Automatic Supply on-off Control in MSEDCL Using GSM & Android Application

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Abstract - *The Automatic Supply On-Off Control system of MSEDCL enhances the efficiency and reliability of power distribution by using automation and GSM technology. It allows operators to remotely control the on-off states of feeders or substations via SMS, improving flexibility, reducing human intervention, and enabling faster. The system includes a microcontroller, GSM module, and relays. It automatically disconnects the supply and sends SMS alerts, ensuring quicker response times, better power management, and improved service reliability.*

Keywords *– Automated bill reminders, Automatic supply control, Android application, Bill management system, GSM Technology*

Introduction

Automatic supply On-Off control in MSEDCL" implements the emerging applications of the 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.
The Arduino serves as central processing unit, coordinating communication between various components to monitor and manage overdue bills efficiently.
Its small form factor and programmability make it an ideal choice for embedded systems and IoT applications.

To enable seamless communication remote- control capabilities, we integrate the GSM Module into our system.This module leverages GSM 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, facilitating timely bill management.

In addition to SMS communication, our system incorporates the app-based interface for admin 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.

Arduino nano control signals, the relay module switches the power supply to specific devices, ensuring efficient management of electricity usage and controlled access to resources.

Furthermore, the system's power supply is carefully designed to ensure stable and reliable operation of all interconnected components.
The power supply delivers the necessary voltage and current to the Arduino, GSM Module SIM800L, relay module, and other peripherals maintaining optimal performance and preventing electrical issues.

Literature Survey

The study "Smart Metering Systems" by P. Siano (2014) in *Transactions on Industrial Informatics* highlights the benefits of smart meters in residential and industrial settings. It focuses on real-time energy monitoring, automated billing, and enhanced transparency between consumers and providers. Smart meters reduce manual intervention, improve energy management efficiency, and support demand response by providing accurate data for resource optimization, ultimately leading to cost savings and better energy conservation.

The study "Wireless Payment Systems and Dummy Payment Integration" by M. Mahapatra, S. Pradhan, and A. Nayak (2018) discusses the use of dummy payment gateways for testing and training in wireless payment systems. It emphasizes the creation of secure simulation environments for practicing transactions without real money, improving system reliability and security. This approach is particularly useful in smart billing systems, ensuring safe and accurate financial transactions.

The paper "Power Cutoff Mechanisms for Energy Control" by Y. Liu, X. Sun, and J. Wang, published in the *Journal of Energy Management* in (2019), discusses automated power cutoff systems designed to manage non-payment and reduce energy wastage. The systems automatically disconnect power when predefined conditions, such as unpaid bills, are met and restore it once payment is made. This mechanism ensures timely compliance by users and improves overall system efficiency.

The research "Energy Conservation through Smart Billing Systems" by T. Johnson and R. White, published in the *Renewable Energy Systems Journal* in (2017), examines how automated billing systems can influence consumer behavior to promote energy conservation. The study finds that timely billing and transparent energy data encourage consumers to reduce unnecessary energy usage and better manage their costs, ultimately leading to more efficient energy consumption.

Methodology

The proposed Smart Electricity Billing and Control System utilizes an Android application, SMS-based communication, a GSM module, Node MCU microcontroller, and relays to manage electricity usage across multiple homes.

Android Application: The interface for users to control power remotely, view consumption, access billing, and simulate payments via SMS commands.

SMS Manager:
Converts user commands into SMS messages, ensuring reliable communication even in areas with poor internet connectivity.

GSM Module:
Receives SMS commands from the app, forwards them to the Node MCU, and sends status updates back to the user.

Node MCU Microcontroller:

Acts as the system's brain, processing SMS commands, controlling relays, and managing power for each home independently.

Relay Modules:
Control power flow to individual homes. Power is cut off automatically for unpaid bills and restored upon payment.

Homes (Home 1, Home 2, Home 3):
Connected via relays, allowing for independent power control based on payment status.

Dummy Payment System:
Simulates real payments, ensuring user familiarity with the system before real transactions.

Automated Power Cutoff:
Automatically disconnects power when bills are unpaid and restores it once payment is made.

