SMART ELECTRICAL POWER THEFT DETECTION AND MITIGATION

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ABSTRACT

The prevalence of electricity theft poses significant challenges for utility companies worldwide, leading to revenue losses and safety concerns. To address this issue, we propose an Internet of Things (IoT)-based Electricity Theft Detection system aimed at identifying and mitigating instances of unauthorized electricity consumption. This system leverages IoT technology to monitor electricity usage in real-time, detect irregularities indicative of theft, and alert utility providers for prompt intervention. By integrating smart meters, sensors, and communication modules, the proposed system offers a comprehensive solution for detecting and preventing electricity theft, thereby enhancing revenue protection and ensuring the safety and reliability of electrical grids.

INTRODUCTION

Electricity is an extremely handy and useful form of energy. It plays an ever-growing role in our modern industrialized society. The electrical power systems are highly non-linear, extremely huge and complex networks. Such electric power systems are unified for economic benefits, increased reliability and operational advantages. They are one of the most significant elements of both national and global infrastructure, and when these systems collapse it leads to major direct and indirect impacts on the economy and national security[1]. A power system consists of components such as generators, lines, transformers, loads, switches and compensators. However, a widely dispersed power sources and loads are the general configuration of modern power systems. Today electricity still suffers from power outages and blackouts due to the lack of automated analysis and poor visibility of the utility over the grid[2]. WSN will give the utility provide the needed view by collecting information from the different sub-systems of the grid.

We can categorise the losses in to technical (TL) as well as non-technical (NTL) . Technical losses are in-built in the system which is reduceable to an appreciable level; the remaining is due to power dissipated in equipment and conductions used to for the distribution and transmission lines. NTL happens due to inaccuracy of metering, stealing or theft of electricity, as well as energy consumed but unrecorded by the energy meter . Electricity theft is the energy consumed by a customer that is unaccounted for or not measured by the energy meter. Theft of electricity happens due to meter tampering, meter bypassing, and service lines tapping to the customers' premises. Due to the deficiencies in the metering system and the lack of transparency and accountability in billing customers of electricity in public utilities, customers take advantage to steal electricity to avoid paying the realistic tariff[3]. Electricity theft causes a very high negative impact on the financial status of power distribution and utility companies, which puts pressure on the future investment of the power sector. The ripple effect is that the losses incurred due to the theft are

passed as the cost to the paying consumers in either poor quality service and higher tariff . Reports suggest 25 per cent of Ghana's current annual average losses are due to electricity theft . However, the emergence of smart grid technologies has informed researchers to utilize the smart grid platform to detect and monitor electricity theft. Our research proposes a generalized IOT based design using raspberry pi to detect electricity theft by comparing the recorded values of current at the utility service intake to the recorded value of current at the energy meter intake. The result of the compared values is stored on the firebase server, which is accessible in real-time [4].

EXISTING SYSTEM

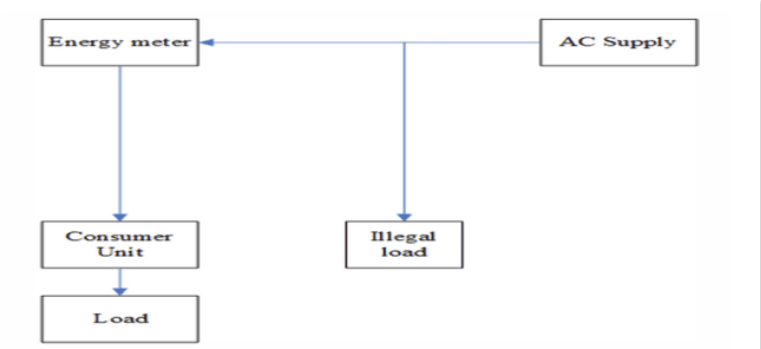
Our enhanced power monitoring project addresses a critical gap in existing systems by introducing a capability to add extra units of power. Unlike conventional systems that solely provide power consumption details, our project leverages RFID technology to empower users to supplement their power allocations seamlessly. Users can now easily tap their RFID tags to initiate the addition of extra units, providing a user-friendly and efficient solution. This innovative feature ensures greater flexibility and control over power usage, bridging a significant functionality gap in traditional power monitoring setups [5]. The integration of RFID technology brings a simple and secure method for users to customize their power requirements as needed.

