



WIRELESS SMART POWER REGULATION AND OVERCURRENT PROTECTION SYSTEM FOR LIVING SPACES

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ABSTRACT- To effectively monitor and control power use, an Internet of Things-based Smart Energy Management and Automatic Control System for Hostel Rooms is introduced. Many people share an electrical load in hostel settings, which frequently results in excessive and uncontrollable power usage. For personal convenience, a lot of students frequently utilize high-power equipment including irons, water heaters, induction cookers, and home entertainment systems. All homeowners' power costs rise as a result of this needless usage, which also adds to the system's overall strain. Additionally, when electrical circuits are overloaded, dangerous circumstances may result. The suggested approach installs a smart energy monitoring system in every dorm room to solve this problem.

I. INTRODUCTION

This system uses sensors to continually measure each user's electrical load and sends the information to an Internet of Things web server. Hostel management can keep an eye on each room's energy usage in real time using this centralized platform. This offers transparency and aids in locating rooms that are using too much electricity. The system's overload detection and control mechanism is a crucial component. The system identifies the problem right away when a user uses high-power appliances and exceeds the specified load limit. The cellphone number of the corresponding room tenant receives a warning SMS notice upon detection. A second warning message is generated as an alert if the overload condition persists. After the third warning, the system automatically disconnects the room's power supply if the user does not lower the load. Concurrently, the hostel control room receives a notice alerting authorities to the infraction. By monitoring the energy usage of every appliance and user, this system also concentrates on smart power monitoring and analysis. In contrast to conventional energy meters, which simply show the overall amount of electricity used, this Internet of Things-based device offers comprehensive insights into individual usage patterns. With the advancement of machine-to-

machine communication, devices can now communicate wirelessly, enabling efficient implementation of IoT solutions. All things considered, this project provides a dependable, automatic, and clever method for managing energy in hostels. Overload control is one of this system's main characteristics. Overuse of high-power appliances like heaters, irons, or induction stoves can result in overloading in many hostel rooms, which can cause electrical risks, equipment damage, or even fire mishaps. When the predetermined threshold is surpassed, the system automatically disconnects the power supply via relays after detecting such overload circumstances using current sensors.

II. OBJECTIVES

- To Monitor Real-Time Energy Consumption
- To Prevent Electrical Overload
- To Provide Automated Control System
- To Enable Remote Monitoring via IoT.
- To Send Instant Alerts and Notifications
- To Ensure Fair Energy Usage
- To Improve Safety of Electrical System

III. SYSTEM OVERVIEW

The system that is being presented is a smart energy monitoring and control system that is intended to effectively manage loads across two rooms and monitor electrical characteristics. Sensing, processing, control, and communication blocks are integrated throughout system development to guarantee intelligent, safe, and dependable operation. Every block contributes significantly to the achievement of the intended functionality, and its effectiveness may be rated according to its significance and effectiveness. The power supply unit, which is made up of a transformer, bridge rectifier, pulsing DC stage, and regulator, is where the development starts. The high AC voltage is reduced by the transformer to a level appropriate for electronic circuits. The bridge rectifier, which transforms AC into pulsing DC, comes next.

In order to give the microcontroller and other parts a steady DC supply, the regulator then smoothes and stabilizes this voltage. Because the system as a whole depends on a reliable power supply, this block is essential. Any variation may result in damage or malfunction. The power supply unit is therefore very dependable. The central component of the system, where all processing occurs, is the microcontroller unit (CPU). It takes in signals from sensors like voltage sensing circuits and current transformers, analyzes the information, and manages the output devices including communication modules, relays, LCDs, and buzzers.

In the event of a fault, the microcontroller is designed to continually monitor parameters, compare them with predetermined thresholds, and take necessary action, such as removing loads. It is the most important part of the system because of its precision, speed, and adaptability. Each load's current

consumption is measured by the current transformer (CT) sensors in Rooms 1 and 2. These sensors offer a secure, isolated method of monitoring current by electromagnetic induction. The microcontroller can understand the proportional signals that are created from the measured data. This aids in determining power usage and identifying overload situations. Because adequate monitoring, efficacy, and dependability depend on correct current measurement.

IV. HARDWARE COMPONENTS

4.1 Transformer

The system's initial stage, the transformer, is essential to both safety and voltage conversion. It works on the basis of electromagnetic induction, in which a voltage is induced in the secondary winding by an alternating current in the primary winding creating a fluctuating magnetic field..