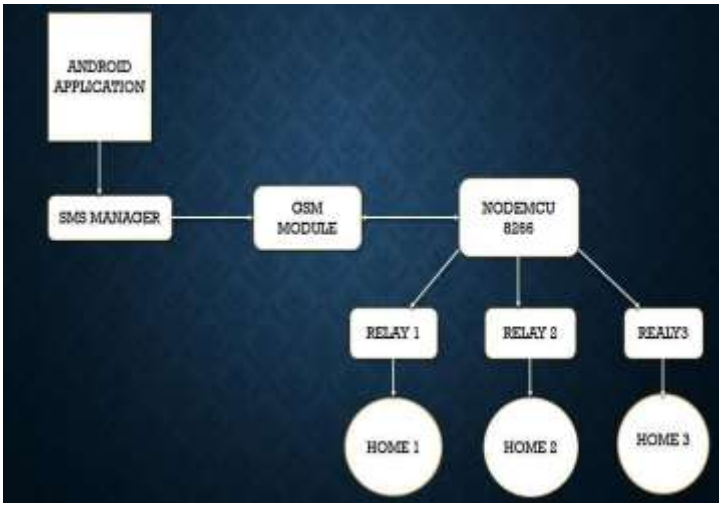

Fig: 1 Block Diagram of proposed system.

Working of the proposed system

The **Android Application** is the user interface of the system, allowing users to monitor electricity consumption, control power (ON/OFF) remotely, and send SMS-based commands to manage power flow. It provides access to billing and payment details, with a feature for simulating transactions using dummy money. The app ensures an easy-to-use interface for efficient electricity management across multiple homes.

The **SMS Manager** in the Android application is responsible for sending user commands as text messages. It ensures secure communication between the user and the system through SMS, quickly relaying commands like "Turn off power for Home 1" to the GSM module. It guarantees reliable messaging, even in areas with limited internet connectivity, acting as a bridge between the user and the GSM module for efficient system control.

The **GSM Module** serves as a critical communication interface, receiving SMS commands from the Android app, such as "Switch off Home 2". It forwards these commands to the Node MCU microcontroller for processing. Additionally, the module acknowledges receipt of commands and sends status updates (e.g., ON/OFF confirmations) to the user via SMS. By utilizing cellular networks, the GSM module ensures the system remains operational in remote or low-bandwidth areas, making it a reliable communication tool for the system.[3]

The **Node MCU (ESP8266) Microcontroller** acts as the central control unit of the system, processing commands received from the GSM module and controlling the relays accordingly. Its key functionalities include interpreting SMS commands to activate or deactivate specific relays, managing power for multiple homes by controlling each home's relay, and maintaining communication with the GSM module to receive control signals. Additionally, it reports the power status (e.g., ON/OFF) back to the user. The Node MCU's ability to interface with both the GSM module and relays makes it an efficient and flexible tool for managing power across different homes in the system.[3]

The system utilizes **three relay modules**, each dedicated to controlling the power supply of a separate home (Home 1, Home 2, and Home 3).

Relay 1 controls Home 1, Relay 2 controls Home 2, and Relay 3 controls Home 3. When the system receives a command to disconnect power, the respective relay switches off, cutting off electricity to the designated home. The power is restored either when the payment is confirmed or when the user sends an "ON" command. These relays function as electrically operated switches that open or close circuits, allowing for the physical control of the electricity flow to each home.[3]

Each home in the system (Home 1, Home 2, and Home 3) is connected via a dedicated relay, allowing for independent management of their electricity supply. If a bill for a specific home remains unpaid, the system can send a cutoff command to the corresponding relay, disconnecting the power. Once payment is made, either through the dummy payment system or real payment, the system automatically restores power by switching the relay back ON.[3]

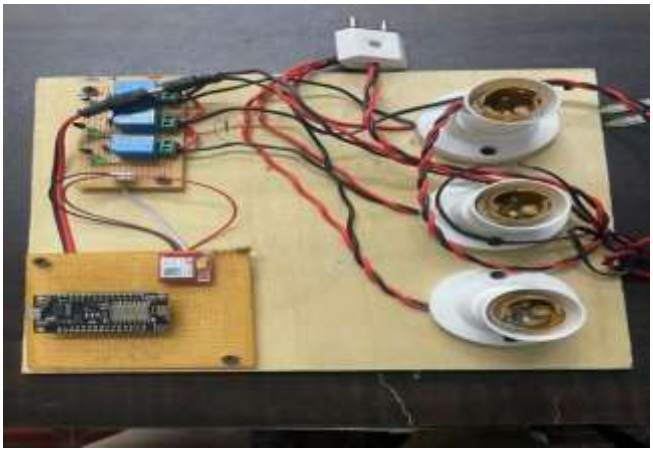

Fig.2 Hardware of proposed system.

