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IoT Smart Electricity Energy Meter

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Abstract: The escalating demand for electric energy, coupled with concerns over sustainability and resource depletion, underscores the need for innovative solutions to monitor and manage electricity usage. This project proposes an Internet of Things (IoT) based household appliance monitoring system to address these challenges. By integrating hardware, software, and cloud technologies, the system provides real-time insights into energy consumption at both the household and device levels. Additionally, it offers transparency and accountability by displaying energy usage and costs, empowering users to make informed decisions to optimize their electricity expenses. Furthermore, the system extends its application to electric vehicle (EV) charging, enhancing efficiency and convenience in this growing domain. Overall, this IoT-based energy monitoring system represents a crucial advancement towards a more sustainable and efficient energy future.

I. INTRODUCTION

In recent years, the demand for electric energy has experienced a significant surge, driven by factors such as population growth and economic development. This escalating demand has created a pressing need for a substantial increase in energy supply. However, despite efforts to meet this demand, there exists a persistent imbalance between energy supply and demand, exacerbating concerns about sustainability and resource depletion. Compounding this issue is the imminent depletion of power generated from fossil fuels, which, according to current projections, may occur within the next two decades.

One notable consequence of this imbalance is the dissatisfaction among consumers with their power bills, particularly in residential settings. While electronic energy monitoring solutions have become increasingly sophisticated, many existing systems only provide aggregate data on household energy consumption, failing to offer granular insights into usage at the device level. This lack of detailed information leaves consumers feeling uninformed about their electricity usage patterns and limits their ability to make informed decisions to manage and optimize their energy consumption.

Fortunately, the emergence of the Internet of Things (IoT) presents a promising solution to these challenges. By integrating hardware, software, and cloud technologies, IoT enables the development of advanced energy consumption models and monitoring systems. Leveraging IoT capabilities, we propose the implementation of a household appliance monitoring system designed to provide real-time insights into energy consumption and empower users to make informed decisions about their electricity usage.

In addition to monitoring overall energy consumption, our system incorporates the use of energy meters to track current and voltage consumption at the device level. This granular data not only allows users to monitor their energy usage more comprehensively but also provides valuable insights into the efficiency of individual appliances and identifies opportunities for optimization. Moreover, by displaying the units consumed and the corresponding costs, our system enhances transparency and accountability, empowering users to better manage their electricity expenses.

One specific application of our system is in the realm of electric vehicle (EV) charging. With the growing adoption of electric vehicles, there is a growing need for efficient and convenient charging solutions. By integrating our energy monitoring system with EV charging infrastructure, we aim to streamline the charging process and optimize energy usage. By providing real-time data on energy consumption and costs associated with EV charging, our system enables users to make informed decisions about when and how to charge their vehicles, maximizing efficiency and minimizing expenses.

In summary, our proposed IoT-based energy monitoring system represents a significant step towards addressing the challenges posed by the growing demand for electric energy. By leveraging IoT technology, we can transform existing energy meters into powerful tools for online monitoring, empowering users to better understand and manage their electricity usage while paving the way for a more sustainable energy future.

II. BLOCK DIAGRAM

The building blocks of the ESP32 Electric energy consumption meter is based on the ESP 32 as a heart Microcontroller receiving sensor data from the SCT-013 current transformer and Voltage sensor and relaying it to the blinky cloud servers as shown in figure 3.1.1

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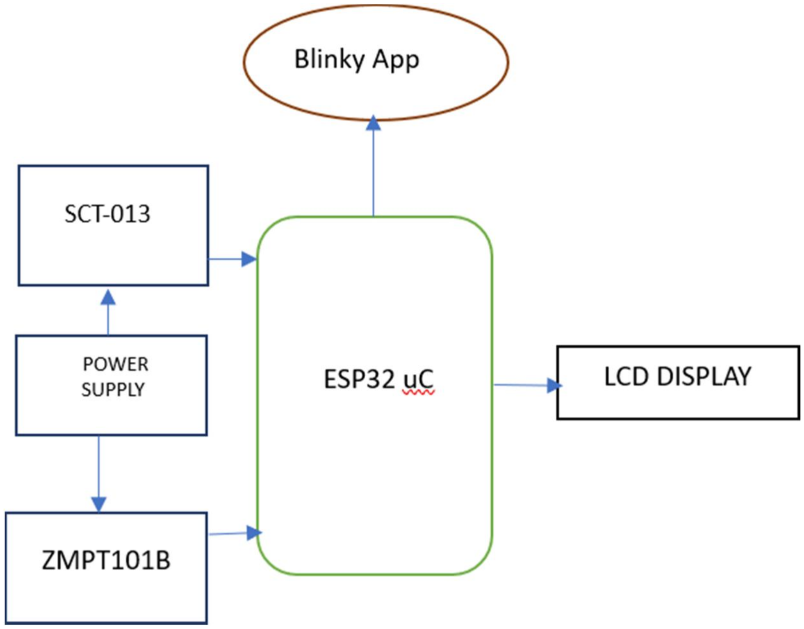

