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An IoT Based Smart Watt Metering for Energy Management System

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Abstract: *This paper presents the analysis of IoT based Smart Watt Metering for Energy Management System. The proposed system, "An IoT Based Smart Watt Metering for Energy Management System," introduces a cost-effective and energy-efficient solution for monitoring and managing power consumption of electrical appliances. Utilizing non-intrusive current and voltage sensors, the system measures key electrical parameters such as current, voltage, and power factor in real-time. The ESP32 microcontroller, known for its low power consumption, processes and transmits this data via Wi-Fi to a central server or cloud platform, enabling remote access through a user-friendly web or mobile application. The interface allows users to visualize power usage trends, set consumption thresholds, and receive alerts for abnormal usage. Additionally, the system incorporates data logging capabilities, storing historical consumption data for long-term analysis and energy-saving decision-making. This innovative approach provides a detailed and accessible means for users to optimize energy usage and reduce costs, contributing to more efficient energy management amidst the global energy crisis.*

Keywords: Energy Management, Internet of Things (IoT), Smart Watt Meter.

I. INTRODUCTION

In response to the global energy crisis, efficient energy management is critical, particularly as electrical appliances, from smart phone chargers to larger systems like air conditioners, dominate our daily lives. Traditional electricity bills provide only a broad overview of energy use, failing to capture the specific consumption of individual devices. To bridge this gap, the "IoT Based Smart Watt Metering for Energy Management System" leverages IoT technology to deliver detailed, real-time insights into power consumption. The system employs non-intrusive current and voltage sensors to measure key electrical parameters, including current, voltage, and power factor, with data processed by a low-power ESP32 microcontroller. This data is transmitted via Wi-Fi to a central server or cloud platform, where users can access it through a user-friendly web or mobile application. The interface allows for real-time monitoring, historical data analysis, and alerts for abnormal usage, enabling users to make informed energy-saving decisions. With its data logging capabilities, the system supports long-term trend analysis, offering a comprehensive and accessible approach to optimizing energy consumption.

II. IOT BASED SMART WATT METERING AND ENERGY MANAGEMENT SYSTEM

IoT-based Smart Watt Metering is an advanced approach to monitoring and managing energy consumption through a network of connected devices. In this system, sensors and smart meters are integrated with IoT technology to measure key electrical parameters such as current, voltage, and power factor in real-time. The collected data is transmitted via wireless communication, typically using Wi-Fi or other IoT protocols, to a central server or cloud platform. This allows users to remotely monitor and analyze their energy usage through a user-friendly interface accessible via web or mobile applications. The system provides real-time insights, historical data analysis, and alerts for abnormal power consumption, enabling users to make informed decisions to optimize energy use and reduce costs. By leveraging IoT technology, smart watt metering enhances energy management efficiency, contributing to smarter homes and businesses while addressing the growing need for sustainable energy practices.

An Energy Management System (EMS) using smart watt metering is a sophisticated solution designed to optimize energy consumption by providing detailed, real-time insights into electricity usage. In this system, smart watt meters

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equipped with sensors are deployed to monitor the electrical parameters of various appliances and systems, such as current, voltage, and power factor. The data collected by these meters is transmitted to a central server or cloud platform, where it can be accessed and analyzed through a user-friendly interface, typically available on web or mobile applications.The EMS allows users to track energy consumption in real-time, set usage thresholds, and receive alerts when consumption exceeds these limits, helping to identify inefficiencies or unusual patterns. Additionally, the system enables historical data analysis, which aids in recognizing long-term trends and making informed decisions to reduce energy usage and costs. By integrating smart watt metering into an EMS, businesses and households can achieve greater energy efficiency, lower utility bills, and contribute to more sustainable energy practices.

