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AUTOMATIC AMOUNT CALCULATION SYSTEM - SMART ENERGY METER USING IOT

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Abstract - In today's reality, Automatic frameworks are being favored over manual frameworks. The quick increment in the number of clients of the web over the previous decade has made the Internet an integral part of life, and IoT is the most recent and rising web innovation. Electricity is one of the fundamental necessities of human beings, it is commonly used for domestic, industrial, and agricultural purposes. These days, power theft is the main issue, costing electricity boards a lot of money and creating payment issues for customers. In our country, these situations are more often. If these thefts are prevented then a lot of power can be saved. This is done using a Smart EB meter. An energy meter chip is used in SEMs to measure the amount of electric energy used, and wireless protocols are used for data transmission. This project presents an EB meter box via automatic billing system by display. electricity continues to rise, the existing grid faces challenges related to aging infrastructure, poor visibility, and mechanical switches. Additionally, greenhouse gas emissions from the electricity industry and other stressors necessitate grid modernization. The proposed smart energy meter leverages Internet of Things (IoT) technology, enabling two-way data communication over LPWAN (Low Power Wide Area Network). These are this system's salient characteristics. The meter incorporates theft and tamper detection capabilities. Users receive notifications in case of any unauthorized interference.

***Key Words*:** *Internet of Things (IoT), Light-dependent resistor (LDR), ESP8266 Microcontroller (NodeMCU), Liquid-crystal display, LoRaWAN, Energy Meter.*

I. INTRODUCTION

In the bustling landscape of modern living, energy consumption is both ubiquitous and critical. Enter the "Automatic Amount Calculation System - Smart Energy Meter Using IoT", a symphony orchestrated by technology, data, and environmental consciousness. The relentless march of technology has permeated every aspect of our lives, and the energy sector is no exception. In this era of interconnected devices, the convergence of the Internet of Things (IoT) with energy management systems has given birth to innovative solutions. One such groundbreaking application is the "Automatic Amount Calculation System - Smart Energy Meter Using IoT." At its core, this system aims to address the challenges associated with traditional energy metering. Gone are the days of manual meter readings and cumbersome billing processes. Instead, imagine a seamless, automated system that not only tracks your electricity consumption but also generates accurate bills without human intervention. IoT-Enabled Sensors: The heart of this system lies in IoT-enabled sensors strategically placed within households. These sensors continuously collect real-time data on electricity usage. Wireless Communication: The collected data is wirelessly transmitted to a central hub, eliminating the need for physical meter reading visits. This hub acts as the nerve center, orchestrating the entire process. Bill Calculation: A predefined set of algorithms processes the data, calculating the total energy consumed over specific intervals. The result an accurate Amount that shows your actual usage level. User-Friendly Interface: The system communicates with users through intuitive interfaces, such as smartphone apps. Imagine receiving your electricity bill directly on your phone, complete with detailed consumption breakdowns. Efficiency: By automating meter readings, the system reduces human error and streamlines the billing process. Cost Savings: Both consumers and utility providers benefit from reduced administrative costs. Real-Time Insights: Users gain insights into their energy consumption patterns, empowering them to make informed decisions.

II. RELATED WORKS

Sirsath N. S, Dhole P. S, et,al…[1] In the symphony of technological evolution, the once-dominant personal computers have gracefully stepped aside. Their grand overture has given way to a new movement the rise of mobile devices. Picture it: iPads, smartphones, and handheld tablets now choreograph our daily tasks, rendering traditional desktops and laptops mere echoes of a bygone era. Reports echo through the digital halls, proclaiming that personal computers no longer lead the orchestra. Instead, the spotlight shines on multi-touch mobile devices, pirouetting across the stage. Their nimble fingers dance with cloud networking, a celestial partner that weaves connectivity into the very fabric of our lives. Imagine a Home Automation system an avant-garde masterpiece born from this union. It waltzes with multi-touch mobile devices, twirls in the arms of cloud networking, and pirouettes with wireless communication. Together, they orchestrate a symphony of convenience, granting users remote control over lights and appliances within their homes. But wait, there's a twist a daring leap. Unlike its peers, this system doesn't crave the spotlight of mobile carriers or the web's vast expanse. No, it pirouettes independently, guided by an in-

home wireless remote. It's a low-cost marvel, adaptable and expandable, conducting a harmonious ensemble of devices. And so, as the curtain rises on this technological ballet, we applaud the Home Automation system a virtuoso that dances to its own beat, untethered by the strings of mobile dependency.