The Dummy Payment System integration allows users to simulate real-world transactions without involving actual money. It enables users to practice payments within the app, ensuring the system operates smoothly before deployment. The system also allows users to manage electricitybills, track payment history for each home, and automatically restore power once a payment is confirmed. This feature helps improve system reliability and user familiarity with the process before integrating real payment gateways, making the system more efficient and user-friendly.[2]The Automated Power Cutoff Mechanism is a key feature that ensures power management is handled efficiently. If a user fails to pay their bill, the system automatically sends a

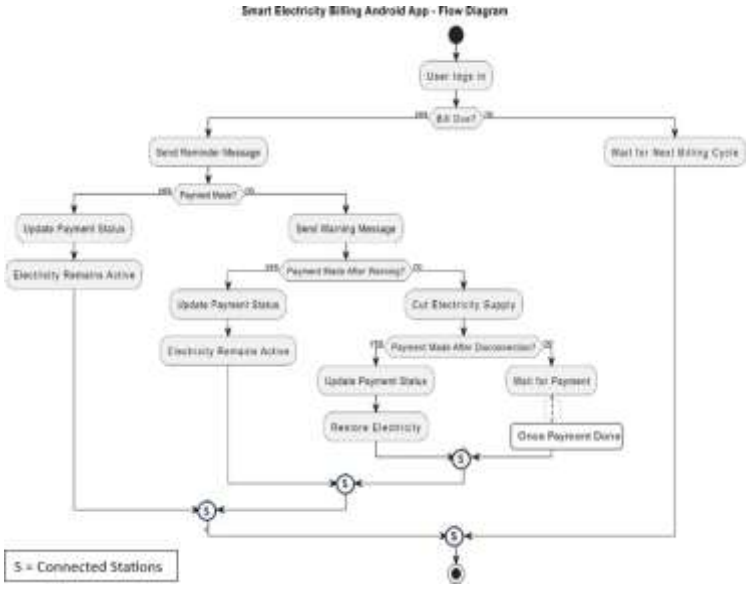

Fig.3 Flowchart of proposed system

command to disconnect power to the respective home. Once payment (either dummy or real) is confirmed, the power is automatically restored without requiring manual intervention. This feature not only ensures timely compliance with payments but also helps prevent energy wastage. By eliminating the need for manual

disconnection, the system reduces operational costs and minimizes the potential for human errors.

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This flowchart illustrates the functioning of a Smart Electricity Billing Android App in detail. The process begins when a user logs into the app. The system immediately checks if there is any pending electricity bill. If there is no bill due, the user is allowed to wait un til the next billing cycle without any further action. However, if a bill is due, the app proactively sends a reminder message to the user, notifying them about the pending payment.[4]

If the user makes the payment after receiving the reminder, the payment status is updated in the system, and the electricity supply remains active without any interruption. On the other hand, if the user fails to make the payment despite the reminder, the app escalates the situation by sending a warning message. If the user still does not make the payment after the warning, the system proceeds to cut off the electricity supply as a consequence of non-payment. Once the electricity is disconnected, the app waits for the user to complete the payment. After the payment is successfully made, the app updates the payment status, restores the electricity supply, and prepares for the next billing cycle. This ensures an automated, efficient, and user-friendly approach to managing electricity billing and service continuity.[4]

Android Application Development

In Android application development, the primary programming languages used are Java and Kotlin. Java has been the staple language for Android development for many years, but Kotlin is quickly becoming the preferred choice due to its modern features, such as null safety, concise syntax, and improved interoperability with Java. Kotlin offers a more streamlined and efficient development process, which makes it a favoured language for both new and experienced developers. Android Studio, the official Integrated Development Environment (IDE) for Android, is widely used to build and test Android apps. It offers a comprehensive set of tools, including code editing, debugging, performance analysis, and a visual layout editor, making the app development process smoother and more efficient.

