SMART ENERGY METER POWERED BY IOT

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ABSTRACT

This paper aims to design a system that allows the monitoring of energy meter readings and provides control over the switching of the energy meter. Additionally, the device features a tamper switch that detects unlawful removal of the energy meter cabinet and instantly warns the authorities through text messages. Real-time data, including tamper warning status, is also delivered to a website. The controlling component utilized in this system is a microcontroller, which communicates with an IoT modem, relay, LCD, tamper switch, and energy meter. The microcontroller was configured to communicate energy measurements to authorities via SMS. Furthermore, it provides control capabilities for the energy meter while delivering tamper-proof functionality. The LCD is employed to show the current reading of the meter. Intelligent programming utilizing embedded 'C' language was implemented on the microcontroller. The project consists of the following modules: an IoT modem for establishingcommunication between the system at the house and the electricity department; an energy meter that continuously provides usage details; an LCD for displaying the meter's current reading; and a relay for disconnecting the power in the event of nonpayment of the bill.

Keywords: Arduino microcontroller, Energy meter, Wi-fimodule, LCD, GSM, Load (Bulb), Arduino IDE, Tinker CAD.

INTRODUCTION

The Smart Energy Meter Powered by IoT is an innovative system designed to revolutionize the monitoring and management of electricity consumption. In today's world, manually tracking and verifying electricity usage can be a tedious and error-prone task, requiring physical visits to meter reading rooms. To address this challenge, our project proposes a cutting-edge solution that leverages the power of the Internet of Things (IoT) to enable users to monitor energy meter readings remotely.

By integrating advanced technologies such as microcontrollers, IoT modems, and Wi-Fi connectivity, our system offers users the convenience of monitoring their energy consumption in real-time from any location with an internetconnection. Gone are the days of relying on manual meter reading and facing potential billing discrepancies. With the Smart Energy Meter Powered by IoT, users can effortlessly access and review their energy usage data, ensuring accurate billing and promoting energy efficiency.

Our smart energy meter is equipped with a microcontroller system that effectively measures and records the units consumed, providing precise information on energy usage. This data is then transmitted securely over the internet using a Wi-Fi connection, enabling users to access it via a user-friendly web application. With just a few clicks, users can conveniently monitor their energy consumption, track their usage patterns, and even estimate their billing costs in real-time. The IoT capabilities of our system allow for seamless communication between the energy meter and the centralized monitoring system. This connectivity not only enables users to stay informed about their energy consumption but also empowers utility companies to optimize energy distribution and detect any irregularities or tampering promptly. In the event of unauthorized removal of the energy meter cabinet, our system is equipped with a tamper switch that triggers an alert, notifying the authorities via text messages, ensuring the security and integrity of the metering infrastructure.

Furthermore, our smart energy meter contributes to a more sustainable and eco-friendly future by promoting energy-conscious behavior. By having easy access to real-time energy consumption data, users can make informed decisions about their electricity usage, identify energy-intensive appliances or activities, and adopt more energy-efficient practices. In summary, the Smart Energy Meter Powered by IoT represents a significant advancement in energy monitoring and management. By harnessing the capabilities of IoT technology, this system provides users with a convenient and accurate means of tracking their energy consumption, ensuring transparent billing, and promoting energy efficiency. With its tamper-proof features and real-time data accessibility, it is poised to transform the way we interact with our energy meters and contribute to a smarter and more sustainable energy future.

LITERATURE SURVEY

Advancements have been made in power disaggregation, energy efficiency calculation, real-time energy monitoring, and IoT-based energy metering through extensive research and practical implementations.

Researchers successfully implemented multi-appliance power disaggregation technology in 2010 using the linear detection algorithm. This algorithm accurately identifies active appliances based on their power contributions.

Cloud computing technology, introduced in 2011, revolutionized the calculation of equipment efficiency. By analyzing energy consumption patterns, this technology optimizes energy usage, leading to improved overall efficiency.

In 2012, the development of a three-feedback system enabled real-time energy monitoring in residential buildings. This system continuously monitors energy usage and provides feedback, encouraging users to save energy and reduce consumption rates.

In 2013, "GREEN" technology emerged as the smallest Zigbee-compatible node capable of sensing various data types, including energy metering and environmental monitoring. This technology allows for versatile sensing applications in different locations.

