An IoT based Electric meter Billing System

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***Abstract*—For usage in residences, workplaces, factories, etc., we created an automated electrical energy meter billing system based on IoT (Internet of Things). Electricity has evolved into one of the fundamental needs for human existence, and it is used extensively for industrial, commercial, and agricultural reasons. Customers frequently express dissatisfaction with electrical network maintenance. They complain that their monthly bills contain statistical mistakes. Therefore, we offer suggestions to avoid technological errors while also attempting to lessen reliance on a human. Additionally, IoT is a key idea utilized in this work (Internet of Things). IoT is a new technology that can send data across a network without requiring human or computer intervention and has unique identifiers. Through the use of this technology, we have attempted to communicate the whole energy usage data via email from a remote site to the customer and electricity board. In addition, we have developed a unique website and uploaded the meter readings there. Customers can regulate the electricity in the proposed system, periodically knowing how much energy they are using. Through the Wi-Fi module, the created invoice can be seen on the web page. The customer may pay the invoice as scheduled. We can use power more effectively and lower the amount of money that the government loses. The implementation of IoT will help better management, conservation of energy and also in doing away with the unnecessary hassles over incorrect billing in electricity modules. Further the IoT will be able to incorporate transparently and seamlessly a number of different devices.**

Keywords—IoT, Electric energy Meter

I. INTRODUCTION

A hyperlink community, in which things are connected to mobile devices and the internet and speak with one another, was developed as a result of the rapid development of information technology (IT). In the twenty-first century, I would like to take the lead in something that occurs at any given moment or location in the world. The Internet of Things, commonly known as IoT or inter-machine communication technology, is the key component of this extremely connected world. Using cutting-edge technologies like Big Data and Hadoop, this technique has been enhanced. This is anticipated to be the next major development that will have a significant impact on our lives. Although IoT is a new technology, it is anticipated to have a huge impact on computing history.

Many of the living and nonliving things that around us will be online in some way due to the rapid increase in population density inside the IoT model. The IoT has advanced past its infancy and is actually on the verge of transforming the current fixed internet into a well-featured upcoming Internet thanks to the popularity of gadgets powered by wireless technological innovation like Wireless Bluetooth, Radio Frequency Identification, Wireless-Fidelity, and Embedded Sensor. There are currently over nine billion linked devices, and by 2020, that number is expected to reach close to fifty billion. The current global environment is one that presents difficulties. The primary issue facing civilization is the energy and water crises.

It is now more crucial than ever to precisely monitor and charge the consumption of electrical energy due to the rising demand for electricity. The field of the Internet of Things (IoT), which is expanding quickly, is altering how we engage with technology. IoT has been applied in recent years to develop more automated and effective systems in a variety of industries, and the energy sector is no different. Electric billing systems built on the Internet of Things (IoT) have become a potential option for precise and effective electricity billing.

IoT sensors and machine learning algorithms are combined in an IoT-based electric billing system to measure energy consumption and produce bills automatically. In order to reduce the possibility of human mistake and billing conflicts, the system is built to deliver precise readings and automate the billing process. The way we bill for power could be completely changed by this technology, which might also result in lower prices for both energy suppliers and consumers.

We will look at the current research and development in the area of IoT-based energy billing systems in this

literature review. We will analyze case studies of effective deployment as well as the advantages and difficulties of this technology.

II. Literature Survey

IoT-based billing systems are a recent innovation that generate automatic billing for a variety of services using IoT devices. The technology works by gathering information from IoT devices and using it to determine how much money consumers owe. We will look at the current research and development in the area of IoT-based billing systems in this literature review.

1. An IoT-based intelligent system for electricity billing and administration is presented in "An IoT-Based Intelligent System for Electricity Billing and Management," by M. A. Rahman and M. F. Hasan, published in IEEE Access in 2020. To measure electricity consumption and produce invoices automatically, the system combines IoT sensors and machine learning algorithms. The proposed system measured electricity consumption with great accuracy and efficiency.

2. An IoT-based water billing system is presented in "Design and Implementation of an IoT-Based Water Billing System," by Y. Zhao and W. Zhang, which was published in IEEE Access in 2019. The technology uses wireless connection and Internet of Things sensors to automatically calculate bills and measure water consumption. The effectiveness of the suggested system in precisely measuring water use has been demonstrated.