Drawbacks:

•In the existing system meter tampering can be done easily

•Manual Work is more and errors may happen

ILLEGAL TAPPING OF UTILITY SERVICE



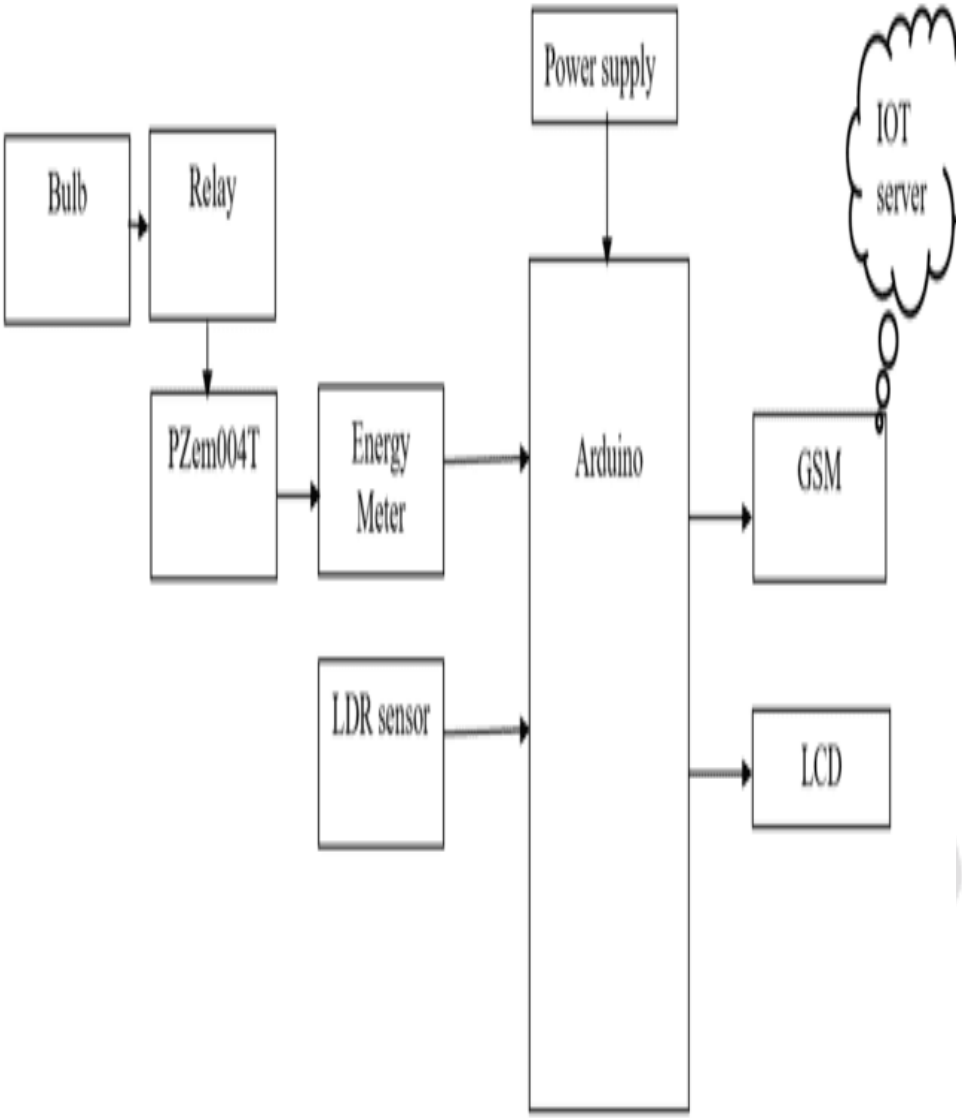
PROPOSED SYSTEM

An energy meter equipped with a microcontroller serves as a real-time power monitoring system, measuring power in watts. The microcontroller retrieves these live power parameters and utilizes a GSM module for seamless connectivity to the cloud6[.] Through the Internet of Things (IoT), the microcontroller establishes a connection with a cloud server, facilitating the transmission of power data for remote monitoring and analysis. The system incorporates an LCD display, providing users with instant access to the current status of power consumption.