GSM technology played a significant role in 2014 by implementing automatic power meter reading. This advancement enables remote and automated collection of energy consumption data, streamlining the metering process.

The focus shifted to Wi-Fi technology in 2016, with the development of applications supporting multiple platforms such as Apple and BlackBerry 10 OS. This expansion improves accessibility to energy management applications for a wider range of users.

In 2017, IoT technology took center stage with the creation of an IoT device for comprehensive energy monitoring in a laboratory building. This device measures voltage, current, power, and energy in a three-phase four-line power line, showcasing the integration of IoT technology.

Furthermore, several research papers have contributedvaluable insights:

Ashna.K proposed a design for a cost-effective wireless GSM energy meter with instant billing capabilities. This system aims to automate billing processes and globally manage collected energy data.

Vivek Kumar Sehgal introduced the concept of a postpaid energy meter that automatically disconnects the power line when a predefined energy usage value is reached. It includesMurmud a user interface for interaction and value setting.

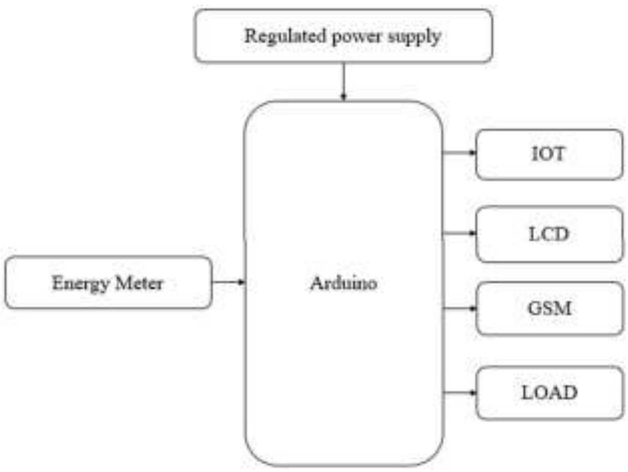
Ms. Prajakta B. e, Mr. Sachin G. Jagdale, and Ms. Sunita D. Giri proposed a GSM-based prepaid energy meter, offering remote operation to address power theft, consumption control, and automated billing.

In conclusion, the literature review suggests that PLC (power line communication) and IoT-based energy meters have the potential to enhance overall system efficiency and identify power losses in various areas. The mentioned research papers provide innovative solutions utilizing technologies such as GSM, wirelesscommunication, and user interfaces to automate energy metering, billing, and management.

PROPOSED SYSTEM

In this paper we aim to develop a system using an Arduino Uno as the main controller to monitor energy consumption. The energy meter in the household continuously reads the consumption of various appliances. The meter has an LED that blinks, and each blink corresponds to a certain unit of energy consumed. Typically, 3200 blinks indicate one unit.The Arduino Uno constantly monitors the LED on the energy meter and counts the number of blinks. By keeping track of the blinks, the Arduino can calculate the units of energy consumed. It acts as a measuring device for energy consumption.

Furthermore, we have designed a web page that displays the measured reading and calculates the cost based on the energy consumed. The Arduino communicates with the web page using Wi-Fi connectivity. Users can access the web page and set threshold values for energy consumption as per their requirements. The continuous display on the web page allows users to monitor their energy consumption in real-time, enablingthem to make informed decisions about energy usage and costs. The system we are developing aims to fulfill the consumer's requirement by providing threshold value notifications for energy consumption. When the consumer's energy consumption reading approaches the set threshold value, the system will send a notification to the consumer. This notification is intended to increase consumer awareness about their energy usage.



Upon receiving the threshold value notification, the consumer can visit the web page associated with the system and adjust the threshold value according to their preference. This flexibility allows consumers to customize their energy consumption limits base on their needs and preferences.

In cases where the consumer is not aware of the threshold notification or fails to adjust the threshold value in time, the meter will automatically switch off. In order to restore functionality, the consumer must revisit the web page and increment the threshold value. This incrementation will automatically switch the meter back on.

Additionally, at the first day of every month, the system will generate an overall monthly bill that includes the calculated cost of energy consumption. This bill will be sent to both the customer and the service provider in the form of a text or notification, providing a convenient way to track and manage energy expenses. Overall, the system aims to enhance consumer awareness and control over energy consumption by providing threshold value notifications, automatic meter control, and monthly billing information.