Deepali Javale, Mohd. Mohsin, et,al…[2] Imagine your home as a symphony of intelligence, were energy conservation and security dance harmoniously. This choreography unfolds seamlessly, making life flexible, healthy, and oh-so-comfortable. In the past, home automation systems resembled bulky mainframes, tethered to the internet like digital behemoths. But our creation? It's a nimble sprite, unburdened by weighty components. Portability is its signature move. Now, let's talk communication. Most systems flirted with Bluetooth, ZigBee, and GSM each with its own quirks. ZigBee, the wallflower, whispered sweet nothings but suffered from bandwidth shyness. GSM, the extrovert, belted out data like an opera diva, leaving bandwidth in its wake. A tragic waste, really. Enter our star performers: Java-based systems and SMS-based systems. Java, the old-school romantic, still clings to web pages a love story that falters when the intranet or internet ghosts us. SMS, the high-maintenance lover, demands costly data transfers from real-time providers. But wait, there's a twist! Our system waltzes to a different beat: the Wi-Fi protocol. Its range pirouettes gracefully within 150-200 meters. And the pièce de resistance? A password-protected mobile application, extending the security encore. So, dear homeowner, let your abode pirouette into the future where intelligence meets elegance, and every room hums with encrypted whispers.

Charith Perera, Arkady Zaslavsky, Dimitrios Georgakopoulos, et,al…[3] As we journey deeper into the era of the Internet of Things (IoT), an ever-growing multitude of sensors blankets the globe. These unassuming devices churn out torrents of data, their significance often hidden within the raw streams. To unlock their true value, we must unravel their secrets. Enter context-aware computing a beacon of understanding amidst the sensor data deluge. In our survey, we traverse the IoT landscape, shedding light on context awareness. We kick off with IoT fundamentals, then delve into the context life cycle. Our lens focuses on a curated set of projects spanning the past decade, dissecting their impact and gleaning insights for the future. Our mission? Not merely analysis, but appreciation a nod to the pioneers who paved the way. So, let's explore context awareness through the lens of IoT, where data whispers its tales, and innovation awaits. As we move toward the era of the Internet of Things (IoT), the proliferation of sensors worldwide has accelerated. Market research indicates substantial growth in sensor deployments over the past decade, with predictions of even greater expansion in the future. These sensors generate big amounts of data. However, to extract value from raw sensor data, understanding is essential. Context-aware computing has emerged as a successful approach for comprehending sensor data. We begin by introducing the IoT paradigm and context-aware fundamentals. Subsequently, we delve into an in-depth analysis of the context life cycle. Evaluating a subset of projects (50) representing significant research and commercial solutions in context-aware computing from 2001 to 2011, we identify valuable lessons and potential directions for future research.

Bill N. Schilit, Norman Adams, et,at…[4] Context-aware computing systems analyze and respond to an individual's dynamic surroundings. These systems facilitate interactions with devices, computers, and other people, aiding navigation in unfamiliar environments. Focusing on proximate context what we can perceive through sight, hearing, and touch is crucial. In the realm of context-aware computing, we delineate four distinct application categories. First, there's proximate selection, which involves manually fetching context-aware information about input/output devices, non-physical objects, services, or locations. Prototypes of these applications have been developed on the PARCTAB, a compact wireless computer. Next, we encounter automatic contextual reconfiguration, where information is dynamically selected or components are altered based on context. Imagine a mobile app that recommends nearby restaurants based on the user's location and preferences. These systems adapt automatically. For instance, a smartphone might switch to silent mode when it detects that the user is in a meeting. These systems, like chameleons, adapt seamlessly.

