ISSN:2229-6107

INTERNATIONAL JOURNAL OF PURE AND APPLIED SCIENCE & TECHNOLOGY

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www.ijpast.in

INTERNATIONAL JOURNAL OF PURE AND APPLIED SCIENCE & TECHNOLOGY
IJPAST

ISSN 2229-6107
www.ijpast.in
Vol 13,Issue 4. Nov 2023

DESIGN OF RASPBERRY PI WEB-BASED ENERGY MONITORING SYSTEM FOR RESIDENTIAL ELECTRICITY CONSUMPTION

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ABSTRACT **- Electric power is an essential need for various purposes, encompassing domestic, industrial, and agricultural applications. To enable the controlled and monitored flow of electric current through electronic circuits, a Smart Meter is employed, equipped with an electronic chip for energy consumption monitoring and a wireless module for data communication. This comprehensive setup includes an automated metering device, a Raspberry Pi, a PZEM Module, and a buzzer, facilitating the measurement and transmission of energy consumption data to a cloud server.This paper endeavors to create a web-based energy monitoring system for residential electricity consumption using a Raspberry Pi. The system offers real-time data and analysis to help homeowners efficiently track and manage their energy usage, tackling issues related to data collection, processing, web interface development, and energy efficiency suggestions. It is adaptable, works with different power supply setups, and enables users to make informed decisions about their electricity consumption. This initiative allows homeowners to actively oversee their energy consumption, pinpoint power-hungry appliances, and adopt energy-saving practices for both cost-effectiveness and environmental sustainability.**

Keywords: **Raspberry Pi, Energy Monitoring, Electric Power, Smart Meter, Data Communication**

1. INTRODUCTION

With the rapid evolution of home automation systems driven by electronic and information technology advancements, smart home systems have emerged as a prominent application, aiding homeowners in the automatic, remote, and centralized control and monitoring of energy consumption. Notably, electricity consumption in Indonesia, as per the Ministry of Energy and Mineral Resources, has been on the rise annually, with one contributing factor being the inefficiency in home electricity usage. This inefficiency stems from incorrect timing, ineffective practices, and a lack of consumer awareness regarding electricity conservation, primarily because consumers lack direct visibility into their electrical energy usage.Electric energy usage encompasses the utilization of electricity for residential, agricultural, and industrial purposes. In 2012, the global electricity consumption reached an estimated 20,900 Terawatt-hours (TWh), and by 2018, it had increased by 4%, marking the highest growth since 2010. While nuclear and renewable energy sources contribute significantly to meeting the electricity demand, there's a rising deployment of coal and internal combustion plants, leading to increased CO2 emissions. India, in particular, experienced remarkable growth in its electricity production, becoming the world's third-largest producer behind China and the United States, yet it still grapples with a substantial power demand. The International Energy Agency predicts a substantial surge in India's power demand between 2018 and 2040. In this context, this project aims to reduce electricity consumption through efficient dynamic power management using IoT technology.

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2. LITERATURE REVIEW

1) Nouby M. Ghazaly, M. M. A. . (2022). A Review on Engine Fault Diagnosis through Vibration Analysis. International Journal on Recent Technologies in Mechanical and Electrical Engineering, 9(2), 01–06.

Various studies have explored the potential of smart grid technologies for efficient energy management. These technologies, including advanced metering infrastructure and demand-side management, are crucial for enabling real-time data collection and analysis, helping homeowners make informed decisions about their electricity consumption.

2) Pawan Kumar Tiwari, Mukesh Kumar Yadav, R. K. G. A. . (2022). Design Simulation and Review of Solar PV Power Forecasting Using Computing Techniques. International Journal on Recent Technologies in Mechanical and Electrical Engineering, 9(5), 18–27

The use of Raspberry Pi in energy monitoring systems is increasingly popular. Researchers have proposed and implemented Raspberry Pi-based solutions for monitoring and controlling energy consumption, thanks to its affordability, flexibility, and ease of integration with sensors and communication modules.

3) Chaudhary, D. S. . (2022). Analysis of Concept of Big Data Process, Strategies, Adoption and Implementation. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(1), 05–08.

