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Automatic On-Off Control In MSEDCL

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***Abstract*—** The project "Automatic Supply On-Off Control in MSEDCL" leverages emerging GSM technology to create a sophisticated embedded system for monitoring and controlling electrical supply. At its core, the Arduino Nano microcontroller coordinates communication and executes bill management logic. The integration of the GSM Module SIM800L enables remote communication via SMS, facilitating notifications, reminders, and confirmations related to bill payments. Additionally, a web-based interface allows administrators to monitor and manage bills efficiently, providing control over electrical devices through a relay module. The system's robust power supply ensures stable operation of all components. This project aims to streamline the management of overdue electricity bills, enhance user convenience, and promote efficient resource utilization in utility management.

Keywords— Automatic supply control, GSM Module SIM800L, bill management system, electricity usage management, Automated Bill reminders

I. 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 [1]. 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.[2]

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 website 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 web interface or SMS messages. Through the Arduino Nano's 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 Nano, GSM Module SIM800L, relay module, and other peripherals, maintaining optimal performance and preventing electrical issues.

II. LITERATURE SURVEY

The advancement of GSM technology and its applications in embedded systems has been widely researched and documented. One notable study by Ma and Jiang (2013) explores the integration of GSM modules in remote monitoring and control systems, highlighting the benefits of real-time communication and the ability to manage devices remotely via SMS. This foundational work provides the basis for implementing GSM technology in various fields, including utility management [1].

Similarly, embedded systems using microcontrollers like the Arduino Nano have been extensively studied for their versatility and ease of integration. Banzi and Shiloh (2014) provide a comprehensive overview of Arduino applications in their book "Getting Started with Arduino," emphasizing its role in IoT and automation projects. Their work underscores the suitability of Arduino Nano for compact and efficient control systems, making it an ideal choice for our project[2]

In the realm of utility management, GSM-based systems have proven effective in enhancing operational efficiency and user engagement. A study by Singh and Kapoor (2015) investigates the use of GSM technology for automated meter reading and bill payment reminders, demonstrating significant improvements in timely payments and customer satisfaction. This research supports the use of GSM modules for communication and bill management in our project[3]

Relay modules, used for remote control of electrical devices, have been explored in numerous studies. S. K. Sharma

and P. Kumar (2016) review various relay control mechanisms in their research, illustrating their application in home automation and energy management systems. Their work provides valuable insights into the practical implementation of relay modules for controlling electrical supply, as utilized in our project.

Collectively, these studies and literature provide a solid foundation for our project, which integrates GSM communication, Arduino microcontroller capabilities, web-based interfaces, and relay control to create an efficient and user-friendly system for managing electricity supply and overdue bills in the MSEDCL context.

III. METHODOLOGY

The methodology for the "Automatic Supply On-Off Control in MSEDCL" project involves a systematic approach starting with defining system requirements and designing the overall architecture. Key components, including the Arduino Nano, GSM Module SIM800L, and relay module, are selected and integrated. The hardware is assembled on a prototype board with proper connections to ensure stable operation. Software development involves programming the Arduino to manage SMS communication and relay control and creating a web-based interface for administrators using HTML, CSS, JavaScript, and a backend server.

3.1 Proposed System

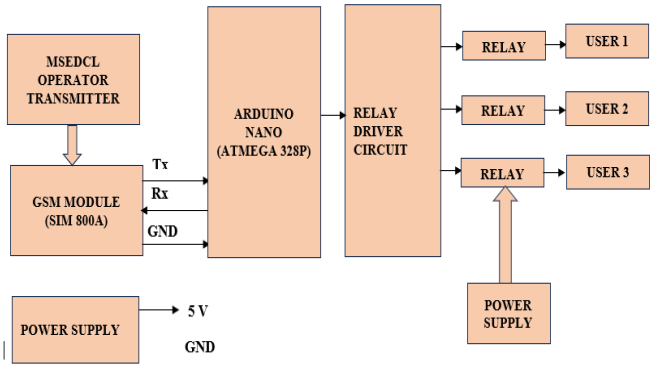

Fig. 1 Block Diagram of proposed system (Hardware block diagram)

