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A Study and Review on Agile – Controlled Solar Metering System using IOT and Ubidots

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Abstract: *This project introduces an innovative solution: an Agile-Controlled Solar Metering System that utilizes IoT and the Ubidots platform for real-time monitoring and control of solar energy production and consumption. Traditional electricity meters often cause concern with high bills, requiring manual checks. With our smart energy meter using an ESP32 Wi-Fi module, users can monitor appliance load consumption in real-time from anywhere globally via smartphones. This IoT-based system provides convenience, allowing control over devices based on power consumption and budget management.*

Keywords: Agile-Controlled, Solar Metering System, Ubidots IoT platform, Electricity meters

I. INTRODUCTION

The Internet of Things (IoT) serves as a catalyst for interactions between machines, humans, and the environment. This concept allows everyday devices to connect over the internet, facilitating remote analysis of connected devices. IoT establishes a crucial infrastructure for bridging the gap between the physical world and computer-based systems. With the proliferation of wireless devices in the market, the IoT concept gains significance. The system employs the ESP-32 Wi-Fi module to enable internet connectivity.

The escalating demand for electricity for various purposes, such as agriculture, industries, households, and healthcare, poses challenges in managing electricity maintenance and requirements. To address these complexities and the increasing demand, there's a pressing need to conserve electricity. As the newer generations demand more electricity, technological advancements become essential. The proposed system represents a significant leap forward from traditional energy meters by leveraging IoT technology, providing a 180-degree technical shift.

The system tackles issues like power theft, which contributes to economic losses for the country. The key objectives include monitoring, optimizing power usage, and reducing power wastage, ushering in a more efficient and advanced energy management system..

1.1 OBJECTIVE

1. Real-time Monitoring: Implement a system that continuously collects data from various sensors and meters installed in a solar energy system. This data includes parameters like solar irradiance, panel temperature, energy production, and system status.
2. Data Transmission: Establish a reliable and secure communication network for transmitting the collected data from the solar metering system to a central server or cloud platform. IoT protocols, such as MQTT, may be employed for efficient data transfer.
3. Remote Control: Develop the capability to remotely control and manage the solar system through the IoT platform. This includes the ability to turn the system on/off, adjust panel angles, and reset inverters or other components as needed.
4. Data Visualization: Utilize the Ubidots platform or a similar data visualization tool to create user-friendly interfaces for data visualization. This allows end-users to easily access and interpret real-time and historical data from their solar system.
5. Performance Analysis: Implement algorithms and data analytics to assess the performance of the solar energy system. This includes identifying inefficiencies, calculating energy yields, and detecting potential issues that may require maintenance or adjustment.

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II. LITERATURE SURVEY

Publication Year	Authors	Paper Title	Overview
2022	Rajkumar Buyya & Amir Vahid Dastjerdi	Internet of Things (Principles and Paradigms)	Comprehensive overview of IoT, discussing core principles, architectures, applications, and challenges. Provides insights into the rapidly evolving technology.
2022	Prayag Tiwari & Mikhail Zymbler	Internet of Things is a Revolutionary Approach for Future Technology Enhancement	Emphasizes the revolutionary nature of IoT, exploring its transformative impact on various industries and its role in shaping the technological landscape.
2021	Shanzhi Chen, Hui Xu, Dake Liu, Bo Hu, Hucheng Wang	IEEE Internet of Things Vision Of IoT: Applications, Challenges, And Opportunities With China Perspective	Explores IEEE's vision of IoT, focusing on applications, challenges, and opportunities, with a unique perspective, particularly in the context of China.
2020	Darshan Iyer N, Dr. KA Radhakrishnan Rao	IoT Based Energy Meter Reading, Theft Detection & Disconnection using PLC Modem and Power Optimization	Presents an IoT-based solution for energy meter reading, theft detection, and disconnection using PLC modems. Discusses power optimization techniques in energy management.
2019	Basma M. Mohammad El-Basioni, Sherine M. Abd El-kader, Mahmoud Abdelmonim Fakhreldin	Smart Home Design using Wireless Sensor Network and Biometric Technologies	The paper likely focuses on designing a Smart Home using Wireless Sensor Networks (WSN) and Biometric Technologies. It may discuss the integration of WSN and biometrics to enhance security, automation, and user experience. The exploration of sensors and biometric data for access control and personalized experiences within the home is anticipated.