Fig.1- Step Down transformer

The transformer in this system reduces the high mains voltage of 230V AC to a lesser value, such 12V AC. This lower voltage protects delicate components and is appropriate for electrical circuits. Additionally, the transformer offers electrical isolation between the low-voltage circuitry and the high-voltage supply, improving user safety and shielding the system from electrical malfunctions. Because the transformer's output is still alternating, more processing is required before digital components can use it. The transformer's current rating guarantees that it can provide enough current to the microcontroller, LCD, and interface circuits, among other system components. To prevent overheating, voltage dips, or inadequate power supply, the transformer must be chosen carefully.

4.2 Rectifier

The rectifier transforms the transformer's AC voltage into the DC voltage needed by electronic circuits. Four diodes grouped in a bridge arrangement make up the full-wave bridge rectifier utilized in this system. Two diodes conduct during the AC signal's positive half cycle, while the other two diodes conduct during its negative half cycle. Compared to a half-wave rectifier, this guarantees that both halves of the AC waveform are used, resulting in improved efficiency.



Fig.2- Full-wave bridge rectifier

A pulsing DC signal with ripples and variations is the rectifier's output. A filter capacitor is attached across the rectifier output to smooth this output. By charging during the peak voltage and discharging when the voltage falls, the capacitor lowers the ripple content. Further control is necessary since the resultant DC voltage is more steady but still not entirely constant. Because DC voltage is necessary for digital components like microcontrollers and screens to function properly, the rectifier step is crucial.

4.3 Voltage Regulator

The circuit components get a steady and consistent DC voltage from the voltage regulator. The DC voltage still has some variations after rectification and filtering, and it may change depending on the load. These fluctuations are eliminated by the regulator, which keeps the output voltage constant. The microcontroller, LCD, and logic circuits in this system typically receive a steady 5V supply from the 7805 regulator, but the 7812 regulator may be utilized when 12V is needed. In order to maintain a consistent output, the regulator modifies the current flow by comparing the output voltage with an internal reference. It also protects the circuit from voltage spikes and overheating through built-in safety features. To increase stability and lower noise, capacitors are often linked to the regulator's input and output. For the microcontroller to operate accurately, a steady power source is essential since variations may result in processing mistakes or system failure. As a result, the regulator guarantees consistent and dependable system functioning.



Fig.3- Voltage Regulator

4.4 WI-FI Module

The Wi-Fi module used in the mentioned project acts as a communication bridge between the microcontroller and external devices such as smartphones, computers, or cloud platforms. Typically, modules like ESP8266 or ESP32 are integrated due to their built-in TCP/IP stack and low power consumption



Fig.4- WiFi Module ESP32

The Wi-Fi module uses pre-established SSID and password credentials to connect to a local wireless network. Once connected, serial communication (UART protocol) is used to establish connection with the microcontroller. The Wi-Fi module receives processed data from the microcontroller, including voltage, current measurements, and system status. The module then uses HTTP, MQTT, or TCP protocols to send this data to a mobile application or distant server. Remote warnings and real-time electrical parameter monitoring are available to users. In some situations, the Wi-Fi module can also transmit control signals back to the microcontroller via the user interface, such as turning a relay ON or OFF.

4.5 Voltage Sensor and Current Sensor

The Smart Energy Management and Overload Control system for a hostel room using IoT operates by continuously monitoring electrical parameters such as voltage and current to ensure safe and efficient energy usage. In this system, voltage and current sensors are connected to a microcontroller, which acts as the central processing unit. These sensors measure real-time electrical values from the load connected in the hostel room.

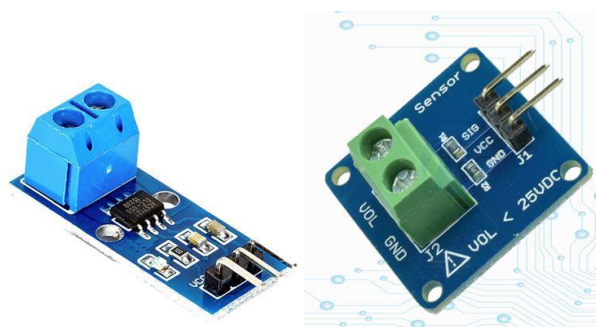


Fig.5- Voltage Sensor and Current Sensor

The collected data is processed by the microcontroller and transmitted to a cloud platform through a Wi-Fi module, enabling remote monitoring via a mobile application or web interface. Whenever the system detects abnormal conditions such as overvoltage, undervoltage, or overload (excess current), it automatically triggers a relay to disconnect the power supply, thereby protecting appliances and preventing electrical hazards. Additionally, the system can display real-time parameters on an LCD or digital display for local monitoring

4.6 PIC Microcontroller

The PIC microcontroller is an advanced 8-bit enhanced flash device designed using RISC (Reduced Instruction Set Computer) architecture, which ensures fast and efficient execution of instructions.

