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IOT BASED SMART ENERGY METER MONITORING WITH THEFT IDENTIFICATION

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Abstract:
An Arduino serves as the principal controller in the study "IoT-Based Smart Energy Metre Monitoring with Theft Detection," which also uses voltage and current sensors to track the energy usage of connected loads. The system's real-time current and voltage data are intended to improve energy metering. The project also uses the ability to detect anomalous increases in voltage or current to implement a theft detection method. The technology instantly notifies the relevant authorities when it detects cases of power theft, such as unauthorised tampering with the energy metre. The security and dependability of energy consumption monitoring are improved by this instant alarm system, which guarantees that any questionable activity is promptly handled. An energy metering system that is more safe and efficient is made possible by the seamless data processing and transmission made possible by the integration of NodeMCU and Arduino.
Keywords: Arduino, LCD, Energy meter, Load, Node MCU

1.Introduction

The potential for Internet of Things (IoT) technology to transform energy monitoring and management procedures has led to a great deal of interest in IoT integration with smart energy metering systems in recent years. The use of Internet of Things (IoT)-enabled smart metres for real-time energy usage monitoring in residential and business contexts has been the subject of numerous studies. The use of theft identification techniques to identify and stop unauthorised energy use is a major area of focus in these investigations. The development of sophisticated algorithms and methods to examine patterns of energy usage and spot anomalies that might point to theft or energy metre tampering has been the main focus of research in this field. These algorithms frequently use data analytics and machine learning techniques to discern between typical and unusual energy usage patterns. These systems can identify anomalies like abnormally high or fluctuating energy consumption levels, which may indicate metre manipulation or unauthorised connections, by continuously monitoring energy usage data from smart metres. Moreover, real-time energy usage data is often transmitted via communication networks by IoT-based smart energy metering systems to a cloud-based server or central monitoring platform. Utility providers and property owners can now remotely monitor trends of energy usage and receive notifications in the event of suspected theft or tampering with metres. Studies have also looked into how to safeguard communication lines and stop illegal access to metering data by integrating advanced security features like authentication protocols and encryption. The body of research on Internet of Things (IoT)-based smart energy metre monitoring with theft identification shows how these systems can boost overall grid dependability, lower revenue losses from theft, and increase energy efficiency. Nonetheless, there are also problems in this industry that need to be researched and developed, including interoperability problems, data privacy concerns, and the expense of establishing IoT infrastructure[1-14].

2. Proposed System

Through the use of IoT technology, the suggested approach introduces an intelligent and effective system that will revolutionise energy metre monitoring. The core processing unit used to communicate with the energy meter's voltage and current sensors is an Arduino controller. These sensors record current and voltage levels continually, allowing the system to instantly deliver insights into the consumer's habits of energy consumption. A NodeMCU module is used to transfer the data to a central hub, enabling wireless connectivity and remote monitoring features. The system uses sophisticated algorithms to examine the received data in order to handle the theft detection issue. In the event that the system detects anomalous or unapproved surges in voltage or current, which could be a sign of possible power theft, notifications and alarms are initiated. These alerts are forwarded to the appropriate law enforcement agencies or utility companies, allowing for swift action to look into and stop the theft. By quickly detecting and addressing cases of power theft, our smart energy metre monitoring system not only guarantees real-time insights for consumers but also improves the security of the energy distribution network.