Moreover, the microcontroller is programmed to trigger automatic notifications when the cost units decrease, ensuring users are promptly informed of any fluctuations in energy consumption [7].

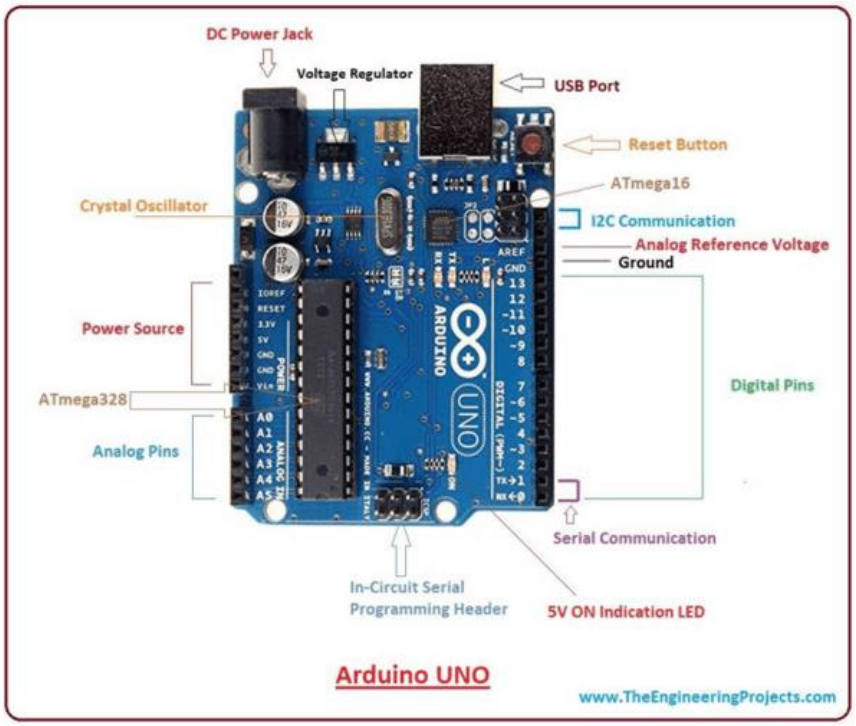
Additionally, the system uploads monitoring values to the IoT server, enabling users to access historical data and trends. This centralized data storage ensures comprehensive and accessible records for analysis and decision-making. Overall, the integration of these technologies enhances the efficiency, transparency, and user-friendliness of the energy monitoring system, contributing to a more sustainable and informed approach to power consumption management.

BLOCK DIAGRAM



SYSTEM DESIGN

Arduino:



Arduino Uno is a microcontroller board developed by Arduino.cc which is an open-source electronics platform mainly based on AVR microcontroller Atmega328.

The current version of Arduino Uno comes with USB interface, 6 analog input pins, 14 I/O digital ports that are used to connect with external electronic circuits[8]. Out of 14 I/O ports, 6 pins can be used for PWM output.

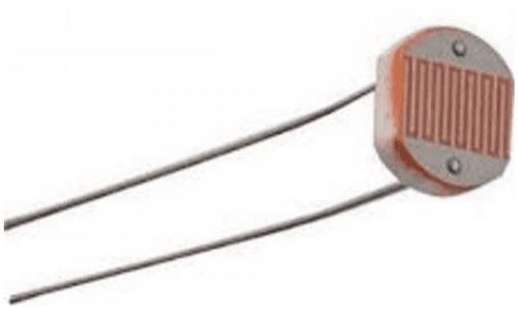
The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

Early arduino boards used the FTDI USB-to-UART serial chip and an ATmega168.[10] The Uno differed from all preceding boards by featuring the ATmega328P microcontroller and an ATmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter

LCD DISPLAY

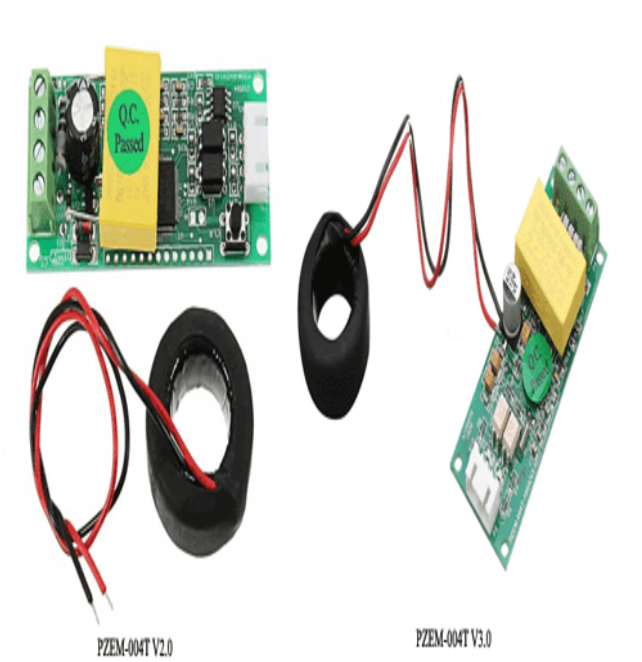
The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc[9]. These displays are mainly preferred for multi-segment light emitting diode and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

LDR SENSOR



A **Light Dependent Resistor** (also known as a photoresistor or LDR) is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light-sensitive devices. They are also called as photoconductors, photoconductive cells or simply photocells .They are made up of semiconductor materials that have high resistance. There are many different symbols used to indicate a photoresistor or LDR, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it.

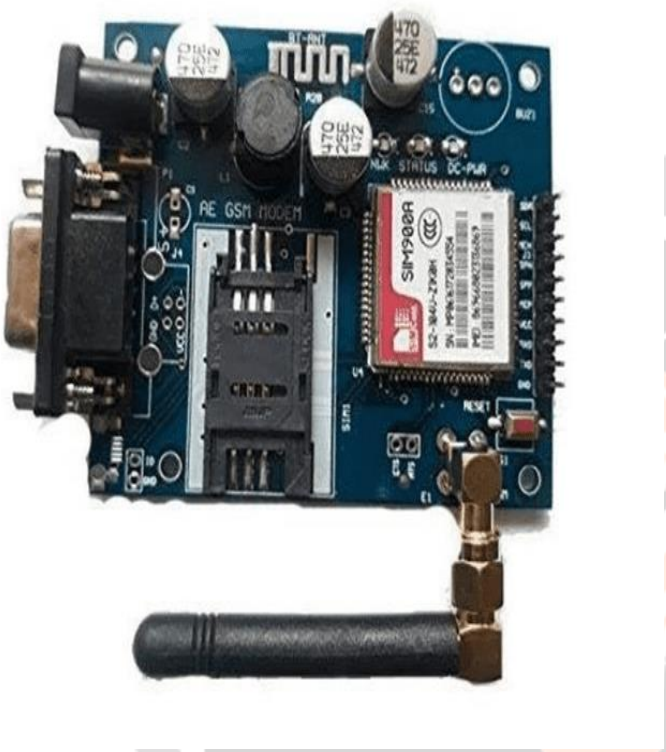
PZEM004T



PZEM-004T is an electronic module that functions to measure: Voltage, Current, Power, Frequency, Energy and Power Factors. With the completeness of these functions / features, the PZEM-004T module is ideal for use as a project or experiment for measuring power on an electrical network such as a house or building[10].The PZEM-004T module is produced by a company called Peacefair, there are 10 Ampere and 100 Ampere models. Please be

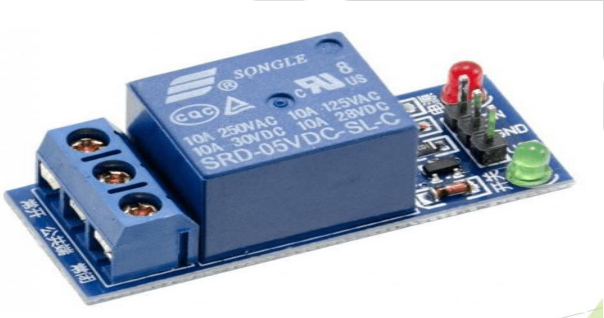
careful because the wiring between the 10 Ampere models with 100 Amperes is different, if a short circuit or a short circuit can occur in the electrical network.