III. MODELING AND RESULTS

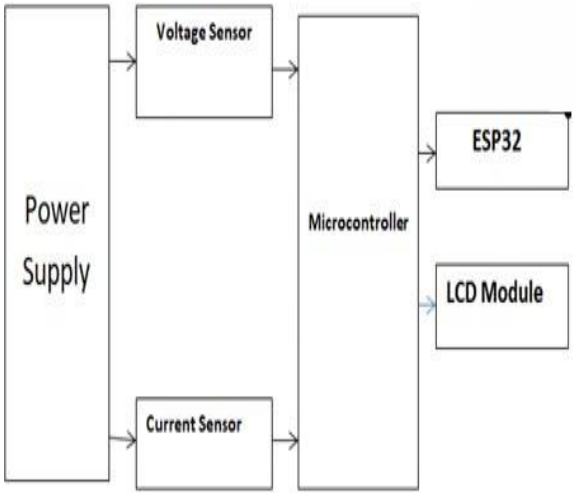

Figure-1: Block Diagram

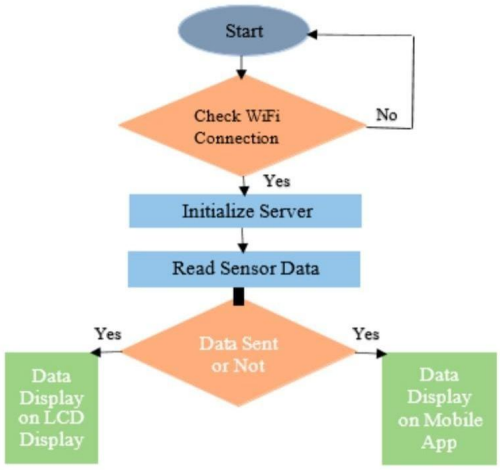

Figure- 2 : Flow chart of Smart Watt

Figure-3 : Snap Shot of Final Model

.**Figure-4:** Output of Final Model

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Testing for an IoT-based smart watt metering system involves several key steps to ensure functionality, performance, and accuracy. First, sensors must be properly integrated, calibrated, and tested across different power loads to confirm accurate power measurement. Functional testing ensures the device accurately captures, collects, and transmits power consumption data to the designated platform, with real-time monitoring capabilities operating as expected. Performance testing focuses on optimizing the device's own energy usage, ensuring efficient and timely data transmission, and assessing scalability as the system grows. Lastly, accuracy and calibration testing involves comparing sensor readings against known standards, verifying data accuracy, and implementing error-handling mechanisms to address any discrepancies in the collected data.

IV. APPLICATIONS

- **Residential Energy Management**: Homeowners can monitor and manage their electricity usage in real-time, optimizing energy consumption, reducing utility bills, and contributing to sustainable living. The system can also integrate with smart home devices to automate energy-saving actions.
- **Commercial and Industrial Energy Monitoring**: Businesses can use smart watt meters to track energy usage across different departments, machinery, or locations. This helps in identifying inefficiencies, reducing operational costs, and ensuring compliance with energy regulations.
- **Smart Grid Integration**: Utilities can integrate smart watt meters with smart grids to manage energy distribution more effectively. This allows for dynamic pricing, load balancing, and better management of peak demand, contributing to overall grid stability.
- **Renewable Energy Management**: In systems using renewable energy sources like solar or wind, smart watt meters can monitor the generation and consumption of energy, ensuring optimal usage and storage. They can also facilitate the selling of excess energy back to the grid.
- **Energy Auditing and Reporting**: For organizations aiming to meet sustainability goals, smart watt meters provide detailed data that can be used for energy audits, carbon footprint analysis, and reporting. This aids in achieving certifications and enhancing corporate social responsibility (CSR) efforts.
- **Predictive Maintenance**: By analyzing energy consumption patterns, the system can predict when equipment might fail or need maintenance, thus reducing downtime and extending the lifespan of machinery.
- **Demand Response Programs**: Smart watt meters enable participation in demand response programs, where consumers can reduce or shift their energy use during peak periods in response to time-based rates or other incentives from utilities.
- **Public Infrastructure and Smart Cities**: In smart city initiatives, smart watt meters can be deployed to monitor and manage energy usage in public buildings, street lighting, and transportation systems, leading to more efficient energy use and reduced carbon emissions.
- **Educational Institutions**: Schools and universities can use smart watt metering systems to monitor energy usage, educate students about energy conservation, and implement energy-saving measures on campuses.
- **Agricultural Energy Management**: Farms can use these systems to monitor the energy used in irrigation, heating, and other processes, optimizing usage to reduce costs and improve efficiency.