The smart meter utilizes an Arduino Nano microcontroller, specifically the ATmega328, which operates within a voltage range of 3.3V to 5V and has an 8- bit data size. The Wi-Fi module (ESP8266) is integrated and controlled through six AT commands. The C language is utilized on Arduino IDE version 1.6.9 to interface the Wi-Fi module, liquid crystal display (LCD), buzzer, and meter pulse. The LCD, a 2-line 16-character display, is activated with a 5V power supply and shows the IP address necessary for connecting the Wi-Fi module and transmitting data to the processor. A crystal oscillator is employed to convert digital current signals to alternating current signals, ensuring the proper functioning of the energy monitoring system module. The load receives power from the power transformer at a voltage of 5V. The energy meter reads the meter pulse to calculate the amount of power consumed by the user, with the pulse count being used to determine the

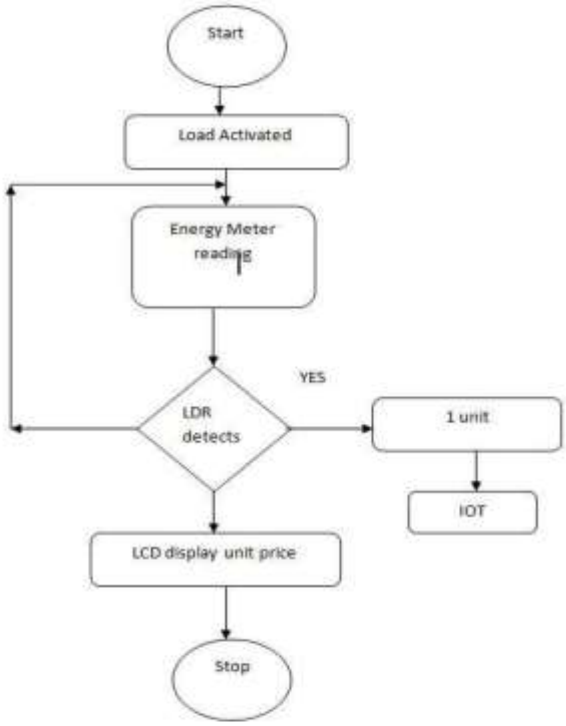


fig:flow chart of Energy Meter

consumed power. An example is provided to illustrate thecalculation of the power consumption amount.

RESULTS

Fig: Project kit

Fig:Message alert in text format by GSM

CONCLUSION

In conclusion, the implementation of a smart energy meter powered by the Internet of Things (IoT) offers numerous benefits and advancements in energy monitoring. By leveraging IoT technology, real-time and accurate power consumption readings are made possible, eliminating the need for manual meter reading and reducing human labor and time requirements.The IoT-enabled smart energy meter facilitates seamless communication between the meter and utility companies, enabling efficient transmission of energy consumption data. This bidirectional flow of information allows utilities to provide valuable insights and services to consumers while also enabling consumers to receive important information, such as tariff updates or outage notifications, from the utilities.One significant advantage of a smart energy meter is the ability to remotely monitor and manage energy usage. With the capability to transmit datato the utilities, consumers can easily track their energy consumption patterns, identify potential areas of waste, and make informed decisions to optimize energy efficiency. Additionally, the remote disconnection feature after a specified period of non-payment ensures effective billing management and discourages energy theft.

The integration of IoT technology in the smartenergy meter also opens up possibilities for further advancements. For instance, the implementation of server software on the PC side allows for automatic data collection, enabling more streamlined energy monitoring processes. This data can be further analyzed and utilized foradvanced energy management strategies, including demand response programs and predictive maintenance. Overall, the smart energy meter powered by IoT holds great potential for transforming the energy sector, promoting energy efficiency, and improving customer experiences. By providing real-time data, enhancing communication with utilities, and offering remote management capabilities, it paves the way for a more sustainable and connected energy ecosystem. Implementation of IoT for Environmental Condition Monitoringin Home"2013 IEEE

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FUTURE SCOPE

In the future scope of Smart Energy Meters Powered by IoT is promising. The integration of advanced technologies, data analytics, and system interoperability will enable greater energy efficiency, grid optimization, and user empowerment in managing their energy consumption. The continued advancements in IoT, renewable energy integration, and smart grid infrastructure will way we consume, manage, and trade energy.

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