Automated IoT Based Power Disconnection for unpaid Subscribers

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Abstract: This project presents an innovative solution leveraging Internet of Things (IoT) technology to automate the process of power disconnections for unpaid subscribers in utility services. The conventional method of manually disconnecting power for non-payment is not only inefficient but also poses operational challenges and risks. Our proposed system aims to address these issues by integrating IoT devices, billing systems, and automated disconnection protocols. Key features of the system include real-time monitoring of subscriber accounts, customizable disconnection thresholds, and secure communication protocols to safeguard sensitive data. Additionally, the system offers flexibility for utility providers to implement payment reminders and grace periods, enhancing customer engagement and satisfaction.
Through simulations and prototype testing, we demonstrate the efficacy and reliability of our automated IoT-based power disconnection system. Our solution not only streamlines the disconnection process but also reduces operational costs, minimizes revenue losses due to non-payment, and enhances overall efficiency in utility management.

1. Introduction

Automated IoT-Based Power Disconnection for Unpaid Subscribers" – a cutting-edge solution that leverages the power of IoT (Internet of Things) technology to address a critical challenge in utility services. This innovative system, created using the ESP8266 microcontroller, optocoupler, and a TRIAC-based circuit, provides a seamless and efficient means to disconnect power services for subscribers with unpaid bills, all controlled through a user-friendly HTML interface.

In a world where reliable utility services are a fundamental necessity, managing subscribers' accounts and ensuring timely payments can be a complex and resource-intensive task for service providers. The "Automated IoT-Based Power Disconnection" system simplifies this process by automating power disconnection for unpaid subscribers, thereby ensuring the fair and efficient utilization of resources while encouraging timely bill payments.

This intelligent system combines hardware and software components to create a seamless user experience. The ESP8266 microcontroller serves as the central control unit, while the optocoupler and TRIAC-based circuit enable safe and precise power disconnection. Users, including utility service providers, can easily interact with the system through a web-based HTML interface.

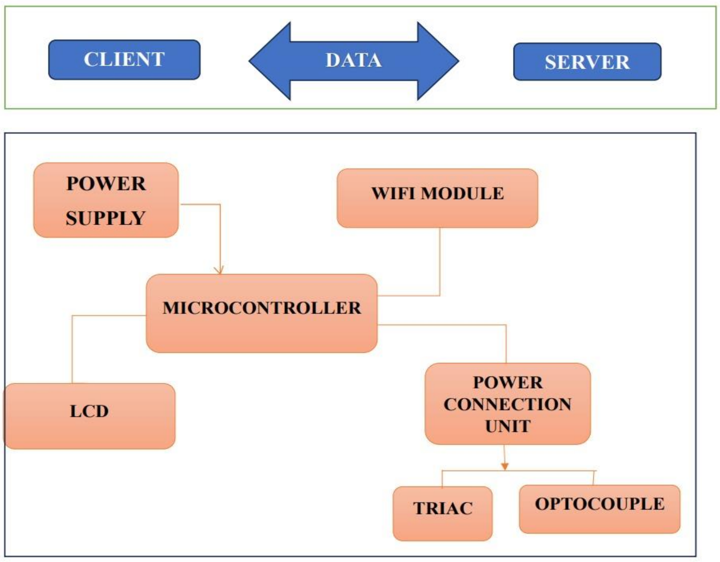
The "Automated IoT-Based Power Disconnection for Unpaid Subscribers" is an innovative system that harnesses the capabilities of the Internet of Things (IoT) and utilizes the ESP8266 microcontroller, optocoupler, and TRIAC-based circuitry to streamline utility service management. This cutting-edge solution offers a practical and automated approach to disconnecting power services for subscribers with unpaid bills while maintaining precision and safety in the disconnection process.

In a world where reliable utility services are paramount, the challenge of managing subscriber accounts and ensuring timely payments remains a critical concern for service providers. To address this issue, our system provides an autonomous, efficient, and real-time means of power disconnection for subscribers with overdue payments.