V. CONCLUSION

In conclusion, an IoT-based smart watt metering system significantly enhances energy management by providing real-time monitoring, data analysis, and control over energy consumption. This leads to increased efficiency, cost savings, and informed decision-making. While the system is scalable and offers substantial benefits, challenges like data privacy, cybersecurity, and implementation costs must be addressed. As IoT technology continues to evolve, such systems will play a crucial role in promoting sustainable energy practices and optimizing energy use across various settings.

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VI. FUTURE SCOPE

It currently focus on monitoring the power consumption of individual appliances, has significant potential for future development. One avenue for expansion could be the integration of machine learning algorithms to analyze patterns in energy consump- tion data. This could enable the system to provide personalized recommendations for reducing energy usage, such as suggesting optimal times to run certain appliances or identifying appliances that are consuming excessive power. Additionally, the project could be extended to support monitoring of multiple appliances simultaneously, allowing users to track their overall energy usage.

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REFERENCES

[1] Noor Nateq Alfaisaly, Suhad Qasim Naeem, Eman K. Jassim, Adnan Ali Abdullah, “Study on Smart Designed Power Monitoring System Using IoT Devices”, International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 11 Issue: 10, October 2023.
[2] Garrab.A, Bouallegue.A, Ben Abdullah, “A new AMR approach for energy savings in Smart Grids using Smart metre and partial power line communication”, IEEE First International Conference on ICICS, vol 3, pp. March 2022.
[3] Landi,c.: Dipt. Di Ing.dell” Inf, SecondaUniv di Napoli, Aversa, Italy; Merola p. “AMR-based energy management system using smart metre and Web server”, IEEE instrumentation and measurement technology conference beijing, pp.1-5 may 2021.
[4] M. K. Hasan, M. M. Ahmed, S. S. Musa et al., “An improved dynamic thermal current rating model for PMUbased wide area measurement framework for reliability analysis utilizing sensor cloud system,” IEEE Access, vol.9, pp. 14446–14458, 2021.
[5] Diya Elizabeth Paul, Prof Alpha Vijayan, “Smart Energy Meter Using Android Application and GSM Network”, Volume – 5 Issue -03 March, 2020 Page No. 16058- 16063.
[6] M. R. Bhuiyan et al., "IoT based smart home energy management system using machine learning algorithm", Journal of Intelligent & Robotic Systems, vol. 97, no. 1, pp. 1-18, 2020.
[7] Abhiraj Prashant Hiwale, Deepak Sudam Gaikwad, Akshay Ashok Dongare and Prathmesh Chandrakant Mhatre. "IoT based smart energy monitoring." International Research Journal of Engineering and Technology (IRJET) 5, no. 03 (2019).
[8] Kurde, Arati and V. Kulkarni. "IOT based smart power metering." International Journal of Scientific and Research Publications 6, no. 9 (2019): 411-415.
[9] K. Dhineshkumar, et al., “Performance analysis of pv powered multilevel inverter,” International journal of electrical and computer engineering (IJECE), vol/issue: 9(2), pp. 735-760, 2019.
[10] S. Usha, et al., “Performance analysis of H-bridge and T-bridge multilevel inverter for harmonics reduction,” International journal of power electronics and drive systems (IJPEDS), vol. 9, pp. 231-239, 2018.
[11] P. R. Joshi & M. S. khan, (2017) “IOT Based Smart Power Management System Using WSN”, International Research Journal of Engineering and Technology (IRJET), Vol. 04, No. 06, pp783-786.
[12] V. S. Kallur & S. N. Kulkarni, (2016) “Power Management, Monitoring and Controlling in Intelligent Buildings Using Wireless Sensor Network (WSN)”, International Research Journal of Engineeringand Technology (IRJET), Vol. 03, No. 07, pp1350-1355.
[13] G. Prakash and C. Subramani, “Space vector and sinusoidal pulse width modulation of quasi Z-source inverter for photovoltaic system,” International journal of power electronics and drive system (IJPEDS), vol/issue: 7(3), pp. 601-609, 2016.
[14] A. M. Vega, et al., “Modelling for home electric energy management: a review,” Renewable and Sustainable Energy Reviews, vol. 52, pp. 948-959, 2015.

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