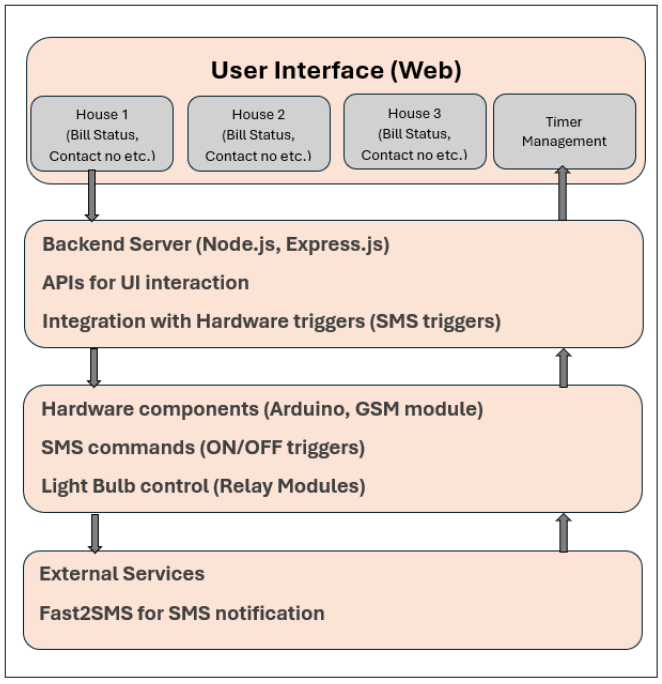

Fig. 2 User interface Block Diagram of proposed system

The proposed system primarily focuses on managing the control of electricity supply based on billing payment information. Upon receiving payment confirmation, the system can restore the electrical supply via the relay module, which physically controls the power supply to the user's premises. The web-based interface allows administrators to monitor billing statuses, manage user accounts, and remotely control the supply based on real-time payment data. This comprehensive approach ensures efficient and timely management of electricity supply, encouraging prompt bill payments and improving resource utilization within the MSEDCL framework.

3.1.1 Circuit Diagram:

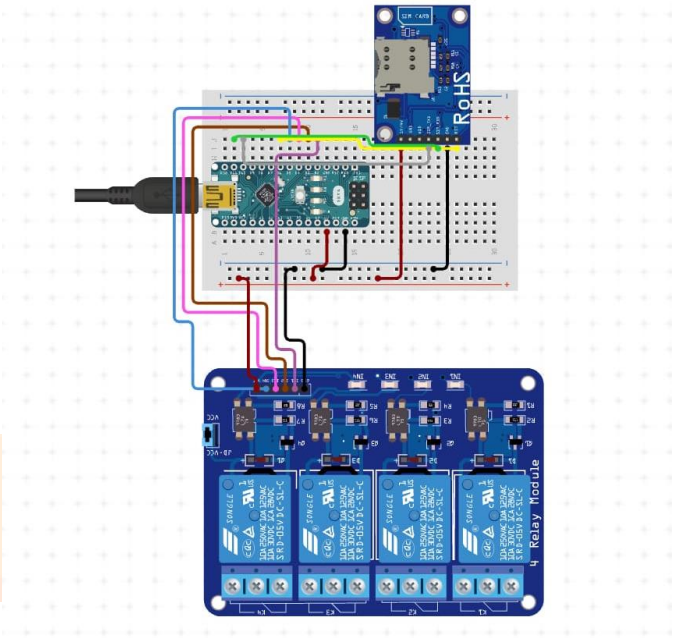

Fig.3 Circuit Diagram for Proposed System

3.1.2 Working:

The working functionality of the proposed system explores the intricate workings of the innovative remote electricity bill management system.

User Interaction and Bill Management (Website) - The system's user interface resides on a website built with ReactJS, HTML, CSS, and JavaScript. This user-friendly interface caters to both the administrator and individual homeowners.

Admin Dashboard - The admin has access to a comprehensive dashboard showcasing details of all registered houses. This includes information like house address, name of the resident, phone number, email address, and most importantly, the bill payment status (paid or not paid). A prominent timer on the dashboard counts down to a pre-defined deadline for bill payments.

User Bill Payment - Homeowners can access a dedicated payment page on the website or mobile with the help of UPI or scanner as a modern technology. This page allows them to conveniently pay their electricity bills online using an integrated payment gateway. Upon successful payment, the website updates the bill status for their house in the system database.