Programming Languages
Java or Kotlin: These are the primary languages used to develop Android applications. Java is more commonly used, but Kotlin is becoming the preferred language due to its modern features.

Android Studio
This is the official Integrated Development Environment (IDE) for Android application development. It provides tools for building and testing Android apps.

XML (Extensible Markup Language)
Used for designing the user interface (UI) in Android applications. XML layouts define the structure and appearance of UI elements like buttons, text fields, etc.

Android application development, using Java, Kotlin, and XML, is widely applied across various industries, transforming how businesses and consumers interact with technology. In the consumer space, it powers mobile apps for social media, e-commerce, entertainment, and healthcare, enabling smooth user experiences with intuitive interfaces built using XML. Kotlin and Java handle the backend logic, ensuring efficient performance for tasks like data processing and real-time communication.

GSM(Global System for Mobile Communication) Communication

Microcontroller Programming (e.g., Arduino, ESP32, or Raspberry Pi):
GSM modules (like SIM900 or SIM800) are integrated with microcontrollers (like Arduino or ESP32). The microcontroller is responsible for receiving signals from the Android app via GSM and controlling the electrical supply.

The microcontroller is programmed using languages like C or C++ (for Arduino).[3]

Serial Communication:

The GSM module communicates with the microcontroller over serial communication (using UART or RS-232 protocols).

Architecture of GSM

User Interface (Android Application):
Mobile Device (Android App**)**: The user interacts with the system through an Android application installed on a mobile device (smartphone or tablet). This app allows the user to send control commands (e.g., turn on/off the power supply) to the system via GSM.

User Inputs: The user inputs commands such as "ON" or "OFF" through the Android app. The app can also provide feedback or alerts about the current state of the power supply.

GSM Communication (via GSM Module):

- SMS Sending/Receiving: The Android application sends commands to the GSM module through SMS (Short Message Service) using the GSM network. The SMS contains the control instructions, such as "TURN ON" or "TURN OFF" the supply.
- GSM Module: The GSM module (e.g., SIM900 or SIM800) is a hardware component that connects to the mobile network. It is responsible for sending and receiving SMS messages between the Android app and the microcontroller. The module also handles communication over the GSM network, ensuring reliable transmission of control signals.
- Microcontroller (e.g., Arduino or ESP32): The microcontroller is connected to the GSM module and interprets the SMS commands received from the Android application. It processes the command and takes the necessary action (e.g., turning the electrical supply on or off).**3.** Power Control and Relay Module:
- Relay or Contactor: The microcontroller controls a relay or contactor that physically switches the electrical supply on and off. The relay acts as an electronic switch, allowing or cutting off the electrical current to the load (e.g., an industrial or residential supply).

- Safety Checks: The microcontroller may also be programmed to monitor conditions like voltage or current to ensure safe operation and prevent damage to the electrical system.

Microcontroller Processing:

- SMS Command Interpretation: The microcontroller continuously checks for incoming SMS messages from the GSM module. Once an SMS is received, the microcontroller extracts the command (e.g., "ON" or "OFF").

- Action Execution:

Based on the extracted command, the microcontroller triggers the relay module to either allow or stop the flow of electricity to the connected system.

- Status Updates:

The microcontroller may send status messages back to the user's Android app, confirming that the action has been executed or if there are any errors.

Power Supply:

- Power Management: The GSM module and microcontroller are powered through a DC supply

(typically 5V or 12V) depending on the microcontroller used. The relay or contactor that controls the electrical supply is typically connected to the mains power, and its operation is governed by the microcontroller.

Conclusion (SIZE 12 &BOLD)

The "Automatic Supply On-Off Control in MSEDCL Using GSM and Android Application" system enables remote monitoring and control of electricity supply, improving efficiency and convenience. By using GSM technology and a mobile app, the system reduces manual intervention, enhances energy management, and allows operators and users to control power remotely. It leads to cost savings, better energy conservation, and smoother operations, with the potential for future scalability and integration of smart grid features.

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