EXISTING SYSTEM

The primary goal is to automatically measure electricity consumption in home appliances and generate bills using IoT. It aims to overcome the drawbacks of manual meter reading and reduce reliance on human labour. It makes the lives of the resident's flexible, healthy, and comfortable. Initially, systems were developed in this regard but those systems had to be deployed on the Internet and heavy machinery like a big Personal Computer. Our system will be free from all these giant components, which, indirectly suggests that our system has a good quality of portability. Most systems would exchange data or communicate with the help of Bluetooth, ZigBee, and GSM. These systems have their disadvantages. For instance, the GSM-implementing system has an excessively big bandwidth for data communication, while the ZigBee-implementing system has an insufficient bandwidth. Thus, there is a waste of the essential bandwidth, which goes without being used. The other systems, that were in use, were, for example, Java-based systems and SMS-based systems. Java Java-based systems still use web pages, which is a disadvantage if the data intranet or Internet is off. Because SMS-based systems need data transfer from real-time service providers, they are more expensive. Facilitates wireless communication between the energy meter and other devices. Cloud Platform: Collects energy consumption data, performs real-time analysis, and generates accurate bills. Also, the gas may lead to fire. Once the danger happens, it will result in huge losses. The smart home system is necessary for safety. The system integrated the sensors to monitor the appliances and whether they work normally. Once the exceptions have been tested, the owner can get the text message immediately with the help of GSM. This system has a light cube. It has 512 lights. After testing, this system works to monitor the home appliances very well at a low cost.

III. PROPOSED METHODOLOGY

The proposed system leverages IoT technology to revolutionize energy metering and billing. By integrating smart meters, wireless communication, and cloud-based analytics, we create an intelligent energy management solution that enhances efficiency, transparency, and user experience. The server controls and monitors the various sensors, and can be easily configured to handle more hardware interface modules (sensors). which the card is inserted, acts as a web server. Two-Way Communication: Our smart energy meter communicates bidirectionally using LPWAN technology. It not only collects energy consumption data but also allows remote control and configuration adjustments. Wi-Fi technology is selected to be the network infrastructure that connects the server and the sensors. Wi-Fi is chosen to improve system security (by using a secure personal user name & Password), and to increase system mobility and scalability. IoT or the Internet of Things is an upcoming technology that makes use of the Internet to control and monitor Electronic and mechanical devices, automobiles, and other physical devices connected to the Internet. The system continuously monitors energy parameters, including energy consumption (kWh/kVAh), current (I), voltage (V), and power. Users can access this data through a webpage interface. We are among the pioneers researching the field of the Internet of Things. Gone are the days of static monthly bills. Our system calculates bills dynamically based on real-time usage. Users receive accurate bills, promoting energy conservation. Theft and Tamper Detection: The smart meter detects any unauthorized access or tampering. Instant notifications alert users, ensuring the security of their energy supply. Cloud Integration: All data is securely stored in the cloud. Users can access their consumption history, trends, and billing details from anywhere, anytime. These Internet of Things projects have been proposed on existing system improve and new innovative solutions to various problems. Our study on Internet of Things projects is never-ending due to the growing possibilities of connecting an increasing amount of hardware to the internet. Bills are generated automatically, reflecting actual usage. Alerts notify users of any anomalies.

BLOCK DIAGRAM

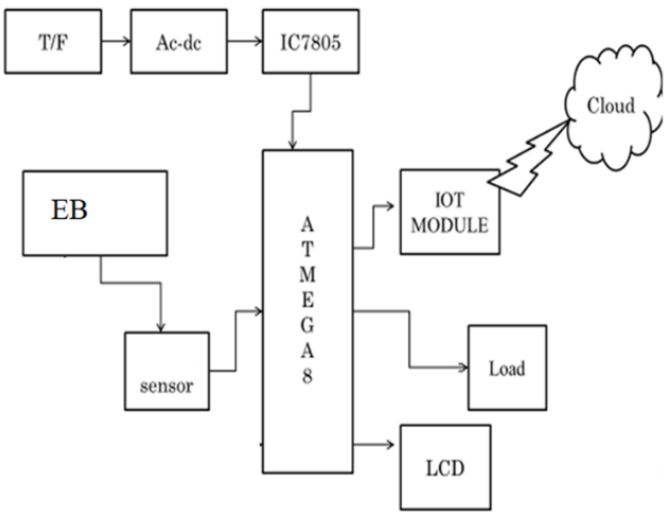

Figure -1: Block Diagram

Light-dependent resistor (LDR)

An LDR's resistance varies based on the amount of light falling on its surface. The resistance of the LDR changes when light strikes it. In the darkness, the resistance is high; in brightness, it decreases.

The underlying principle is photoconductivity: incident light excites electrons from the valence band to the conduction band in the semiconductor material.

The photons in the light must have energy greater than the semiconductor's band gap for this effect to occur.