The Internet of Things (IoT) plays a pivotal role in modern energy monitoring systems. IoT devices can be used to collect real-time data from various sensors and transmit it to a central server or cloud platform, allowing users to access information remotely.

4) Malla, S., M. J. . Meena, O. . Reddy. R, V. . Mahalakshmi, and A. . Balobaid. "A Study on Fish Classification Techniques Using Convolutional Neural Networks on Highly Challenged Underwater Images". International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 4, Apr. 2022.

Energy conservation and sustainability are major global concerns. Researchers have emphasized the importance of developing systems that not only monitor energy consumption but also provide recommendations for improving energy efficiency, which aligns with the project's goals.

Understanding the energy policies and regulations in the target region (in this case, residential energy consumption in Indonesia) is essential for the successful implementation of an energy monitoring system. Researchers have explored the impact of policies on energy consumption and management.

3. METHODOLOGY

ENERGY MONITORING SYSTEM

The energy monitoring system employs components to monitor voltage, current, and power within the electrical system. In this study, the PZEM-004T is utilized for measuring energy usage, an Arduino Uno serves as the data acquisition system, and a Raspberry Pi 4 functions as a web server for both data storage and user interface. To address compatibility issues with communication formats between the PZEM-004T and Raspberry Pi, the Arduino Uno is employed as a data repeater, facilitating the transmission of data from the PZEM-004T to the Raspberry Pi 4. These components are interconnected via serial communication, as depicted in Figure 1.

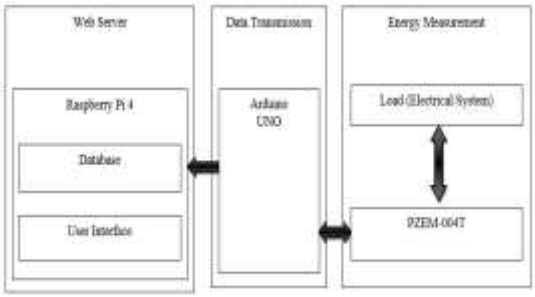

Figure 1: Block Diagram of Raspberry Pi Web-Based Energy Monitoring System.

The Raspberry Pi web-based energy monitoring system comprises three primary subsystems: energy measurement, data transmission, and the web server. Initially, the PZEM-004T measures voltage and current flow within the load, using this information for energy measurement. The Arduino Uno sends request bytes to the PZEM-004T, which, in turn, transmits voltage, current,

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IJPAST

ISSN 2229-6107
www.ijpast.in
Vol 13,Issuse 4. Nov 2023

power, and energy data to the Arduino Uno through serial communication. Subsequently, the Arduino Uno forwards this data to the Raspberry Pi 4. In the final subsystem, the Raspberry Pi stores the data in a database and displays it on a web-based user interface, providing users with a convenient means to monitor and analyze energy consumption.

The schematic of the Raspberry Pi 4 web-based energy monitoring system, depicted in Fig. 2, outlines the key connections and components involved in the setup. Initially, the AC power source and CT sensor are linked to the PZEM-004T for voltage and current sensing, crucial for power and energy calculations. The RX and TX pins of the PZEM-004T are connected to the digital pins of the Arduino Uno. These Arduino digital pins are configured as serial communication pins through software settings, enabling the transmission of data from the PZEM-004T to the Arduino Uno. The Arduino Uno processes and adapts the data to align with the communication protocol of the Raspberry Pi 4. Subsequently, a USB interface connects the Arduino Uno and Raspberry Pi 4, facilitating the data transfer from the Arduino Uno to the Raspberry Pi 4. This schematic ensures the seamless transmission of voltage, current, power, and energy data to the Raspberry Pi 4, enabling the monitoring of electrical energy through the Raspberry Pi 4 web server.

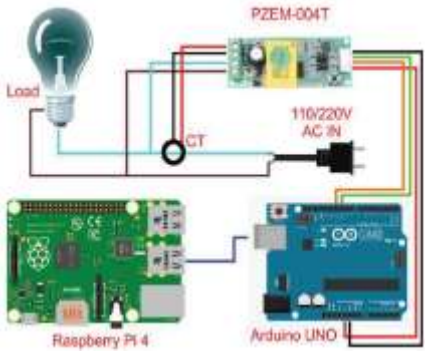

Figure 2: Schematic of Raspberry Pi Web-Based Energy Monitoring System.

