings to industrial setups. By integrating IoT technology with power monitoring sensors, this system provides comprehensive insights into power usage patterns, enabling users to optimize energy efficiency and reduce wastage. The system's architecture consists of embedded microcontrollers connected to sensors. The system gathers information on electrical parameters such as voltage levels, current flow, and overall energy usage, which is then transmitted to a cloud-based platform for analysis and visualization. Through a simple and accessible interface, users can monitor their energy consumption in real-time, set customized alerts, and make data-driven decisions to minimize costs. This IoT-based solution not only enhances energy management but also facilitates predictive maintenance by identifying irregularities or excessive power usage. Consequently, it supports the development of sustainable practices by promoting energy conservation and resource optimization. The implementation of such a system demonstrates the potential of IoT in advancing power management, offering scalability, accessibility, and adaptability for future smart grid applications.

Keywords: Power Monitoring System, Load Management, Wireless Power Monitoring.

I. INTRODUCTION

In the past few years, the surge in energy demands the need for more sustainable solutions have led to a greater focus on monitoring and optimizing power consumption across various sectors. The Internet of Things (IoT) innovation has emerged as a transformative technology, allowing devices to interact and transfer data continuously. In the field of power management, IoT-based systems offer new opportunities for continuous monitoring and efficient energy use. Traditional power monitoring methods often require manual checks and lack the flexibility to provide real-time data or instant insights into usage patterns. By integrating IoT technologies, power monitoring systems can now provide real-time data collection, analysis, and visualization, allowing users to make informed decisions on energy consumption.

In IoT-based power monitoring system generally includes various sensors and microcontrollers that capture and transmit data such as voltage, current, and overall power usage to a central platform, typically a cloud server. This data can be accessed through a user-friendly interface, enabling users to track their energy usage at any time and from any location. Such systems also allow users to set alerts for unusual consumption patterns, facilitating proactive measures to reduce energy wastage. Moreover, the data insights enable organizations and households to implement energy-saving practices and contribute to environmental sustainability.

II. LITERATURE REVIEW

In 2017, C. Choi and colleagues introduced an IoT-based power monitoring system designed to predict energy demand. This system primarily leveraged LoRa technology and renewable energy sources; however, it lacked a detailed explanation of how data collection and power calculations were performed. That same year, Hiremath

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et al. conducted research focused on IoT-enabled energy control and management. They developed an energy meter using an Arduino microcontroller to measure electrical device power consumption, which was then transmitted to a server via a Wi-Fi module. Users could monitor consumption globally through a web-based application. This study emphasized the technological tools employed, though it did not provide extensive measurement data or insights into the experiment's specifics. Additionally, in 2018, Medina and associates explored IoT-driven monitoring of electrical energy use with a Raspberry Pi setup, which aimed to enhance control and visibility of energy consumption. An Android application displayed collected data. Their study indicated that current sensor analog inputs were managed by an Arduino and processed by the Raspberry Pi, with data subsequently stored in a database. The results revealed variability in accuracy, with some systems performing well while others were less precise.

In 2019, Prasetyo et al. conducted a study on Smart Home systems aimed at monitoring and managing electrical energy consumption. This research was carried out in Indonesia with the goal of evaluating electricity usage efficiency through cloud-based IoT monitoring and control mechanisms. The Smart Home setup involved several components, including an Arduino board, the Connectivity module, an AC voltmeter, relays, an LDR sensor, and a PIR motion sensor. The outcome of this study was primarily a conceptual design, as development and implementation of the actual system had not yet commenced.

III. PROPOSED SYSTEM

This IoT-based power monitoring system tracks electrical consumption by measuring current with a current transformer (CT) sensor placed around the live wire of an electrical load. The CT sensor's signal is processed by a conditioning circuit to ensure accurate readings, which are then sent to a microcontroller, such as an ESP8266 or ESP32. The microcontroller calculates power usage and displays it on an LCD screen, providing real-time information on energy consumption. Additionally, the system's Wi-Fi capability allows for remote monitoring, making it ideal for tracking power usage from anywhere on an IoT platform.