III. METHODOLOGY

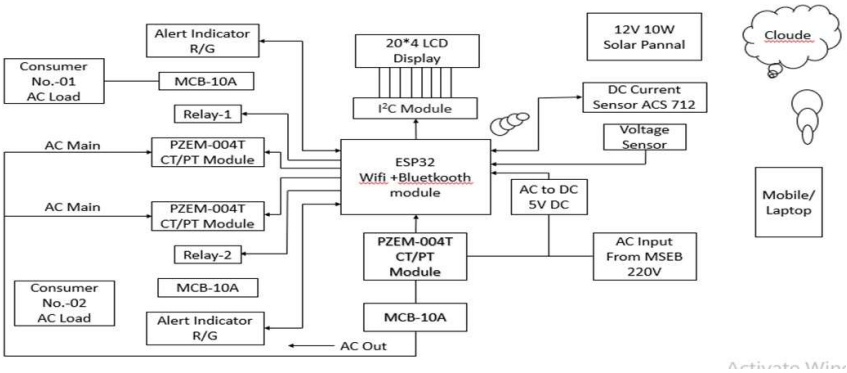

Fig.1 System Architecture

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3.1 Hardware:

- Solar Plate
- DC Current Sensor(ACS712)
- DC Voltage Sensor
- DC TO AC Converter
- ESP 32(Wifi + Bluetooth)
- AC Sensor=Voltage +Current + P.F + Frequency (PZEM-004T)
- LCD Display
- Relay
- Miniature Circuit Breaker(MCB)

3.2 Software:

1. Ubidots

1. Solar Plate:

Fig.2 Solar Plate

Solar radiation may be converted directly into electricity by solar cells (photovoltaic cells). In such cells, a small electric voltage is generated when light strikes the junction between a metal and a semiconductor (such as silicon) or the junction between two different semiconductors. (*See* photovoltaic effect.) The power generated by a single photovoltaic cell is typically only about two watts. By connecting large numbers of individual cells together, however, as in solar- panel arrays, hundreds or even thousands of kilowatts of electric power can be generated in a solar electric plant or in a large household array.

2. DC Current Sensor(ACS712):

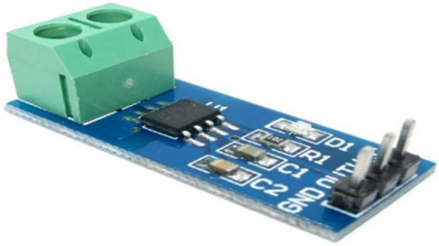

Fig.3 DC Current Sensor

ACS712 Current Sensor Module - 30A can sense upto 30A of current flow. Sensing and controlling the current flow is a fundamental requirement in wide variety of applications, which includes over-current protection circuits, battery chargers, switching mode power supplies, digital watt meters, programmable current sources, etc.

3. DC Voltage Sensor:

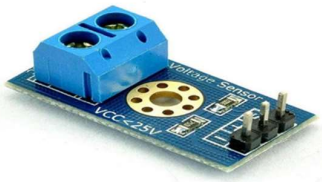

Fig.4 DC Voltage Sensor

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Voltage Input Range: DC 0-25V - This is the range of input voltages that the sensor can measure. It can accept voltages from 0V to 25V DC.
Voltage Detection Range: DC 0.02445V - 25V - This specifies the range over which the sensor can detect and accurately measure voltages. It can measure voltages as low as 0.02445V (24.45mV) up to 25V.

4. DC TO AC Converter:

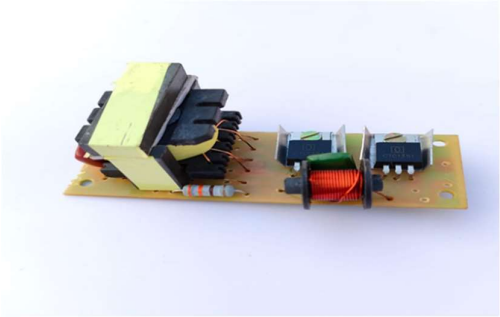

Fig.5 DC TO AC Converter

Input Voltage: 12V DC - This is the voltage level of the DC power source that the inverter accepts.
Output Voltage: 220V AC - The inverter produces a sinusoidal or modified sine wave AC output voltage of 220 volts, which is compatible with standard household appliances and electronics in many regions.

5. ESP 32(Wifi + Bluetooth):

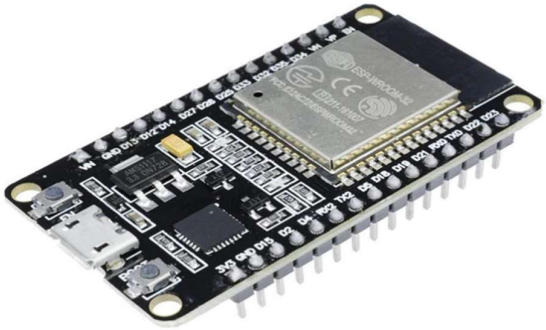

Fig.6 ESP 32(Wifi + Bluetooth)

Doit esp32 development board wifi+bluetooth , dual core esp 32 esp 32s esp 32 similar esp8266 esp32 is integrated with antenna and rf balun, power amplifier, low noise amplifiers, filters, and power management module. The entire solution takes up the least amount of printed circuit board area. This board is used with 2.4 ghz dual mode wi fi and bluetooth chips by tsmc 40nm low power technology, power and rf properties best, which is safe, reliable, and scalable to a variety of applications.