Automated Bill Reminders - The system proactively sends automated SMS reminders to homeowners as the payment deadline approaches. An initial reminder is triggered when a specific time threshold is reached (e.g., 2 minutes before the timer expires). A second, more urgent reminder is sent even closer to the deadline (e.g., 50 seconds before the timer expires).

System Logic and Remote Control (Backend and Hardware Integration) - The website's backend is built using Node.js and Express.js, providing robust functionality and efficient data management. This backend seamlessly integrates with the hardware component to enable remote control of the electricity supply.

SMS Integration - The backend utilizes Fast2sms, an SMS gateway service, to send automated bill reminders and control messages to the hardware module.

Hardware Control via SMS - The hardware component comprises an Arduino Nano microcontroller as the central processing unit. A GSM800L module embedded within the Arduino facilitates communication over a cellular network, allowing it to receive SMS messages sent from the website backend.

Relay Driver Circuit - A crucial element of the hardware is the relay driver circuit. This circuit translates the low-power control signals from the Arduino into high-power signals capable of controlling the electricity supply to individual houses. The circuit typically employs transistors or other driver components to amplify the Arduino's control signal. Relays within the circuit act as remote-controlled switches. Based on the SMS commands ("ON" or "OFF") received by the Arduino, the relays connect or disconnect the light bulbs (representing houses) from the power supply, effectively controlling electricity access.

System workflow From Bill Reminders to Electricity Control – The system operates in a well-defined sequence, ensuring timely bill payments and potential disconnection for non-payment.

Admin Updates and User Interaction -The administrator maintains the system by updating house information and setting the bill payment deadline on the website's dashboard. Homeowners can view their bill status and conveniently make payments through the integrated payment gateway.

Automated Bill Reminders – As the bill payment deadline approaches, the website's backend triggers automated SMS reminders to be sent to homeowners with outstanding bills. These timely reminders nudge users to prioritize bill payments before disconnection. The reminder time is hard set to 2 minutes and another one to 50 seconds, It can be updated inside code, of Home page, Inside timer's use Effect hook.

Time-Based Control and SMS Commands - A prominent timer on the admin dashboard counts down to the predefined payment deadline.

Critical Deadline and Control Action - When the timer reaches zero and a bill remains unpaid, the website backend sends a specific SMS command (e.g., "OFF1" for House #1) to the GSM module in the hardware.

SMS Reception and Relay Control - The Arduino receives the SMS containing the control command. The Arduino's SMS parser extracts the house number (e.g., 1) from the message content.

Relay Activation and Electricity Control - Based on the extracted house number and the command (OFF), the Arduino sends a control signal to the corresponding relay on the relay driver circuit. The activated relay disconnects the light bulb representing that particular house (House #1) from the power supply, effectively cutting off electricity.

Bill Payment and Reconnection - If a homeowner settles the outstanding bill after receiving the disconnection SMS or website notification, they can contact the administrator to initiate reconnection. The administrator can remotely send a reconnection command (e.g., "ON1") via SMS to the Arduino.

1.3 Flow Chart:

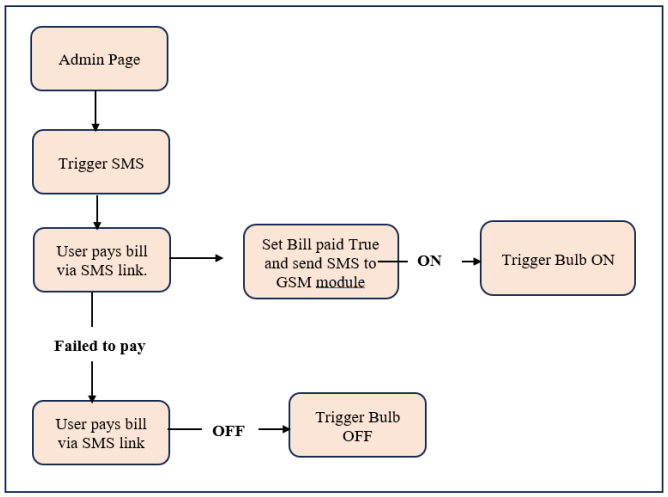

Fig. 3 Flow chart for the proposed system

The proposed flow chart is shown in the above fig. explains the procedure:

1. The timer on the website counts down.
2. When the timer reaches zero and the bill is not paid, the website sends a warning SMS to the user (optional).
3. The Arduino receives an SMS containing a command like "ON1" or "OFF2".
4. The SMS parser in the Arduino extracts the house number (1, 2, or 3) from the message content.
5. Based on the house number and the command (ON or OFF), the Arduino sends a control signal to the corresponding relay on the relay driver circuit.
6. The activated relay controls the corresponding light bulb (House #) by turning it on (ON command) or off (OFF command).