Through a user-friendly HTML interface, both subscribers and utility providers can access and control the system, thus enhancing accountability, reducing unpaid subscriptions, and ensuring the equitable distribution of resources. The solution is designed for scalability, making it adaptable to various utility services, such as electricity, water, and gas providers.

The "Automated IoT-Based Power Disconnection for Unpaid Subscribers" marks a significant advancement in utility service management, offering a more efficient and user-centric approach to address payment delinquencies, while safeguarding service quality and reliability. This innovation stands as a testament to the transformative potential of IoT technology in enhancing the modern utility service landscape

2. Block Diagram



1) Node MCU:

Node MCU is an open-source IoT platform based on the ESP8266 Wi-Fi module. It integrates the ESP8266 microcontroller with an onboard USB-to-serial converter and a voltage regulator. The Node MCU board is popular for its ease of use and compatibility with the Arduino IDE, making it suitable for IoT applications requiring wireless connectivity.

Key features of Node-MCU:

- ESP8266-based microcontroller with Wi-Fi connectivity.
- Built-in USB-to-serial converter for easy programming and debugging.
- Supports Lua scripting language for rapid development.
- GPIO pins for interfacing with sensors, actuators, and other peripherals.
- Integrated TCP/IP stack for internet communication.
- Can be programmed using Arduino IDE, Lua scripts, or other compatible development environments.
- In the project, Node-MCU serves as the central control unit for managing communication between smart meters, the backend server, and other components of the automated power disconnection system. It facilitates wireless communication over Wi-Fi, enabling remote monitoring and control of power disconnection processes.

2) LCD (Liquid Crystal Display):

LCD displays are commonly used for visualizing information in electronic devices. They consist of a grid of liquid crystal cells that change optical properties in response to an electric current. LCDs are available in various sizes and configurations, including character displays and graphical displays.

Key features of LCD displays:

- Provides a visual interface for displaying text, numbers, and graphical elements.
- Low power consumption, making them suitable for battery-powered devices.
- Can be interfaced with microcontrollers using standard protocols such as I2C, SPI, or parallel communication.
- Available in different sizes and resolutions to suit specific application requirements.
- Suitable for indoor and outdoor use, depending on the type of display and backlighting.
- In the project, an LCD display is used to provide real-time feedback and status updates to users or technicians overseeing the power disconnection process. It can display relevant information such as subscriber details, billing status, and system alerts, enhancing the usability and accessibility of the automated disconnection system.

3) Triac and Optocoupler:

Triac (Triode for Alternating Current) is a semiconductor device used for controlling AC power. It acts as a bidirectional switch, allowing current to flow in both directions when triggered. Optocouplers, also known as opto-isolators, are devices that provide electrical isolation between input and output circuits using light.

Key features of Triac and Optocoupler:

- Triac allows for precise control of AC power by switching it on or off at specific points in the AC waveform.

- Optocoupler provides electrical isolation between low-voltage control signals (input) and high-voltage AC circuits (output), enhancing safety and reliability.
- Suitable for applications requiring galvanic isolation, noise immunity, and protection against voltage spikes.
- Triac and Optocoupler are commonly used together in AC switching circuits to provide isolation and control.
- In the project, Triac and Optocoupler are used in the power disconnection mechanism to safely disconnect power to subscribers' premises when triggered by the central control unit. The Optocoupler isolates the low-voltage control signal from the Node -Mcu, while the Triac controls the flow of AC power to the subscriber's connection.

4) Wi-Fi Module:

Wi-Fi module is a hardware component that enables wireless communication over Wi-Fi networks. It typically consists of a Wi-Fi transceiver, antenna, and associated circuitry for connecting to Wi-Fi networks and exchanging data wirelessly.