4. PROPOSED SYSTEM

The proposed system is a Raspberry Pi-based web-based energy monitoring solution designed to overcome the limitations of existing systems, providing homeowners with an accessible, customizable, and cost-effective means of monitoring and managing their electricity consumption. Its advantages include real-time data monitoring, a customizable dashboard, detailed data analysis, personalized energy efficiency recommendations, historical data tracking, scalability, and compatibility with different power supply systems, all while offering a cost-effective solution. By utilizing the PZEM module, the system enables users to monitor their power usage, facilitating power consumption reduction, with the data displayed on a cloud server. The central microcontroller in this project is the Raspberry Pi, a Wi-Fi-based controller. This comprehensive solution empowers users to make informed decisions about their electricity consumption, identify energy-saving opportunities, and promote energy efficiency for both cost savings and environmental sustainability.

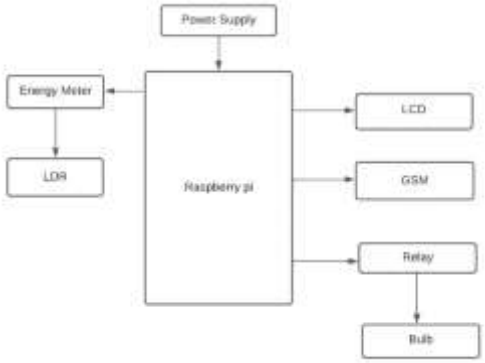

Figure 3: Raspberry Pi Web-Based Energy Monitoring System.

5. REQUIREMENT SPECIFICATIONS

HARDWARE REQUIREMENT:

1. Raspberry Pi 4
2. PZEM-004T Sensor

Raspberry Pi 4

The Raspberry Pi is a compact, Linux-based computer designed for running a wide range of applications, particularly those that require efficiency and quick results. The Raspberry Pi 4 B+ (RP4) is a durable model produced by the organization, equipped with the latest wired and wireless communication systems commonly used in many smart projects. The RP4 features a Quad-Core processor, with three distinct versions offering varying RAM sizes. It supports miniature HDMI and includes two ports capable of handling two 4K displays, making it versatile for various applications.

In this project, the Raspberry Pi 4 serves as the central component and brain of the energy monitoring system. It is responsible for hosting a web server that collects, processes, and stores real-time electricity consumption

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IJPAST

ISSN 2229-6107
www.ijpast.in
Vol 13,Issuse 4. Nov 2023

data. The Raspberry Pi 4 communicates with the PZEM module and Arduino Uno to obtain voltage, current, power, and energy data.

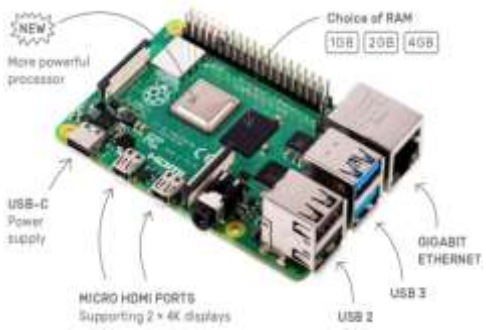

Figure 4: Raspberry Pi 4

It then presents this information through a user-friendly web interface, allowing homeowners to monitor and analyze their energy usage efficiently. Additionally, the Raspberry Pi 4 facilitates the transmission of this data to a cloud server for remote access and long-term storage, empowering users to make informed decisions about their electricity consumption and promote energy efficiency.

PZEM-004T Sensor

The PZEM-004T sensor plays a pivotal role in this project as the primary energy measurement device. It is connected to the electrical load, where it senses voltage and current, enabling the calculation of power and energy consumption. The data obtained from the PZEM-004T is transmitted to the Arduino Uno via serial communication. The sensor's accurate measurements of voltage, current, and power usage are crucial for providing real-time energy consumption data, which is then processed and presented to homeowners through the Raspberry Pi-based web interface. This data empowers users to actively monitor their electricity usage, make informed decisions, and implement energy-saving measures, contributing to cost savings and environmental sustainability.

