A Review Paper on Smart Energy Meter with Calibrated Mobile Application and Real-Time Payment System

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***Abstract*—The Automatic Supply On-Off Control system in Maharashtra State Electricity Distribution Company Limited (MSEDCL) aims to enhance the reliability and efficiency of power distribution networks by integrating automation and communication technologies. This system leverages a combination of embedded applications and GSM (Global System for Mobile Communications) technology to enable real-time monitoring, control, and automation of electrical supply. The traditional manual methods of switching the supply on and off often lead to inefficiencies, delayed response times during faults, and difficulty in remote control, especially in rural or remote areas. By employing GSM-based communication, this system allows MSEDCL operators to remotely control the on-off states of electrical feeders or substations via SMS commands, offering improved flexibility, reduced human intervention, and faster fault recovery. The proposed system consists of a microcontroller-based interface for automated control of electrical supply, a GSM module for communication, and sensors for fault detection and monitoring. In case of a fault, the system can automatically disconnect the supply to avoid further damage, while simultaneously alerting the control canter and operators through SMS notifications. This real-time information enables swift action, reducing downtime and preventing potential hazards or overloading. Overall, this automation-based approach enhances the operational efficiency of MSEDCL's distribution network, ensuring better power management, quicker fault detection, and improved service reliability for consumers.**

***Index Terms*—GSM Based Automation, Smart Energy Meter, Arduino, Automated Billing, Real Time Monitoring**

I.INTRODUCTION

Automatic supply On-Off control in MSEDCL implements the emerging applications of GSM technology. Using GSM networks, a control system has been proposed that will act as an embedded system which can monitor and control supply in MSEDCL using built-in input and output peripherals. At the heart of our system is the Arduino Nano, a compact yet powerful microcontroller board renowned for its versatility and ease of integration. The Arduino Nano serves as the central processing unit, coordinating communication between various components and executing logic for bill management tasks. Its small form factor and programmability make it an ideal choice for embedded systems and IoT applications. To enable seamless communication and remote-control capabilities, we integrate the GSM Module SIM800L into our system. This module leverages GSM/GPRS technology to establish cellular communication, allowing the system to send and receive SMS messages. This functionality is crucial for notifying users about overdue bills, sending payment reminders, and receiving confirmation messages, enhancing user engagement and facilitating timely bill management.
In addition to SMS communication, our system incorporates a web-based interface for administrators to monitor and manage overdue bills efficiently. The application includes an admin page where authorities can log in and access a dashboard displaying details of houses, check bill statuses, trigger SMS notifications, and remotely control electrical devices such as light bulbs. The relay module plays a pivotal role in our system by providing remote control of electrical devices based on commands received from the application interface or SMS messages.

II.LITERATURE SURVEY

1. Smart Metering Systems
- Authors: Siano, P.
- Publication: IEEE Transactions on Industrial

Informatics
- Published Year: 2014

Findings:
This study explores the benefits of smart metering in residential and industrial setups. It emphasizes real-time monitoring of power usage, automated billing, and enhanced transparency between providers and consumers. Smart meters significantly reduce manual intervention and promote efficient energy management.

2. Wireless Payment Systems and Dummy Payment Integration
- Authors: Mahapatra, M., Pradhan, S., & Nayak, A.
- Publication: International Journal of Smart Technology and Research
- Published Year: 2018

Findings:
The research highlights how dummy payment gateways can be used for testing and training environments. It provides insights into creating secure simulation systems for users to practice financial transactions without real money. This technology improves system reliability and is widely applied in smart billing systems.

3. Power Cutoff Mechanisms for Energy Control
- Authors: Liu, Y., Sun, X., & Wang, J.
- Publication: Journal of Energy Management
- Published Year: 2019

Findings:
The paper describes how automated power cutoff mechanisms can be used to manage non- payment and reduce energy wastage. These systems cut the power supply if predefined conditions (such as unpaid bills) are met, restoring it upon payment. This ensures timely user compliance and enhances system efficiency

4. IoT-Enabled Billing Systems
- Authors: Gupta, R., & Sharma, D.
- Publication: Journal of IoT Applications
- Published Year: 2020

Findings:
This study explains the role of IoT in smart billing systems, focusing on remote monitoring and user alerts. It demonstrates how mobile apps integrated with IoT modules can offer seamless billing experiences and enable users to monitor consumption patterns in real-time.