Figure 3.1.1: Block diagram of the proposed system

III. HARDWARE EQUIPMENT

1) SCT-013 Current Transformer

Figure 3.2.1 SCT-013 Current Transformer

The SCT-013 is a non-invasive AC current sensor as shown in figure 3.2.1 that measures up to 100 amps of AC current using a split core clamp meter sensor. Alternating current is measured by sensors called current transformers (CTs). They are particularly helpful for figuring out how much electricity a facility uses overall. The SCT-013 current sensors can beconnected directly to the live or neutral wire, negating the need to rewire high-voltage electrical work. A current transformer is made up of a primary winding, a magnetic core, and a secondary winding. The secondary winding is contained within the transformer's casing and is made up of several twists of thin wire.

2) ZMPT101B AC Voltage Sensor:

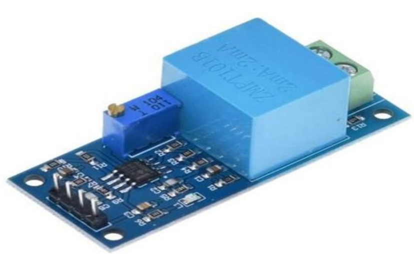

Figure 3.2.2 ZMPT101B AC Voltage Sensor

A high-precision ZMPT101B voltage transformer is the foundation of the ZMPT101B AC Single Phase voltage sensor module as shown in figure 3.2.2, which is used to detect precise AC voltage. With an Arduino or an ESP32, you can measure AC voltage quite effectively using this method. The analog output of the ZMPT101B sensor can be adjusted in response tothe sensor's ability to measure voltage up to 250V AC. The module contains a multi-turn trim potentiometer for calibrating and adjusting the ADC output, and it is simple to use. In the prototype, the voltage signal is being measured and sent to the ESP32 microcontroller.

3) ESP32 Microcontroller:

Figure 3.2.3 ESP32 Microcontroller

The ESP32 family of system-on-a-chip microcontrollers are inexpensive and low-power devices that come equipped with dual-mode Bluetooth and built-in Wi-Fi. The ESP32 series' Tensilica Xtensa LX6 dual-core or single-core, Tensilica Xtensa LX7 dual-core, or Tensilica RISC-V single-core microprocessors have integrated antenna switches, RF baluns, power amplifiers, low-noise receive amplifiers, filters, and power-management modules. Espressif Systems, a Chinese business with its headquarters in Shanghai, invented and created the ESP32, which is produced by TSMC using their 40 nm technology. The ESP 32 microcontroller is the prototype's brains as shown in figure 3.2

4) 20X4 I2C LCD Display

Figure 3.2.4 20X4 I2C LCD Display

This LCD display as shown in 3.2.4 screen has an I2C interface and a 16x2 resolution. This I2C 20X4 Arduino LCD Screen uses the I2C communication interface. The LCD display only needs four pins: VCC, GND, SDA, and SCL. It will spare at least four digital/analog pins on the Arduino. The connectors are all XH 2.54 compliant (Breadboard type). The jumper wire allows direct connection.

IV. WORKING

The project aims to develop an innovative IoT-based Smart Electricity Energy Meter tailored specifically for Electric Vehicle (EV) charging stations. Leveraging the ESP32 microcontroller and the enhanced capabilities of the Blynk 2.0 application, this solution offers comprehensive monitoring of electricity consumption, enabling users to track units consumed and associated costs in real-time.

At the heart of this system lies the integration of high-quality sensors: the SCT-013 current sensor and the ZMPT101B voltage sensor. These sensors work synergistically to accurately measure critical electrical parameters such as voltage, current, power, and total energy consumption, expressed in kilowatt-hours (kWh). By combining these measurements with relevant tariff information, the system computes the equivalent monetary value of the consumed energy, facilitating transparent billing processes.

The operational flow begins with the sensors continuously collecting data on voltage and current. These readings are then processed by the ESP32 microcontroller, which performs necessary calculations to determine power consumption and energy usage. Concurrently, the microcontroller interfaces with the Blynk 2.0 application, a versatile IoT platform that provides a user-friendly interface for data visualization and management. Through the Blynk 2.0 dashboard, users gain remote access to real-time consumption metrics, conveniently monitoring their electricity usage and associated costs from any location with internet connectivity. This accessibility enhances user convenience and promotes informed decision-making regarding energy consumption habits and billing optimization. Moreover, the system incorporates a robust contingency plan to address power outages. In the event of a power disruption, a backup battery seamlessly takes over, ensuring uninterrupted operation of the energy meter. During this period, the system continues to display the latest consumption data, maintaining transparency and accountability. Notably, while the energy meter remains non - operational during power outages, EV charging functionality is temporarily suspended to prevent any discrepancies in energy readings.