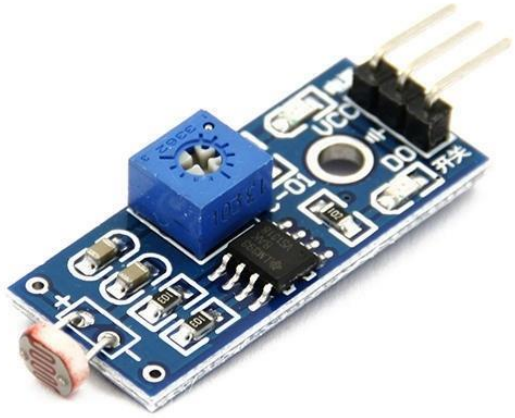

Figure -2: Light-dependent resistor (LDR)

NODE MCU

ESP8266-Based: NodeMCU is built around the ESP8266 Wi-Fi System-on-a-Chip (SoC). The ESP8266 is a powerful 32-bit microcontroller unit (MCU) with built-in Wi-Fi capabilities.

Lua-Based Firmware: NodeMCU runs an open-source Lua-based firmware. Lua is a lightweight scripting language that allows developers to write code interactively. It simplifies IoT development by providing an easy-to-use platform.

The underlying hardware module that runs this firmware is the ESP-12E, which is based on the 32-bit ESP8266 MCU. The firmware runs on the ESP8266 Wi-Fi SoC from Expressive Systems.

Figure -3: Node MCU

LCD Display

LCD can show numbers, characters, and designs. The microcontroller's (P0.0–P0.7) I/O port is interfaced with the showcase. Multiplexed mode is used for the presentation. In one-tenth of a second, the following exhibition illuminates. Because of Vision's diligence, the show will result in a continuous display of tally.

A liquid crystal solution is layered between two transparent electrodes and glass substrates to form the fundamental building blocks of an LCD. The molecules in the liquid crystal layer rotate in response to an applied electric field, which modifies the polarization of light that passes through them.

LCD displays are driven by electronic circuits that control the voltage applied to individual pixels, causing them to change their optical properties and produce images. The display controller processes input signals and sends appropriate signals to each pixel to generate the desired image.

LCDs have many benefits, including as wide viewing angles, great image clarity, high resolution, and interoperability with a variety of input sources. They are widely used in applications ranging from consumer electronics to industrial and medical devices due to their versatility and reliability.

Figure -4: Liquid-crystal display

EB Energy Meter

Smart meters measure electricity, unlike traditional analog meters, which require manual readings by meter readers, smart meters provide accurate and up-to-date consumption data. They enable both utilities and consumers to monitor and manage energy usage more effectively.

For electricity meters, sensors measure the voltage and current flowing through electrical circuits. These values are multiplied to calculate power consumption (measured in watts). By integrating power consumption over time, the meter determines total electricity use (measured in kilowatt-hours).

Once a smart meter measures and records energy consumption data, a communications module transmits usage information to the utility company.

Figure -5: Energy Meter

IV. RESULT & DISCUSSION

In this project, the authors propose an efficient system for monitoring energy consumption using IoT. The main objective is to measure electricity consumption in home appliances and generate bills automatically. The system utilizes a distributed topology for the energy grid, which can dynamically absorb different energy sources. Key components include Arduino, energy meter, Wi-Fi module, and IoT.

This paper discusses a novel smart energy meter designed for automatic metering and billing. Researchers have explored methods to establish communication between electricity boards and consumers for transmitting electricity consumption data and cost values. An IoT-based smart energy meter is proposed, capable of two-way data communication over LPWAN technology. The meter measures real-time energy parameters such as consumption, current, voltage, and power.

These meters can measure various energy parameters in real time, including:

- Energy consumption (kWh/kVAh)
- Current (I)
- Voltage (V)
- Power

The ability to monitor these parameters allows for better energy management and optimization.

IoT-based smart energy meters enable two-way data communication. They can communicate with utility providers, users, and technicians remotely. This communication facilitates tasks such as meter reading, billing, and monitoring.

These meters use Low-Power Wide-Area Network (LPWAN) technology for communication. LPWAN ensures long-range connectivity with low power consumption, making it suitable for energy meters.

V. CONCLUSIONS

The home mechanization utilizing the Internet of Things has been tentatively demonstrated to work attractively by uniting straightforward machines to it and the apparatuses were effectively controlled remotely through the web. The composed framework not only screens the sensor information, similar to temperature, gas, light, and movement sensors but additionally impels a procedure agreeing to the prerequisite, for instance exchanging on the light when it gets dim. It elegantly preserves the sensor parameters in the celestial embrace of Gmail's cloud. This will help the client to break down the state of various parameters in the home when ever anyplace.

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