3. An IoT-based gas billing system is presented in "Design and Implementation of an IoT-Based Billing System," by M. A. Rahman and M. F. Hasan, which was published in the Journal of Sensors in 2019. IoT sensors are used by the system to automatically calculate invoices and measure gas use. The effectiveness of the suggested technology in precisely measuring gas usage has been demonstrated.

4. An IoT-based electricity billing system utilizing smart grid technology is presented in K. Wang's article, "IoT-Enabled Smart Grids for Electricity Billing System in Smart Cities," which was published in the Journal of Energy and Power Engineering in 2018. The suggested system measures electricity consumption and generates bills automatically using IoT sensors and smart meters. The effectiveness of the technology in lowering energy use and increasing billing accuracy has been demonstrated.

5. An IoT-based water management system including a billing component is presented in "IoT-Based Integrated Water Management System," by R. Gupta and S. R. Vishwakarma, which was published in the International Journal of Engineering and Technology in 2020. The suggested method makes use of Internet of Things sensors to track water usage and produce bills automatically. The effectiveness of the method in lowering water waste and enhancing billing accuracy has been demonstrated.

The potential of IoT devices to increase billing accuracy and decrease wastage in a variety of services has been shown by the research that has already been done in the field of IoT-based billing systems. To measure usage and produce bills automatically, these systems combine IoT sensors and wireless communication technology. The suggested solutions have proven to be extremely accurate and effective in calculating usage and producing bills, and they have the potential to save costs for both service providers and customers.

How IoT based Billing System has Implemented:

A. The design, simulation, and development of a GSM-based electricity theft have been completed. It is completely powered by Arduino and GSM for power theft detection and protection. As this operation inhibits direct communication between the stop person and the workers, it has covered more than a few sorts of electrical energy theft, including servicemen's lack of accountability, billing problems, and money theft with the help of utility companies. The created gadget may also be able to help Utilities reduce the instances of household electrical energy theft through remote monitoring of the meter reading and SMS alerts whenever there are unexpected readings in the customer's electrical energy meter. The majority of this machine's focus is on single-section electrical distribution systems. As the meter keeps a timed track of the consumer's load, automation of the customer billing system is now complete. Therefore, this approach eliminates manual meter analysis with its associated time-consuming equipment penalties and consignment manipulation that affects the organization while increasing payments to the customer. The work also involves automatic disconnecting and reconnecting when the recharge is insufficient or excessive, respectively, and the ability to remove added value from reconnecting.

B. Design of an Overload Trip Facility Smart Energy Meter: In this assignment, we began with a suggested approach to energy management from the perspective of the consumer to show how to educate the consumer about energy management so that he can control his load, limit the bill, and also participate in energy conservation. So, after researching the amazing features this project needs, we chose the least priced microcontroller that also met our project's requirements. The ARDUINO UNO, which is utilized for this purpose and is programmed in C,

was effectively compiled using the Arduino software programme before being successfully loaded onto the microcontroller. We tested our hardware after connecting amazing digital components like GSM, ACS712, and relays to the Arduino on the Veero board. For each of the three phases, current and voltage are measured, and energy is estimated according to how the load is managed. A notification stating "System Overload" was sent to the user whenever the predefined threshold price was exceeded.

Development of Arduino Based IoT Metering System for On-Demand Energy Monitoring, This lookup developed an IoT based totally smart metering gadget whilst inspecting its integration procedure. Using a Composite Design methodology, the work furnished an easy and beneficial answer in the structure of an electricity consumption price Wi-Fi meter. The device used to be proven to be profitable in measuring current, electricity consumption and additionally processing the value incurred by using a customer. These metrics are the electricity consumption and price to the cloud server. This makes it less complicated for clients to view consumption prices ubiquitously.

The article by H Amatulla Patawala, "IoT Based Water Management System for Smart City," [2], All life on earth depends on water as a valuable resource. In that, due to uneven distribution, some individuals do not receive enough water. This strategy will ensure that everyone receives the same amount of water. Additionally, it is utilized to prevent water wastage during the distribution phase. The prior system required the employee to visit the location, open the valve for a predetermined amount of time, and then return to the location to close the valve. The suggested system has total automation. Human labor and time are conserved here.