IV. TOOLS AND TECHNOLOGY USED

Major components used for the proposed system include Arduino Nano ATmega 328P for Interpreting SMS commands (e.g., "ON1", "OFF2"), Sending signals to the relay module to control the power supply and Managing the timing and sequence of operations. GSM module SIM 800L is used for Sending bill reminders and notifications to users, Receiving and forwarding user responses (e.g., payment confirmations) to the Arduino Nano and Providing a communication link between the system and the user's mobile devices. Relay module is used for Switching the electrical supply on or off for specific houses as per the commands (e.g., turning off the supply for unpaid bills) and Responding to control signals from the Arduino Nano to manage the power state of connected devices. Power Supply is used for Delivering a consistent and stable power source to prevent interruptions in system operation and Ensuring that all electronic components receive the appropriate voltage and current required for optimal performance.

4.1 Applications:

i. Utility Management Systems
ii. Remote monitoring and control
iii. Commercial and Indusrial applications

4.2 Advantages:

i. Time saving system
ii. Life saving system
iii. Easy to install
iv. System is user friendly
v. Cost is moderate

V. RESULTS AND ANALYSIS

Below fig. shows the actual prototype implementation and tests executed. The results and analysis of the proposed system include the improved billing management effectiveness, evidenced by timely payments and reduced overdue bills. Enhanced user engagement and satisfaction through SMS notifications and reminders. Increased operational efficiency for MSEDCL with reduced manual tasks and resource utilization. Positive impact on energy conservation and resource optimization through optimized electricity management. Reliable system performance.