Figure 5: PZEM-004T Sensor

SOFTWARE REQUIREMENT

1. Raspberry Pi OS
2. Geany Programmer's Editor
3. Embedded C
4. Python

6. WORKING AND RESULTS

To power up the Raspberry Pi board, connect a USB cable to the laptop while ensuring the laptop is connected to a power supply. Install Advanced IP Scanner and VNC Viewer on the laptop. Link the Raspberry Pi to the laptop via a Type-C cable connected to a 5-volt adapter. Activate your mobile hotspot and verify that the Raspberry Pi's MAC address appears in the connected devices list. Open Advanced IP Scanner on the laptop and initiate a scan to identify the Raspberry Pi's IP address, then paste it into VNC Viewer. The Raspberry Pi's operating system interface will become accessible. Click on the icon and select 'yolo_test.py'. Opt for Python 3 IDLE and execute the code by clicking 'run module'. This will enable the retrieval of six charts on Thingspeak displaying voltage, current, power, energy, frequency, and power factor data.

7. CONCLUSION

In conclusion, the design of a Raspberry Pi-based web-based energy monitoring system for residential electricity consumption presents a compelling array of advantages when compared to existing solutions. By rectifying the limitations inherent in current systems, the proposed setup offers homeowners a more accessible, adaptable, and cost-effective approach to overseeing their energy consumption. With real-time data monitoring, users can actively and instantly track their electricity usage and make necessary adjustments for optimization. The system's customizable dashboard and in-depth data analysis offer tailored insights, enabling the identification of energy-intensive devices and informed decisions for energy conservation. Furthermore, the system's energy efficiency recommendations provide actionable guidance, encouraging users to adopt power-saving practices and reduce their environmental footprint. Its scalability and compatibility ensure adaptability to evolving energy monitoring needs and various power supply systems. Notably, the system's cost-effectiveness, leveraging the affordable Raspberry Pi platform, eliminates financial barriers for homeowners, providing comprehensive energy monitoring features. In sum, this Raspberry Pi-based system empowers users to actively manage energy consumption, promote efficiency, achieve cost savings, and contribute to environmental sustainability, ultimately fostering a more sustainable future through effective energy management.

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7. REFERENCES

[1] Nouby M. Ghazaly, M. M. A. . (2022). A Review on Engine Fault Diagnosis through Vibration Analysis. International Journal on Recent Technologies in Mechanical and Electrical Engineering, 9(2), 01–06.

[2] Pawan Kumar Tiwari, Mukesh Kumar Yadav, R. K. G. A. . (2022). Design Simulation and Review of Solar PV Power Forecasting Using Computing Techniques. International Journal on Recent Technologies in Mechanical and Electrical Engineering, 9(5), 18–27.

[3] Ghazaly, N. M. . (2022). Data Catalogue Approaches, Implementation and Adoption: A Study of Purpose of Data Catalogue. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(1), 01–0

[4] Chaudhary, D. S. . (2022). Analysis of Concept of Big Data Process, Strategies, Adoption and Implementation. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(1), 05–08.

[5] Malla, S., M. J. . Meena, O. . Reddy. R, V. . Mahalakshmi, and A. . Balobaid. “A Study on Fish Classification Techniques Using Convolutional Neural Networks on Highly Challenged Underwater Images”. International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 4, Apr. 2022.

[6] A. Chawla, “Phishing website analysis and detection using Machine Learning”, Int J Intell Syst Appl Eng, vol. 10, no. 1, pp. 10–16, Mar. 2022.

[7] M. Dursun and N. Goker, “Evaluation of Project Management Methodologies Success Factors Using Fuzzy Cognitive Map Method: Waterfall, Agile, And Lean Six Sigma Cases”, Int J Intell Syst Appl Eng, vol. 10, no. 1, pp. 35–43, Mar. 2022.