III.OBJECTIVE

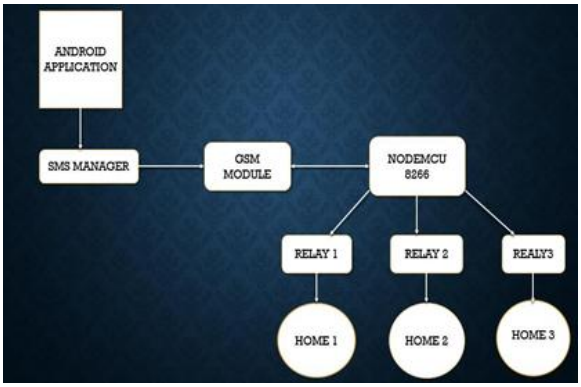
To design and implement a smart energy metering system that enables accurate energy measurement, mobile-based calibration, and secure real-time payment to improve efficiency, transparency, and consumer control over electricity usage.

1. Accurate Energy Measurement
- To measure real-time electrical parameters such as voltage, current, power, and energy consumption with high precision.
- To minimize human errors associated with manual meter readings.

2. Mobile-Based Calibration System
- To develop a mobile application that allows authorized users or technicians to remotely calibrate the energy meter.
- To ensure long-term accuracy of the meter through periodic software-based calibration instead of manual intervention.
- To enable diagnostics and fault detection through the mobile app.

3. Real-Time Data Monitoring
- To provide users with real-time energy consumption data via the mobile application.
- To display historical usage trends for better energy management and conservation.

4. Real-Time Payment Integration
- To implement a prepaid or postpaid real-time payment system linked to actual energy consumption.
- To allow users to make instant payments through digital platforms (UPI, wallet, card, or net banking).
- To automatically disconnect and reconnect power supply based on payment status (if applicable and compliant with regulations).



Block Diagram for Smart Energy Meter with Calibrated Mobile Application and Real-Time Payment System

IV.METHODOLOGY

1. Transparency and User Control
- To eliminate billing disputes by providing accurate, real-time billing information.
- To empower users with alerts and notifications for low balance, high consumption, or abnormal usage.

2. Utility Provider Efficiency
- To reduce operational costs for electricity providers by eliminating manual meter reading and billing processes.
- To enable remote meter management, firmware updates, and fault reporting.

3. Security and Data Integrity
- To ensure secure data transmission between the energy meter, mobile application, and payment gateway.
- To protect user data through authentication, encryption, and access control mechanisms.

4. Scalability and Smart Grid Compatibility
- To design the system to be scalable for residential, commercial, and industrial usage.
- To ensure compatibility with future smart grid infrastructure and IoT-based energy systems.

5. Android Application

Role: Acts as the primary user interface for system control.
- Functionality:
  - Users can send commands (like ON/OFF) to control power for individual homes.
  - Allows users to view billing status, energy consumption, and simulate payments using dummy money.
  - Provides alerts or notifications if bills are unpaid or if power cutoff is scheduled.
- Communication: Sends SMS commands through the SMS Manager to initiate power control actions.

Fig. (Android Application)

6. SMS Manager

The SMS Manager is responsible for handling communication between the Android application and the GSM module using SMS. It acts as a bridge that allows users to control devices remotely without requiring an internet connection.

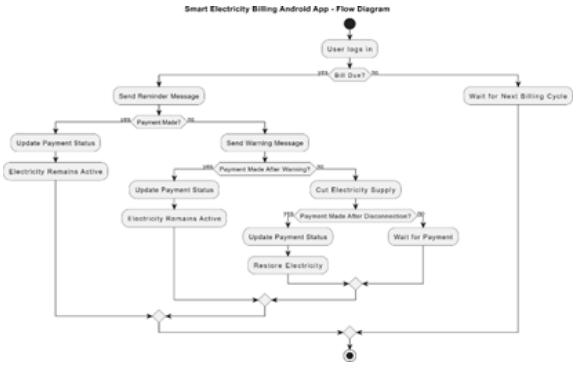
When a user performs an action such as turning a device ON or OFF, the SMS Manager converts this action into a predefined SMS command. The message is then formatted in a structured way so that the GSM module can easily understand it.

After formatting, the SMS Manager sends the message through the mobile network using the device's SMS service. If the message fails to send, the system can retry to ensure reliable communication.

The SMS Manager also receives reply messages from the GSM module, such as status updates. It processes these messages and updates the application interface to reflect the current state of the device.

Fig. (SMS Manager)

Flow Chart



V. CONCLUSION

The smart energy meter integrated with a calibration-enabled mobile application and a real-time payment system represents a significant advancement in modern energy management. This system successfully combines accurate energy measurement, remote calibration, real-time monitoring, and seamless digital payments into a single, user-friendly platform. By eliminating manual meter readings and traditional billing delays, it enhances transparency, reliability, and convenience for both consumers and utility providers.

The mobile-based calibration feature ensures sustained accuracy of the energy meter while reducing maintenance effort and operational costs. Real-time energy monitoring empowers users to understand and manage their electricity consumption more effectively, encouraging energy conservation and informed decision-making. Additionally, the real-time payment system simplifies the billing process, enables instant transactions, and minimizes disputes, revenue losses, and electricity theft.

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