GSM



GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world[11]. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.

RELAY



A relay is an electromagnetic switch that is used to turn on and turn off a circuit by a low power signal, or where several circuits must be controlled by one signal.

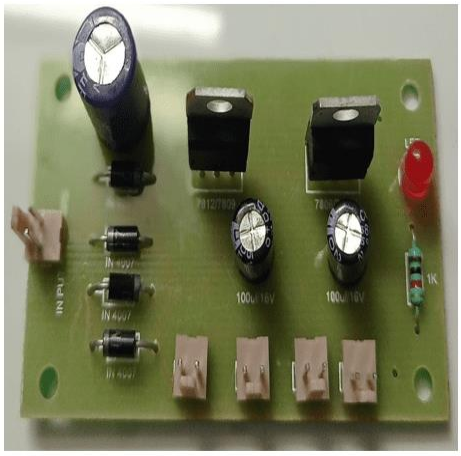
Most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically[12]. Relays consist of an electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet.

Latching relays require only a single pulse of control power to operate the switch persistently. Another pulse applied to a second set of control terminals, or a pulse with opposite polarity, resets the switch, while repeated pulses of the same kind have no effects.

BULB

The electronic bulb is the simplest electrical lamp that was invented for illumination more than a century ago. It was the small and simplest light that brightened the dark space. The electronic bulb is also known as an incandescent lamp, incandescent light globe or incandescent light bulb[13]. Bulb comes in different sizes and light output and operates with a voltage range from 1.5 Volts to about 300 Volts. Now let us study the parts and structure of the bulb in detail.

POWER SUPPLY

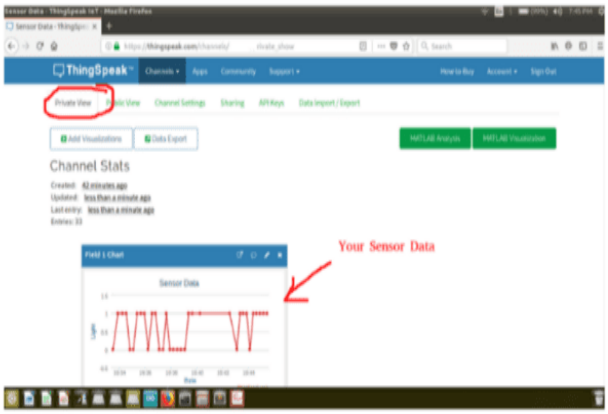


A power supply is a component that provides at least one electrical charge with power. It typically converts one type of electrical power to another, but it can also convert a different Energy form in electrical energy, such as solar, mechanical, or chemical[14].A power supply provides electrical power to components. Usually the term refers to devices built into the powered component. Computer power supplies, for example, convert AC current to DC current and are generally located along with at least one fan at the back of the computer case.

ARDUINO IDE

The Arduino IDE (Integrated Development Environment) is used to write the computer code and upload this code to the physical board. The Arduino IDE is very simple and this simplicity is probably one of the main reason Arduino became so popular[15]. We can certainly state that being compatible with the Arduino IDE is now one of the main requirements for a new microcontroller board.

THINGSPEAK



The first thing you need to do is to create an account with ThingSpeak. Since the collaboration with MATLAB, you can use your MathWorks credentials to login to ThingSpeak using the Sign In link from this page: **THINGSPEAK** . After logging in, you need to create a new channel for the data to be stored. For this go to Channels–>My Channels and click on New Channel.

ADVANTAGES

- Helpful for Fault Management
- Reduced hazards
- Real time monitoring

- Remote Access
- Periodical collection of data.

APPLICATIONS

- Energy production
- Substations
- Houses or Apartments
- Industries

CONCLUSION

The proposed IOT based electricity theft is easy to install and beneficial for both energy Provider and Customer. This reduces revenue cost and reduces the human errors and problems like over running of the meter etc. This leads to reduction of outstanding dues. This device improves usage level and energy monitoring. The proposed system continuously monitors the meter reading and shut down the power supply remotely whenever the recharged units become zero. It avoids the human intervention, provides efficient meter reading, avoid the billing error and reduce the maintenance cost.

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