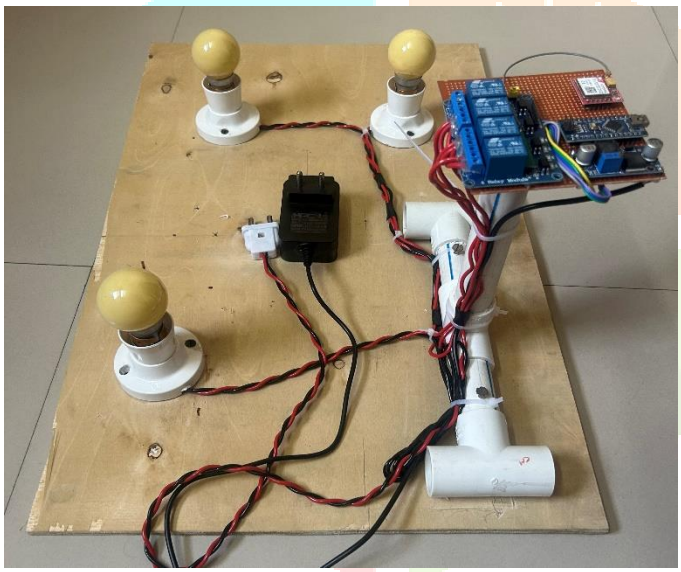

Fig. 4 Proposed System Hardware

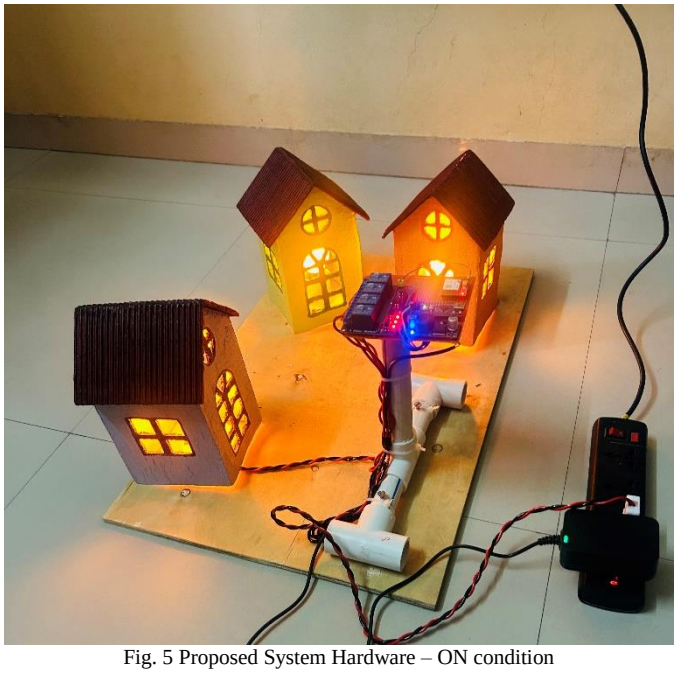

Fig. 5 Proposed System Hardware – ON condition

Fig. 6 Project software (Admin login)

Fig. 7 Project software (website login)

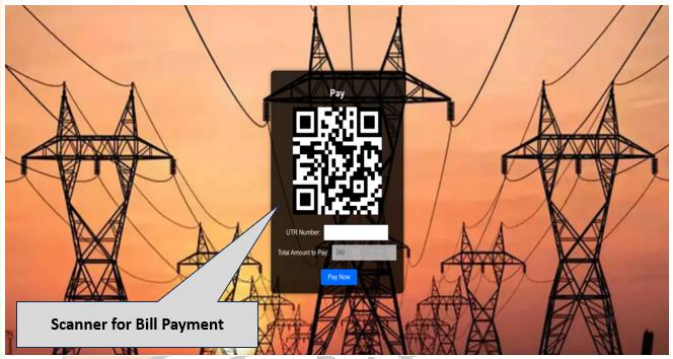

Fig 8 Scanner for bill payment

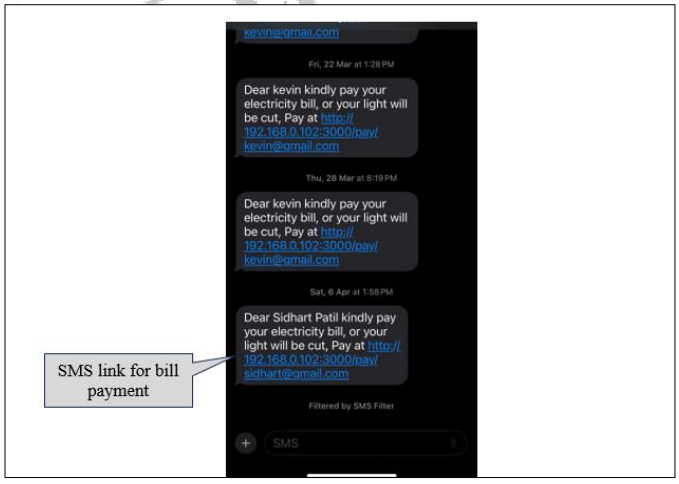

Fig. 9 SMS link for bill payment

VI. FUTURE SCOPE

In future the system can be adapted for electricity theft protection by incorporating additional features and technologies.

Smart Meter - Use smart meters that provide real-time data on electricity consumption. These meters can detect unusual patterns indicative of theft, such as sudden spikes or drops in usage.

Advanced Data Analytics – It will help in making informed decisions regarding energy distribution, load management, and infrastructure maintenance.

VII. CONCLUSION

The propsed system effectively leverages GSM technology, microcontroller capabilities, and relay mechanisms to automate electricity supply management based on billing information. By integrating components such as the Arduino Nano, GSM Module SIM800L, and relay modules, the system provides a robust solution for remote monitoring and control of electrical supplies. This enhances operational efficiency for utility providers, ensures timely bill payments, and improves user convenience through automated notifications and controls. Furthermore, the system's potential future enhancements—such as smart metering, renewable energy integration, advanced data analytics, and theft detection mechanisms—highlight its scalability and adaptability, positioning it as a comprehensive tool for modern utility management. Ultimately, this project demonstrates a significant step towards more efficient, secure, and user-friendly electricity management systems, paving the way for further innovations in the utility sector.

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