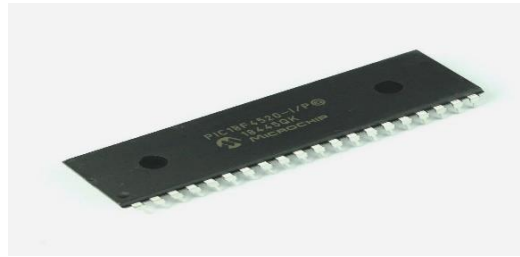


Fig.6- PIC Microcontroller

It is extremely power-efficient and appropriate for energy-sensitive applications since it uses nano-Watt technology. For academic projects, engineering students particularly choose the microcontroller, which has become increasingly popular in the market. It is a great option for creating embedded systems because of its versatility, simplicity of programming, and broad variety of applications. All things considered, the PIC microcontroller provides a well-balanced mix of cost-effectiveness, performance, and versatility.

V. WORKING PRINCIPLE

The microcontroller unit (CPU), which serves as the setup's brain, is in the center of the system. It continually gathers input signals from a variety of sensors and control components, processes the information, and uses preprogrammed logic to make choices. The microcontroller is in charge of regulating relays, monitoring load conditions, identifying anomalies, updating display units, and interacting with other platforms like Internet of Things webpages.. Two current transformers (CTs), designated Room 1 CT and Room 2 CT, are part of the system. The current passing through each room's electrical loads is measured by these sensors. The CT operates on the electromagnetic induction principle, in which a proportionate current is induced in the secondary winding of the CT by the current flowing in the main conductor. The microcontroller receives this secondary current after it has been transformed into a measurable voltage signal. The system can ascertain each room's power usage and identify overload or unusual circumstances by evaluating this data. The system includes a voltage sensing device in addition to current sensing. By measuring the supply voltage, this block makes sure it stays within acceptable working bounds.

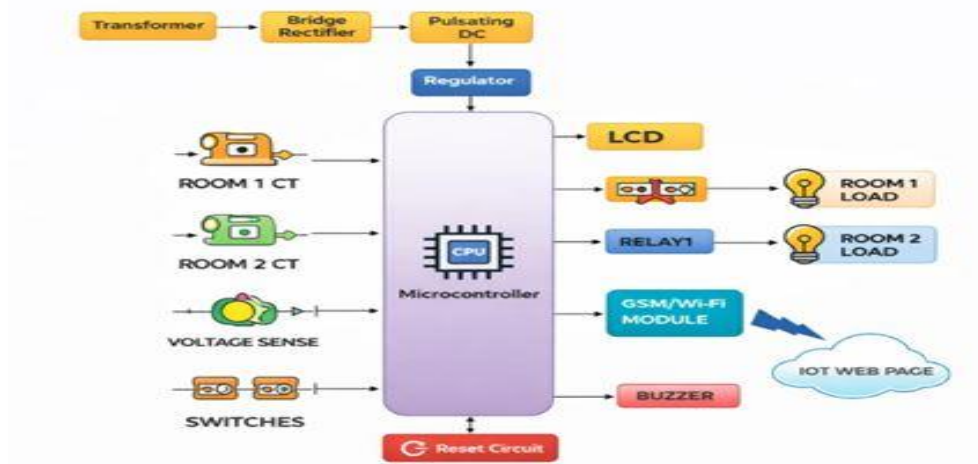


Fig.7- Block diagram of proposed system

Before delivering the voltage to the microcontroller, the voltage sensor usually steps it down to a detectable level using a voltage divider circuit. This enables the system to identify situations that might harm electrical equipment or the system itself, such as undervoltage or overvoltage. Switches attached to the microcontroller enable user interaction. These switches provide manual system control, including switching operational modes, resetting the system, and turning loads on or off. When a problem occurs or the microcontroller has to be reinitialized, the reset circuit makes sure that it may be securely restarted