III. Objectives

Urban billing systems are in terrible shape and are unable to provide appropriate bills for the flats' gas, electricity, and water usage. Some urban flats' water usage is not accurately measured, and the generation of bills occasionally falls short of the requirements specified by the management board. The goal of developing this system is to aid in the development of cutting-edge approaches to water, electricity, and gas utility systems in urban residences, societal structures, etc. This project will implement an intelligent method of keeping track of documents and create an intelligent billing system in accordance with guidelines established by the management board in metropolitan areas. The device is set up to calibrate a certain bill for the number of units used. The collected data, including the number of units used and the bill of consumption, is kept in the cloud and may be viewed via Web, Android, or iOS applications. The water flow sensor, gas flow sensor, and electricity sensor are assembled with a microprocessor or controller that is configured to monitor flow data in an IoT-based utility monitoring and billing device or apparatus. The technique will be utilized in apartments to create the bill by tracking the records using inexpensive IoT sensors.

The goal of this work was to provide the Smart Energy Management System's monitoring component. It has since been expanded to include effective control of the connected connections by the main electricity inlet, or the main line. In addition, the expanded work will demonstrate how the presented SEMS can assist with real-time configuration and monitoring of smart power grids. To give one example, IoT offers many options for exchanging collected data via the grid to improve its operation.

By using SMs to send this data to distant areas, utilities may control the power grids to meet the demands of their customers.

IV. PROPOSED SYSTEM

The suggested system intends to handle all of the organization's users in a single location and provides information on the overall cost incurred through pie, bar, and line graphs. As a result, there are less aspects to consider, such as keeping a journal or book that contains records, not worrying about losing data, and managing everything in one location that is accessible from anywhere in the world. We can break the system down into different modules to better understand it.

Objectives of the proposed work are

- To learn about different energy meter reading systems.
- To study and understand the various methods and models used by various researchers for energy meter reading systems.
- To take necessary action to make the solution reliable, robust and effective.
- To avoid human intervention in bill generation process

Working:

1. Data Collection: The smart meters will collect real-time data on electricity consumption and transmit it to the central server.

2. Data Processing: The central server will receive data from the smart meters and process it to generate electricity bills. The server will use a billing algorithm

based on the tariff structure set by the electricity provider.

3. Bill Generation: The generated bills will be sent to the consumers through the mobile application.

4. Payment: The consumers will be able to view their electricity bills on the mobile application and make payments through the integrated payment gateway.

5. Data Analysis: The central server will store the data collected from the smart meters for future reference and analysis. The data can be used to generate reports on electricity consumption patterns and improve the efficiency of the billing system.

Flow Chart:

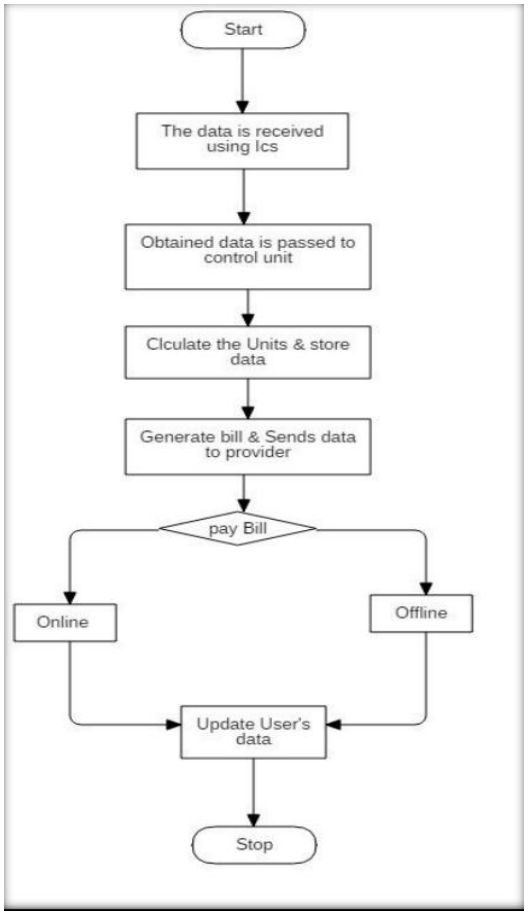

Figure: Data Flow Diagram

System Architecture:

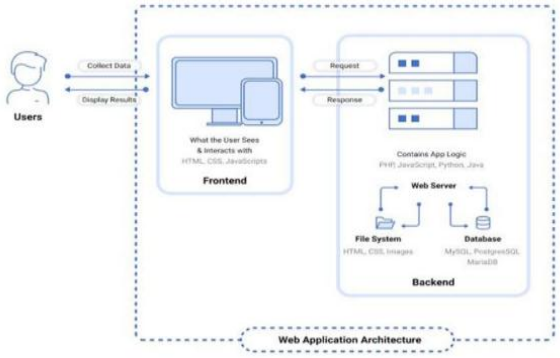

Figure. System Architecture

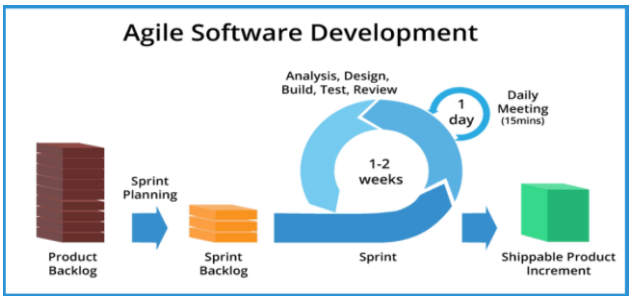

Figure: Agile Software Development

V. Technology Used

This system is used keeping different technologies in mind and also the user as our first priority. Our main aim is to build a system that is robust and that stands the test of time which also helps us in the scalability of the product and is also beneficial to the user. Here we are using MySQL as the database. This is a very powerful database that helps us in managing our data properly.

MySQL due to its ability to store huge volumes of data and can be used as an excellent distributed database was the ideal choice, as the web application would be connected to companies' very own data centers to keep the integrity of their company. Another technology that we used is Spring Boot. It is an open-source Java-based framework used to create a micro Service. It is developed by the Pivotal Team and is used to build stand-alone and production-ready spring applications. This has been quite helpful with our APIs and also various different functionalities that we have to fulfill. On the other hand, it is quite versatile and easy to understand. For the front-end, we are using Angular, HTML, and CSS. The creation of the front-end becomes quite easy when we use Angular. The GUI and the entire front-end are made with great precision and better user understanding for easier navigation through our web application.

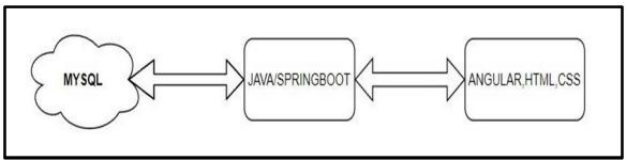

Figure. Technology Used

VI. Advantages

The followings are advantages of IoT based billing system:

1. Billing that is accurate and based on actual consumption data is made possible by the deployment of IoT sensors to measure usage. This lessens the possibility of mistakes and conflicts arising between the provider and the customer.

2. IoT-based billing systems automate the billing process, doing away with the need for paper-based billing and manual meter readings. This lowers administrative expenses and boosts billing procedure effectiveness.

3. Real-time information: IoT sensors can supply real-time information on energy use, enabling service providers to monitor usage and spot possible problems. This can aid providers in improving their overall service and energy distribution optimization.

4. Energy conservation: IoT-based billing systems can help to promote energy conservation by providing consumers with real-time data on their energy consumption. This can encourage consumers to make more informed decisions about their energy usage and reduce their overall consumption.

5. Cost savings: By automating the billing process and reducing the potential for errors, IoT-based billing systems can help service providers to save costs. This can result in cost savings for consumers as well.

6. Scalability: IoT-based billing systems can be easily scaled to accommodate a large number of users, making them suitable for use in a variety of settings, from homes to large commercial and industrial applications.

Increased accuracy, automation, real-time data, energy conservation, cost savings, and scalability are just a few benefits of IoT-based billing systems. These advantages make this system a promising option for precise and effective energy billing.

VI. Conclusion

The proposed IoT based electric billing system will provide a more efficient and accurate way to bill electricity consumption. The system will eliminate manual errors and provide consumers with a convenient way to view their bills and make payments. The data collected by the system can also be used to improve the efficiency of the billing system and reduce energy waste. The Corporation Billing System provides a well-designed solution for smart corporation billing, and the IoT platform is used to forecast energy and water demand for smart cities.

The suggested system performs ongoing monitoring, management, and invoicing of the water and power use (measured in liters and watts, respectively). It will automatically notify the client to recharge via smartphone if the consumption of electricity and water reaches the minimum level. The entire system model in this study is monitored and controlled by NodeMCU. IoT adoption will promote improved management, water and energy conservation. This method does away with the need for human oversight of corporations and local governments. The billing system has the ability to continuously track how much water (in liters) and power (in watts) are used. The figures will be presented on the smartphone, eliminating the need to physically visit the electricity or water meter to check the readings. The amount of electricity and water that will be consumed may be seen by the consumer, along with how much it will cost in rupees.

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