The key elements necessary for the system are:

1. PZEM 004t meter Module
2. Node MCU (ESP8266)
3. LCD Display
4. SMPS (Power Supply)

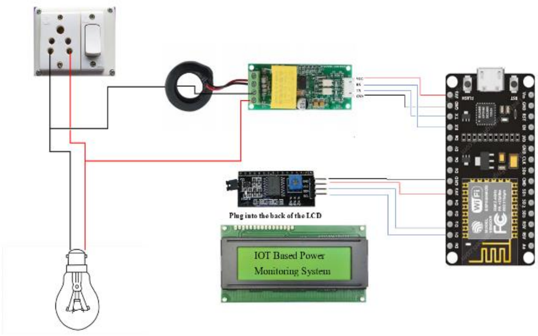

Figure 1: Block Diagram of Power Monitoring System

IV. HARDWARE COMPONENTS

1. PZEM 004t meter Module:

Figure 2: PZEM 004t meter Module

PZEM-004t multifunction ac power monitor is a popular choice for projects focused on tracking electrical consumption it effectively measures key measures such as voltage, current, power, and energy with a built-in serial interface it also includes an overload detection feature the heart of the pzem-004t module is the sd3004 chip

2. Node MCU (ESP8266):

Figure 3: Node MCU (ESP8266)

The Arduino platform lacks native Wi-Fi capabilities, requiring developers to add an external Wi-Fi module and implement additional code to enable wireless connectivity. In contrast, Node MCU is a microcontroller featuring integrated Wi-Fi support, specifically designed to simplify IoT application development. Built on the cost-effective ESP8266 chip, Node MCU offers an open-source environment for both software and hardware build processes, allowing for low-level hardware control. Additionally, Node MCU is compatible with the Arduino IDE, providing a familiar programming interface for Arduino users while streamlining the development process for wireless IoT solutions.

3. LCD Display:

Figure 4: 20*4 LCD

This is a 20x4 LCD display screen featuring an I2C communication interface. It requires only four pins to operate: VCC, GND, SDA, and SCL

4. SMPS

Figure 5: SMPS

SMPS, or switched-mode power supply, is primarily utilized to produce a controlled DC output provided by an unconditioned AC input. It delivers power from the source to various loads and plays a significant role in managing power consumption. Compared to linear regulators, SMPS units are more efficient, with far less power loss than In our project, we utilized transformer-based power sources. a 5-volt, 1-amp power supply

V. WORKING

In our project, data from the NodeMCU is transmitted to the server using the HTTP protocol. We have chosen Firebase as our preferred server for easy relay control and configuration. Users can access real-time data through a web or Android application, enabling them to monitor and control loads from anywhere in the world, which helps in reducing electricity costs. The web development is implemented using the Python Django framework. The MIT App Inventor serves as a third-party platform, acting as the user interface between the mobile device and the controlled equipment, and it is an open-source platform for building mobile applications.

VI. RESULT

The Power Monitoring System using ESP8266 and PZEM-004T provides real-time tracking of electrical values like voltage, current, power, and energy consumption. The ESP8266 wirelessly transmits this data to a cloud-based service or online application, giving users the ability to monitor power usage remotely via smartphones or computers. The system helps optimize energy consumption, reduce electricity bills, and detect inefficiencies or faulty equipment. Additionally, users can control connected devices remotely, offering greater convenience and energy savings. The system's data logging and analysis features allow for monitoring trends over time, providing insights into usage patterns and further optimizing energy management.

The power monitoring system will enable real-time tracking, control, and optimization of electrical energy consumption, providing both cost savings and the ability to prevent equipment malfunctions. By leveraging ESP8266 for wireless communication and PZEM-004T for precise energy monitoring, this project offers a highly efficient solution for remote power management and energy monitoring in both residential and industrial settings.

VII. CONCLUSION

The IoT-based power monitoring system effectively addresses the need for real-time power consumption monitoring, offering users an efficient and convenient way to manage and optimize energy usage. By leveraging IoT technology, the system allows users to track power consumption across multiple devices and locations, providing valuable insights into usage patterns. The integration with cloud services enables remote monitoring and data storage, making it accessible anytime and from anywhere.

The project demonstrated that IoT-powered monitoring can significantly reduce energy costs by identifying high-consumption appliances and optimizing usage habits. It also offers the potential to contribute to sustainability efforts by reducing unnecessary energy waste. The system's scalability ensures it can adapt to various environments, from residential homes to industrial settings, highlighting its versatility and broad applicability.

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