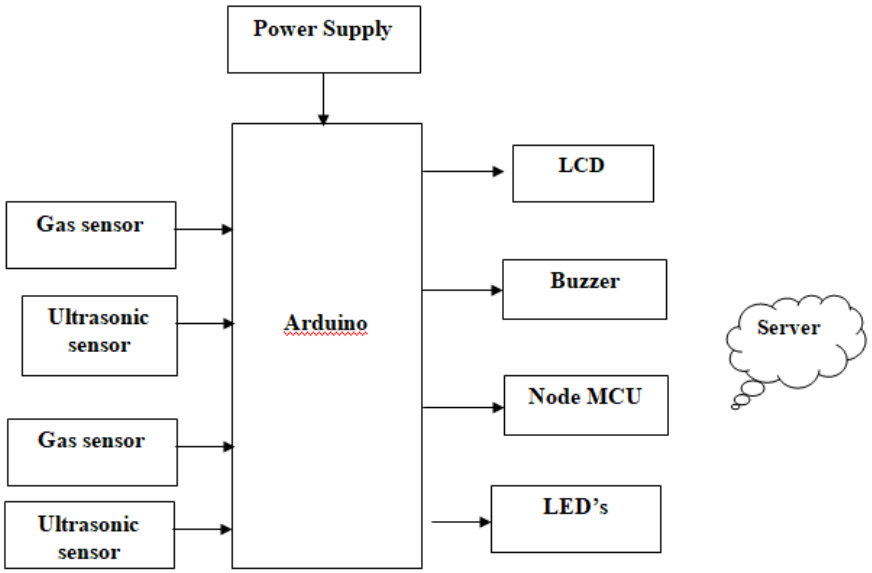


Figure.1.Block diagram of project

2.1 Hardware description

2.1.1 Introduction to Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller that can be programmed to sense and control objects in the physical world. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. They are used for a variety of purposes, including creating interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino boards come in various shapes and sizes, each with its own set of features and capabilities. Some of the most popular Arduino boards include:

Arduino Uno: The Uno is one of the most popular Arduino boards. It features a microcontroller, digital and analog input/output pins, USB connection, and a power jack.

Arduino Mega: The Mega is similar to the Uno but with more digital and analog input/output pins, making it suitable for larger projects that require more I/O.

Arduino Nano: The Nano is a compact board with similar features to the Uno but in a smaller form factor, making it ideal for projects with space constraints.

Arduino Due: The Due is based on a more powerful microcontroller than the Uno, making it suitable for projects that require more processing power.

Arduino Leonardo: The Leonardo is similar to the Uno but with built-in USB communication, making it easier to interface with computers.
In addition to the hardware, Arduino also provides a software development environment that allows users to write, compile, and upload code to their Arduino boards. The Arduino IDE (Integrated Development Environment) is a simple yet powerful tool that is used to write code in the Arduino programming language, which is based on Wiring, and upload it to the board.
Overall, Arduino is a versatile platform that is used by hobbyists, students, and professionals alike to create a wide range of projects, from simple blinking LED lights to complex robotics projects. Its ease of use, coupled with its affordability and flexibility, has made it one of the most popular platforms for electronics prototyping and experimentation.