.Circuit Diagram: -

The given circuit diagram represents a complete smart power monitoring and control system designed using a microcontroller, sensing circuits, communication modules, and load control units. The system integrates multiple functional sections such as power supply, controller, input devices, sensing circuits, display unit, communication interface, and output drivers. Each component in the circuit plays a vital role in ensuring proper operation, monitoring, and protection of electrical loads. The circuit begins with the power supply section, which takes a 12V AC input through a connector. This AC voltage is converted into DC using four diodes (D1–D4) arranged in a bridge rectifier configuration. These diodes allow current to flow in one direction, effectively converting AC into pulsating DC.

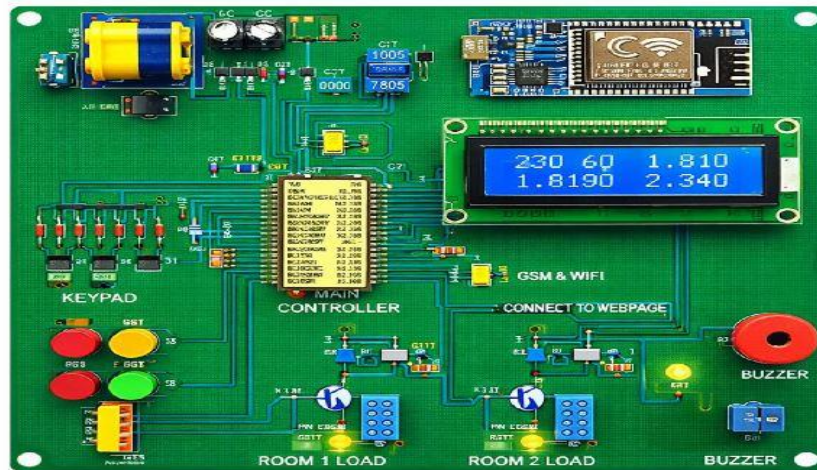


Fig.8- Circuit Diagram of the System

Capacitors such as C1 and C2 are used as filter capacitors to remove ripples and smooth the DC voltage. The filtered DC is then passed to a voltage regulator IC (U1, typically 7805), which converts the input voltage into a stable 5V DC output required for the microcontroller and other digital components. A capacitor at the output ensures voltage stability, and an LED (D5) with a resistor (R1) is used as a power indicator to show that the circuit is active. At the center of the circuit is the microcontroller (U2), which acts as the brain of the system. It is responsible for processing inputs, executing programmed instructions, and controlling outputs. The microcontroller receives signals from the keypad, current transformers, and voltage sensor. It uses its internal ADC (Analog-to-Digital Converter) to convert analog signals into digital values for processing. The microcontroller is powered by the regulated 5V supply and is supported by a crystal oscillator circuit (if present) for accurate timing operations. A reset circuit ensures that the controller can be restarted safely when required. The keypad section consists of multiple push-button switches (SW1–SW4) connected in a matrix format along with pull-down resistors (R2–R5). These switches are used for user input, allowing manual control of loads or system settings. When a switch is pressed, it sends a signal to the microcontroller, which interprets the command and performs the corresponding action, such as turning a load ON or OFF.

Flow Chart of the System

The given flowchart represents the working process of an electrical monitoring and control system using a Yes/No decision format. The process starts with the Transformer, which supplies power to the system. The first decision block asks: “Pulsating DC Generated?” If the answer is No, the system goes to Stop, indicating that without DC generation the process cannot continue. If the answer is Yes, the output is sent to the Regulator to stabilize the voltage. After regulation, the power is supplied to the Microcontroller, which acts as the central processing unit of the system. The next step checks whether the regulator output is proper. If Yes, the system proceeds to monitor energy consumption in different rooms