Overall, the IoT-based Smart Electricity Energy Meter offers a sophisticated yet user-friendly solution for EV charging stations, empowering users with real-time insights into their energy usage and expenditure. By amalgamating cutting-edge sensor technology with seamless connectivity and backup mechanisms, this project exemplifies innovation in energy management and IoT integration, paving the way for sustainable and efficient electric vehicle infrastructure.

V. CONCLUSION

In conclusion, the development of the IoT-based Smart Electricity Energy Meter for EV charging stations represents a significant leap forward in energy management technology. By harnessing the capabilities of the ESP32 microcontroller, alongside high-precision sensors and the Blynk 2.0 application, this project offers users unparalleled visibility into their electricity consumption and costs. The seamless integration of real-time data monitoring and remote accessibility empowers users to make informed decisions regarding energy usage, ultimately contributing to more efficient and sustainable practices. Moreover, the incorporation of a robust backup system ensures uninterrupted operation, even during power outages, maintaining transparency and reliability. With its innovative features and user-friendly interface, this energy meter not only facilitates convenient billing processes but also fosters a culture of responsible energy consumption. As electric vehicles continue to proliferate, solutions like these will play a crucial role in shaping the future of transportation and energy infrastructure.

REFERENCES

[1] Ammar Othman, Nur Hafiza Zakaria, “Energy Meter based Wireless Monitoring System using Blynk Application via smartphone”, IEEE, 2020, DOI: 10.1109/IICAIET49801.2020.9257827

[2] Issa Ahmed Abed and Hayder Yasir Naser, “ESP32 Microcontroller Based Smart Power Meter System Design and Implementation”, Al-Rafidain Engineering Journal (AREJ), Volume: 25, Issue 2, Accepted Dates: Received: 14/5/2020, Accepted: 13/7/2020

[3] Mayur Pimple, Suraj Thopate, Avdhut Nikam, and Santosh Gadekar “IOT Based SmartEnergy Meter Using ESP 32". It was presented at the 3rd International Conference on Communication and Information Processing (ICCIP-2021).

[4] Muhammad Ridwan Arif Cahyono, "Design Power Controller for Smart Grid System Based on Internet of Things Devices and Artificial Neural Network" It was published in the2020 IEEE International Conference on Internet of Things and Intelligence System (IoTaIS)with the paper accepted on August 31, 2020.

[5] Ravi K Kodali and Shubhi Sahu, "MQTT Based Smart Metering", at 2018 IEEEConference.

[6] Mohamed Aashik S, Jayarama Pradeep, Abishlal N S, Abinayaa Sri T, Jenin Benedict A,“Smart Energy Management and Load Monitoring of Individual Loads”, Department of EEESt. Joseph’s college of engineering, Chennai, India

[7] Paul Stone Macheso and Doreen Thotho, “ESP32 Based Electric Energy Consumption Meter”, Journal: International Journal of Computer Communications and Information (IJCCI), Volume: 4, Issue: 1, Accepted Date: Year 2022.

[8] Faisal Theyab Abed, Haider Th. Salim ALRikabi, “Monitoring the Consumption of Electrical Energy Based on the Internet of Things Applications”, International Journal of Interactive Mobile Technologies Volume: 14, No. 13, Paper Accepted Dates: Submitted 2020-12-01, Resubmitted 2021-01-19, Final acceptance 2021-01-19

[9] Mehmet Büyük, Ercan Avşar, and Mustafa İnci, "Overview of smart home concepts through energy management systems, numerical research, and future perspective". The paperwas published in the journal "Energy Sources, Part A: Recovery, Utilization, and Environmental EffectsThe paper was accepted on January 11, 2022. The DOI of the paper is 10.1080/15567036.2021.2024924.

[10] Jorge Yasuoka, Gabrielly Araújo Cordeiro, José Luiz Pereira Brittes, Robert Eduardo Cooper Ord oñez, Sergio Valdir Bajay, Eduardo Nunes, “IoT solution for energy management and efficiency on a Brazilian university campus – a case study”, Journal: International Journal of Sustainability in Higher Education, Volume: 24, Issue 2, Accepted Dates: Received 30 August 2021, Revised 1 December 2021, 3 December 2021, 6 December2021, 11 March 2022, Accepted 8 April 2022.