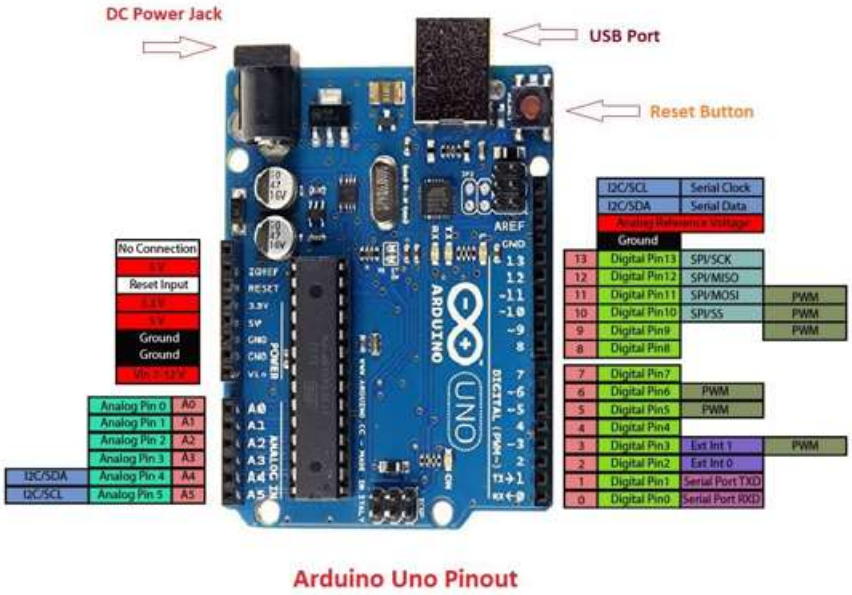
2.1.2 Features of the Arduino

Arduino boards come with a variety of features that make them suitable for a wide range of projects. Some of the key features of Arduino boards include:
Microcontroller: Arduino boards are equipped with a microcontroller, which is the brain of the board. The microcontroller is responsible for executing the program and controlling the inputs and outputs of the board.
Digital Input/Output Pins: Arduino boards come with a number of digital input/output (I/O) pins that can be used to connect the board to external devices such as sensors, LEDs, and motors. These pins can be configured as either inputs or outputs, allowing the board to read data from sensors or control external devices.
Analog Input Pins: In addition to digital I/O pins, Arduino boards also feature analog input pins that can be used to read analog signals from sensors. These pins allow the board to measure variables such as light intensity, temperature, and sound level.
PWM (Pulse Width Modulation) Pins: Some Arduino boards come with PWM pins, which can be used to generate analog-like signals. PWM is often used to control the brightness of LEDs or the speed of motors.

USB Connection: Arduino boards feature a USB connection, which allows them to be connected to a computer for programming and serial communication. The USB connection also provides power to the board, eliminating the need for an external power source.
Power Jack: Arduino boards come with a power jack that can be used to connect an external power source, such as a battery or a wall adapter. This allows the board to be powered independently of the USB connection.
Reset Button: Arduino boards feature a reset button that can be used to restart the board and re-run the program.
Integrated Development Environment (IDE): Arduino boards are programmed using the Arduino IDE, which provides a simple and intuitive interface for writing, compiling, and uploading code to the board.
Open-Source: Arduino is an open-source platform, which means that the hardware designs and software libraries are freely available for anyone to use and modify. This has led to a large community of Arduino users who share their projects and collaborate on new ideas.
Overall, Arduino boards are versatile and easy-to-use platforms that are ideal for beginners and experienced makers alike. Their combination of features, affordability, and flexibility make them a popular choice for a wide range of projects, from simple blinking LED lights to complex robotics applications.

2.1.3 Arduino Pinout

- Arduino Uno is based on an AVR microcontroller called Atmega328. This controller comes with 2KB SRAM, 32KB of flash memory, and 1KB of EEPROM. The Arduino Board comes with 14 digital pins and 6 analog pins. ON-chip ADC is used to sample these pins. A 16 MHz frequency crystal oscillator is equipped on the board. The following figure shows the pinout of the Arduino Uno Board



Arduino Uno Pinout

Figure.2. Arduino UNO Pinout diagram

3.Results and Discussion

BEFORE POWER THEFT

AFTER POWER THEFT

4.Conclusion

In conclusion, the implementation of the IoT-based Smart Energy Meter Monitoring with Theft Identification system marks a significant advancement in energy management and security. Through the integration of IoT technologies, real-time monitoring capabilities, and theft detection mechanisms, the project offers a comprehensive solution for optimizing energy usage, reducing losses, and ensuring the integrity of energy distribution networks.

Firstly, the paper addresses the pressing need for enhanced energy monitoring and management in both residential and industrial settings. By providing stakeholders with access to real-time data on energy consumption, the system empowers them to make informed decisions about energy usage, identify areas of inefficiency, and implement targeted measures for optimization. This not only helps to reduce electricity bills for consumers but also improves overall energy efficiency and sustainability.

Secondly, the incorporation of theft identification features adds an extra layer of security to the energy infrastructure, particularly in regions prone to electricity theft and tampering. By leveraging advanced analytics and anomaly detection algorithms, the system can accurately identify unauthorized access, meter tampering, or energy diversion attempts in real-time. This proactive approach enables utility companies to mitigate losses, combat revenue leakage, and ensure fair billing practices, ultimately contributing to the financial viability and stability of the energy sector.

Lastly, the project underscores the potential of IoT technologies to drive innovation and transformation in the energy industry. By harnessing the power of interconnected devices, sensor networks, and cloud-based analytics, stakeholders can unlock new opportunities for energy optimization, grid management, and sustainable development. Moving forward, continued research and development in this area will be essential to further refine the capabilities of IoT-based energy monitoring systems and address evolving challenges in the energy landscape. Overall, the IoT-based Smart Energy Meter Monitoring with Theft Identification project represents a promising step towards a more efficient, secure, and sustainable energy future.

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