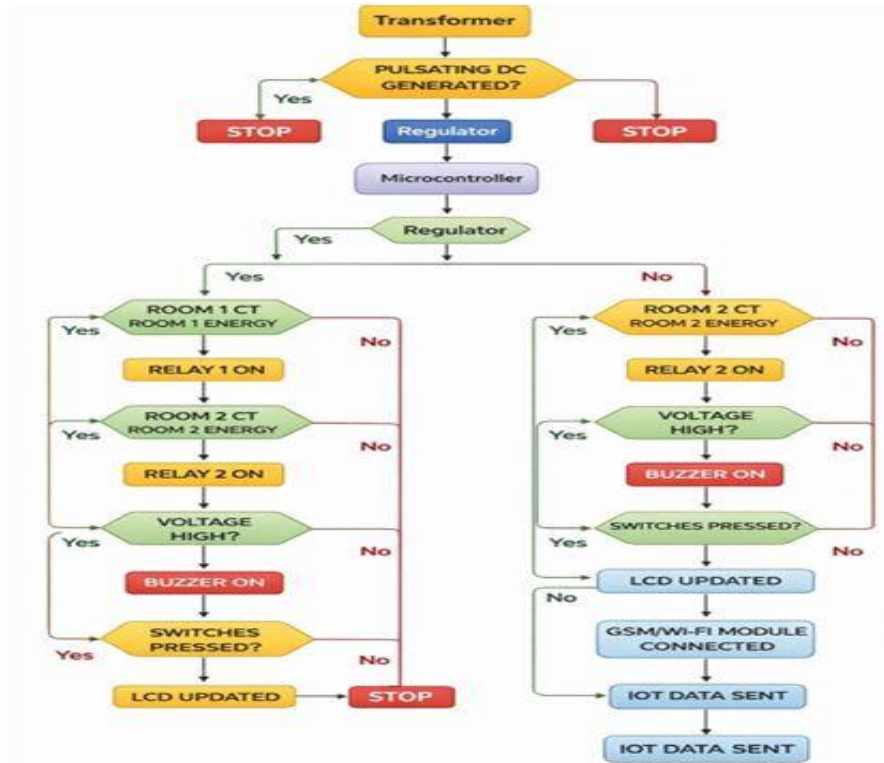


Fig.9- Flow Chart of the System

If No, the system may stop or prevent further operation to protect the circuit. The next decision block checks “Room 1 CT – Room 1 Energy?” CT (Current Transformer) senses the load current in Room 1. If the answer is Yes, meaning energy is detected, then Relay 1 ON is activated to allow power supply to Room 1 load. If the answer is No, the system bypasses Relay 1 activation and moves to the next condition. After Room 1, the system checks “Room 2 CT – Room 2 Energy?” If Yes, Relay 2 ON is activated to power Room 2 load. If No, Relay 2 remains OFF, preventing unnecessary energy flow. Next, the system verifies “Voltage High?” This is a safety check. If the answer is Yes, it indicates overvoltage condition. The system immediately turns Buzzer ON to alert the user. If the answer is No, it proceeds without activating the buzzer. After voltage verification, the flowchart checks “Switches Pressed?” If Yes, the LCD Updated process takes place to display updated status information such as room energy usage, relay condition, or fault message. If No, the system may stop or continue monitoring without updating the display.

Experimental Set up

The circuit diagram consists of the following interconnected sections:

- 1) AC Input Section: 230V AC mains connected to transformer primary.
- 2) Rectifier & Filter Section: Bridge rectifier converts AC to DC followed by capacitor filtering.
- 3) Voltage Regulator Section: 7805 regulator provides constant 5V supply.
- 4) Microcontroller Section: Acts as brain of the system, processes sensor data and controls relays.
- 5) Voltage Divider Network: Reduces AC voltage to safe measurable level.

- 6) Current Sensor Section: Measures load current and provides analog signal.
- 7) Relay Driver Section: Transistor-based driver energizes relay coil.
- 8) Load Section: Domestic loads (bulbs) connected through relay contacts.
- 9) Communication Module: GSM/Wi-Fi for remote monitoring and alert.
- 10) Display & Alert Section: LCD for parameter display and buzzer for fault indication