Key features of Wi-Fi modules:

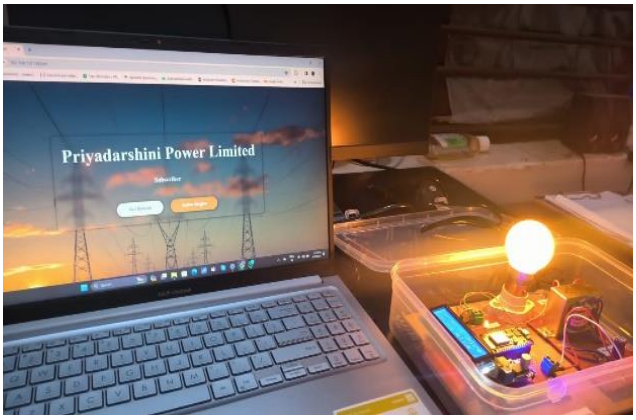
- Enables devices to connect to local Wi-Fi networks for internet access and communication with other devices.
- Supports standard Wi-Fi protocols such as IEEE 802.11b/g/n/ac, providing compatibility with a wide range of Wi-Fi networks.
- Can be integrated into various electronic devices, including IoT devices, smartphones, tablets, and laptops.
- Provides secure communication over encrypted Wi-Fi connections, ensuring data privacy and integrity.
- Supports features such as Wi-Fi Direct, WPA/WPA2 encryption, and power-saving modes for efficient wireless communication.

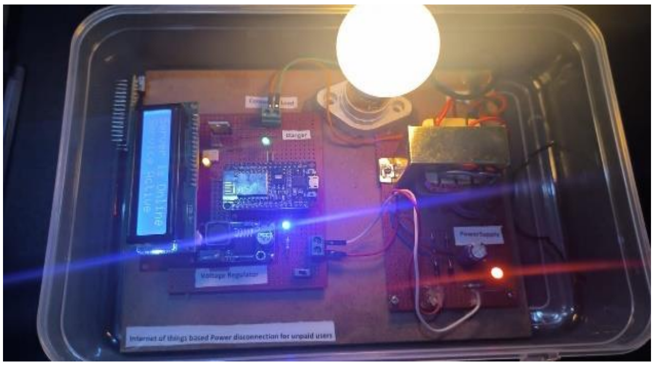
Construction And Working

Phase 1: Hardware and Software Setup

- Device Integration: Procure and integrate IoT devices (such as sensors, smart meters) into the existing utility infrastructure for data collection.
- System Configuration: Configure the ESP8266 modules to establish secure connections with IoT devices and set up communication protocols.
- Software Development: Develop and refine the server-client communication software for data transmission and reception between the ESP8266 (server) and the laptop (client).
- Testing and Validation: Conduct rigorous testing to ensure seamless communication, data accuracy,

and reliability between the server and client components.





Phase 2: Data Collection and Analysis

- Data Gathering: Initiate data collection through IoT devices regarding power consumption, irregularities, and non-payment indicators.
- Database Setup: Establish a robust database infrastructure to store and organize the collected data securely.
- Data Analysis Tools: Develop data analysis tools or algorithms to identify irregular consumption patterns and non-payment instances.
- Pilot Testing: Perform pilot testing of the system to validate data accuracy and effectiveness in detecting non-payment scenarios.

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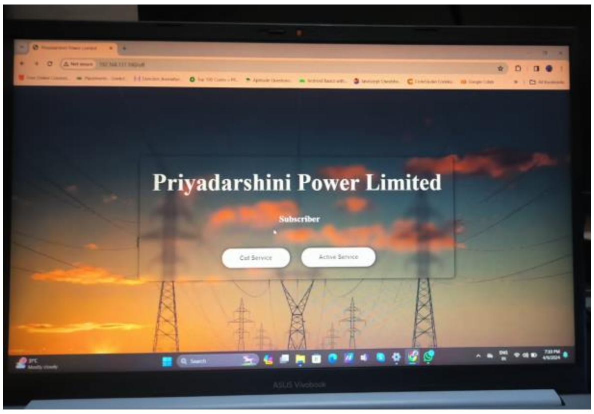

Phase 3: Disconnection Automation

- Disconnection Protocols: Design and implement automated disconnection protocols triggered by non-payment indicators detected by the system.
- Reconnection Mechanism: Develop a secure reconnection process upon payment verification, ensuring swift and efficient restoration of services.
- User Interface Development: Create a user-friendly interface for utility providers to manage disconnections, reconnections, and view payment statuses.
- Integration Testing: Integrate the automated disconnection and reconnection mechanisms into the system and conduct comprehensive testing.