6. AC Sensor:

This document describes the specification of the PZEM-004T AC communication module, the module is mainly used for mensuring AC voltage, current, active power, frequency, power factor and active energy, the module is without display function, the data is read through the TTL interface.

Fig.7 AC Sensor

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7. LCD Display:

5V DC 20 x 4 Lines ASCII Character HD44780 LCD Display With BLUE Backlight Product Overview Product Description: o LCD display module with BLUE Backlight o SIZE : 20x4 (4 Rows and 20 Characters Per Row) o Can display 4-lines X 20-characters o Operate with 5V DC o Wide viewing angle and high contrast o Built-in industry standard HD44780 equivalent LCD controller o Commonly Used in: Student Project, Collage, copiers, fax machines, laser printers, industrial test equipment, networking equipment such as routers and storage devices o LCM type: Characters ABOUT This is a basic 20 character by 4 line display BLUE Backlight . Utilizes the extremely common HD44780 parallel interface chipset (datasheet). Interface code is freely available. You will need 7 general I/O pins(If use in 4-bit Mode) to interface to this LCD screen. Includes LED backlight.

Fig.8 LCD Display

8. Ubidots:

The proposed system can be used to display load energy usage reading in terms of Watts along with money drawn by the devices. The data would be accessed by each and every user from anywhere in the world. Ubidots.com is one such webpage which takes the help of the MathWorks MATLAB analytics to present the device information in a more detailed analysis in both description and visualization.Ubidots.com provides the user to add any number of channels to at least one account and in each account information are fed into 8 fields . An account may be assigned at least one division of an area and n channels are often created to a set of n meters within the locality. The analytics can be viewed by both the consumer and service provide.

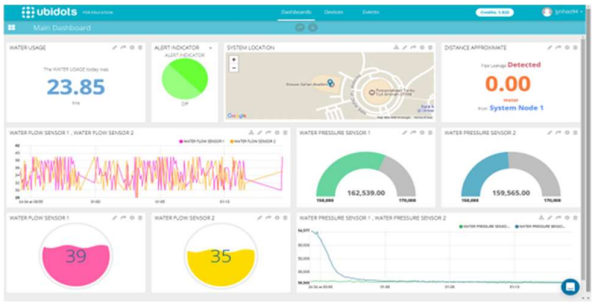

Fig.9 Ubidots Software

The Internet of Things provides access to a broad range of electronic devices(specially embedded devices) and web services. Ubidots is one of the free IoT platforms empowering innovators and industries to prototype and scale IoT projects to production. Ubidots offers a REST API that allows you to read and write data to the resources available:data sources, values ,events and insights. location-tracking applications, and a social network of things with status updates. Ubidots delivers a secure, white glove experience for our users with device friendly APIs that provide a simple and secure connection for sending and retrieving data to/from our IoT data performance optimized time series backend(cloud).

IV. ADVANTAGES

1. Real-Time Monitoring: The system allows real-time monitoring of solar energy production, consumption, and overall system performance. Users can access data and insights on energy generation and usage, enabling informed decision-making.

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2. Energy Efficiency: With access to real-time data and analytics, users can optimize energy consumption patterns and make adjustments to maximize the utilization of solar-generated power. This leads to improved energy efficiency and reduced costs.
3. Remote Control: The system often includes remote control capabilities, allowing users to make adjustments to the solar panel orientation, battery charging, or load management from anywhere with an internet connection. This remote control is particularly useful in off-grid or remote locations.
4. Data-Driven Insights: IoT devices collect a wealth of data that can be analyzed for insights. Machine learning algorithms can identify trends, patterns, and anomalies, enabling proactive maintenance and energy optimization.
5. Alerts and Notifications: The system can be configured to send alerts and notifications via email or SMS in case of critical events, such as low battery levels, system faults, or deviations from expected energy production.
6. Scalability: IoT and cloud-based solutions like Ubidots are scalable, allowing the addition of more sensors or devices as energy needs grow. This scalability makes it suitable for both residential and commercial applications.

V. CONCLUSION

Energy Monitoring through IoT is an innovative and crucial application that is poised to play a significant role in the years to come. This application allows the remote control of home appliances from anywhere globally through cloud connectivity. The proposed project employs a current sensor to detect and display current information on the web using IoT. The system updates information approximately every 3 to 4 seconds, considering a slight delay due to the relay module's connection with appliances for home automation.

In this new system, the Wi-Fi technology is utilized to access and monitor the load consumption of appliances, empowering consumers to avoid unnecessary electricity usage. The project introduces an IoT system that enables consumers to monitor energy consumption, pay bills online, and receive SMS notifications in case of overdue electricity bills. Additionally, the system offers the advantage of home automation, enhancing the overall functionality and utility of the project.

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