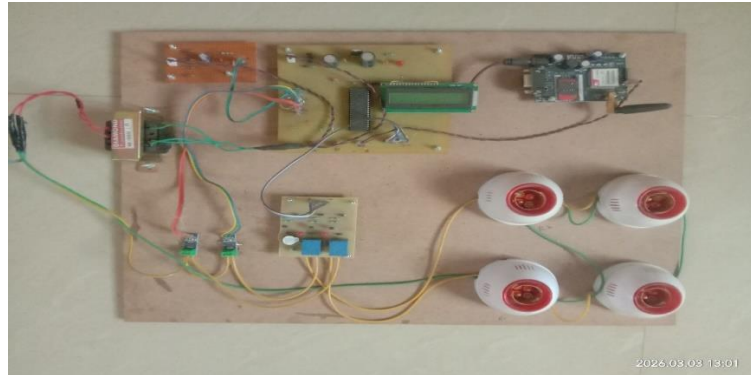
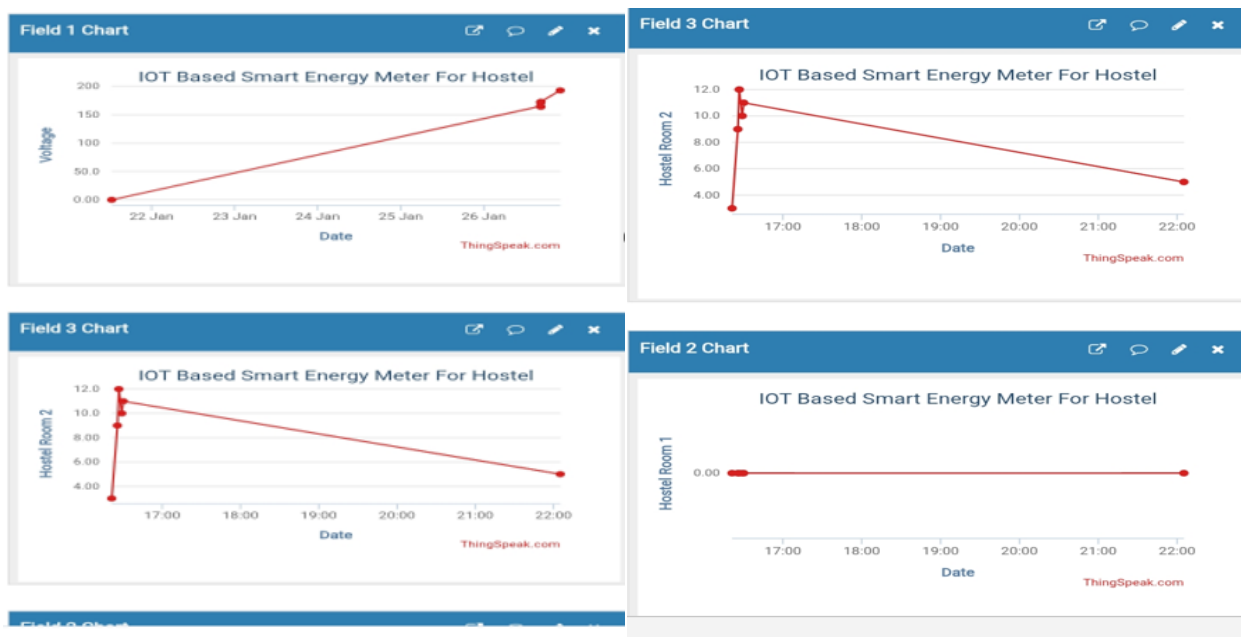


Fig.10- Experimental Setup

VI. RESULT AND DISCUSSION

A smart hostel meter's voltage and room-specific energy statistics are shown on the Thing Speak IoT dashboard. Over the course of the documented dates, voltage slowly rises. The utilization of Hostel Room 2 is stronger at first and then progressively declines at night. Room 1 of the hostel is still mostly empty. The outcomes validate the effectiveness of remote IoT data visualization and real-time monitoring.





The Thing Speak IoT energy meter charts indicate that Hostel Room 2 shows fluctuating energy consumption, initially high and gradually decreasing by 22:00. In contrast, Hostel Room 1 remains at zero consumption throughout the observed period. This demonstrates effective real-time monitoring and comparison of room-wise energy usage patterns.

VII. CONCLUSION

An effective, dependable, and contemporary way to monitor and manage electrical energy use is the Wireless Smart Power Regulation and Overcurrent Protection System for Living Spaces. To guarantee real-time voltage and current tracking, the project effectively combines sensors, a microcontroller, communication modules, and control devices. By lowering waste and promoting sensible electricity use, the technology also enhances energy efficiency. Furthermore, features like buzzer alarms and LCD displays offer both audible and visible signals of system health and defects, guaranteeing prompt resolution of problems. The project is scalable, affordable, and appropriate for actual application in dorms and other comparable settings.. In conclusion, this system improves safety, reduces electricity costs, and supports smart energy management, making it a valuable solution for modern electrical systems.

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