Phase 4: Privacy and Security Measures

- Data Privacy Compliance: Ensure compliance with data privacy regulations and implement encryption and access control measures.
- Security Audits: Perform security audits to identify and address vulnerabilities, ensuring robust protection against unauthorized access.

Phase 5: Documentation and Finalization

- System Documentation: Prepare comprehensive documentation outlining the system architecture, protocols, and usage guidelines.
- Final Testing and Feedback: Conduct final testing and seek feedback from utility providers and users for further refinements.
- Deployment Plan: Develop a deployment plan for the implementation and roll-out of the IoT-Based Disconnection Management System.

Future Enhancement

Customer Communication Solutions: Developing interacting platforms or mobile applications where subscribers can receive notifications about payment deadline, outstanding balances, and disconnection earnings. These platforms can also provide easy payment options access to support services, enhancing transparency and empowering customers to manage their accounts effectively.

Behavioural Economics Strategies: Applying behavioural economics principles to encourage timely payments and responsible energy usage. Implementing incentives, nudges, or gamification techniques to motivate subscribers to maintain positive payment behaviour avoid disconnections.

Discussion

Primicanta et al. [3] [4] propose hybrid Automated Metering Reading (AMR) system which is a combination of ZigBee and GSM technology. In that system ZigBee module is attached to the meter by using interface board and the data collector is connected to the central computer by using GSM. The system is suitable with Malaysian condition which already implemented GSM-based AMR in LPC. With this system TNB can save cost in doing meter reading and provide better services to their customers.

Meanwhile Norozina, A. [5] stated that Tenaga Nasional Berhad was a pioneer in the utilization of ICT as a critical enabler in supporting its business and service delivery. TNB utilizes ICT in supporting its end-to-end business life-cycle inclusive of planning, development, operations and customer services processes. ICT is also extensively utilizing in supporting management and administrative processes within TNB in the areas of finance, procurement and human resource management.

In 2003, Koay et al [10], had been successfully designing and implementing Automatic Meter Reading systems using a Bluetooth device, or Bluetooth-Enabled Energy Meter.

Tan et al. [6] had developed a GSM automatic power meter reading (GAPMR) system. The GAPMR System is consists of GSM Digital Power Meters installed in every consumer unit and an Electricity E-Biling System at the energy provider side. The GSM Digital Power Meter (GPM) is a single-phase standard compliance digital kWh power meter with embedded GSM modem which utilizes the GSM network to send its power usage reading using Short Messaging System (SMS) back to the energy provider wireless

Conclusion

Automated IoT-based power disconnection systems offer a multifaceted solution to the longstanding challenge of managing unpaid subscriptions. By leveraging IoT technology, these systems provide utilities with a streamlined approach to disconnecting power for delinquent subscribers, ensuring greater efficiency and accuracy in the process. Through real-time monitoring and data analysis, these systems can identify accounts with outstanding payments and initiate disconnection protocols swiftly and automatically, minimizing the administrative burden on utility providers. Moreover, by integrating with billing systems, they facilitate seamless communication between billing and disconnection processes, enhancing overall operational effectiveness. However, while these systems offer significant benefits in terms of efficiency and cost-effectiveness, careful consideration must be given to privacy concerns and potential implications for vulnerable populations. Overall, automated IoT-based power disconnection systems represent a promising advancement in utility management, offering a balanced approach that prioritizes both operational efficiency and consumer protection.

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