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Electrical Power Theft Detection and Monitoring Using Innovative Technique

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Abstract

Power theft poses a significant challenge in many developing countries, leading to revenue losses for governments and people. ***Aim:*** *This study proposes a solution to address the issue of power theft by utilizing IoT to detect and enhance energy management. By using this system, detecting power theft becomes more accurate, and it is also more affordable to install compared to traditional methods for addressing this issue. This system has various other IOT devices like a relay, which cuts off the current when power theft is detected, and a buzzer is used to blow when power theft is detected so that consumers also become aware of this situation. Result: In this system, we have utilized GSM technology for instant messaging to providers regarding power theft issues, and by using IoT, we are displaying system data in real-time on the website, allowing both providers and consumers to view the system data in real-time.*

Major Findings: *Major research covers power theft between pole to pole, so we are finding solutions to power theft between the pole and the consumer. This system helps to minimize the cost and increase reliability in the system. This makes this system a foundation for smart grid development.*

Keywords: *Energy Management, GSM Technology, IOT, Power Theft Detection, Real-Time Data*

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1.0 Introduction

Internet of Things (IOT) is defined by how IOT devices connect and share information with each other and with cloud platforms[1,2]. IOT development was started in early 2000 with technology such as RFID (Radio Frequency Identification). It helps for basic connectivity between physical objects and the internet[3,4]. The major evolution of IOT was from 2010, when different types of devices could be connected to IOT, then the integration of IOT with big Data made a huge impact in the field of IOT, as IOT transmits a lot of data and cloud helps to save that data and helps to display it in real time on website[5,6]. IOT contributes to building smart cities, helping to give more security and privacy, and helps to make smart homes[7,8]. In industry, it helps to measure, monitor, and control things as per requirement sufficiently, which helps it to become more usable in different fields[9,10]. Efficient management and conservation of electricity are important at this time when technology is continuing to change in our lives, the theft of power is a crime that cannot be avoided, and has a direct impact on the country's economy[11,12]. Using power efficiently and without losses is a major task. To avoid power theft, devices to monitor and measure these parameters must be installed[13,14]. Countries that are developing and densely populated face a lot of these power theft issues. At this point of technology evolution, the issue of unauthorized electricity usage may be resolved without the use of computers and the need for human intervention[15,16].

1.1 Literature Summary

By using IOT in this field, we can overcome this gap and can reduce power theft significantly[17,18]. By using IOT and IOT devices, we are going to find the difference between units collected on the pole side meter and units collected on the consumer side meter with the help of ardunio uno and if there is a difference between them, then we are going to declare it as a power theft[19,20]. Integration of the IOT based detection and monitoring of electricity theft is a technology advancement, and it is vital in this fast-developing time[21,22].

2.0 Objectives

2.1 Finding Power Theft between Pole to Consumer

By using ardunio uno and IOT module, we will count the number of units passed through the master meter (meter which is placed on pole) and number of units collected by slave meter (meter which is placed on the consumer's side) and if there is difference between their units, and if they are greater than 3 units we are declaring it as power theft[23,24].

2.2 A Reactive System will be Triggered if there is Power Theft Detection for Security and Mitigation Purposes

When power theft is detected, we use a relay so that the current is cut off immediately. After that, we use a buzzer that will blow at the consumer's place so that consumers will become aware of a power theft incident[25,26]. We have included a GSM module in this, as when power theft is detected, a message will be sent to the provider to tell them that power theft is detected. the messages will be sent to the provider at a particular time interval[27,28].

2.3 Providing Real-Time Monitoring of the System

By using IOT module, we are providing the ability to see the real-time voltage level, their energy consumption, and whether power theft is detected or not. This will help them to use appliances properly and will help to use energy efficiently[29,30]. On the provider side we are providing data in form of graph of the consumption of energy of the master meter and slave meter of that particular consumer and also a difference between their units consumed and we are also providing the consumer location so that if power theft is detected provider can find exact location of power theft[31,32].

3.0 Methodology

3.1 Process Parameters

The description of IOT for a solution to prevent power theft is addressed in this paper. The use of IOT in the energy sector and how it can help us to stop power theft, as well as its ability to provide real-time system monitoring[33,34]. The IOT system helps providers as well as consumers to get real-time data from the system and helps to take action as per the requirements[35,36]. Using IOT and IOT devices would offer a simple solution to identify electrical power stealing without human intervention[37,38]. Let's understand this problem and its solution with

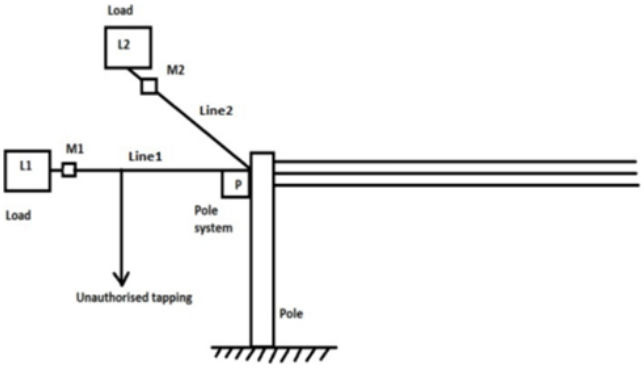


Figure 1. Conceptual diagram[1]

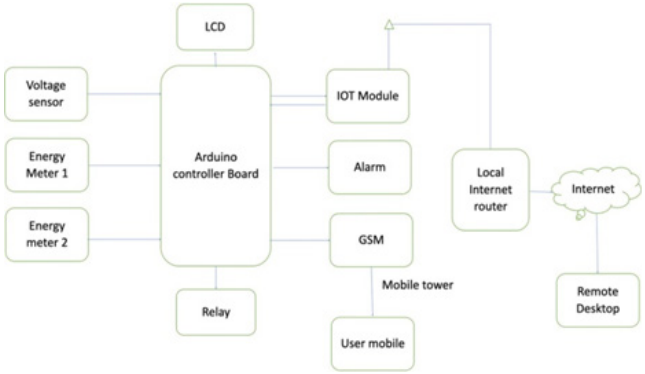


Figure 2. Block diagram[4]

the help of the diagram shown below, Figure 1. Let's understand the below diagram. We have a poll (P) and we have two consumers naming it as Load 1 (L1) and Load 2 (L2), and we have energy meters on the consumer side (M1, M2).Let's discuss the condition where power theft is not present[39,40]. At that time, units passed through the poll (P) (Master meter) will be the same as units gained by the Load (L1) and Load (L2)(Slave meter)as we have discussed earlier, if the units of master and slave are same then there is no power theft condition[41,42]. Let's see the power theft condition. Now let's assume there is an unauthorized load between the poles (P) to load (L1) as shown in Figure 1, and then the units passed through the master will not be the same as units gained by the two slaves. If the difference between their units is greater than 3, then we will declare it as a power theft condition[43,44].

In this work, we have used an Arduino Uno (ATmega328), which has an operating voltage of 5V. It has 14 digital pins and 6 analog pins. The first input as we can see in block diagram Figure 2 is the voltage sensor, voltage sensor senses the voltage level of the energy meter and gives it to Arduino Uno, and then it passes through Wi-Fi module to display it in real time on the website. Then we have used two energy meters (Polycarbonate Electronic Energy Meter) Rating: 5-20Amps. In this energy meter 1unit = 3200pulse/KVh.Now, we have used an LCD display (16 * 2) which works on 5V supply. It shows units passed from energy meter1(Master) and units consumed by energy meter 2 (Slave). We are also displaying the difference of units in between both meters, it also shows voltage rating and when power theft is detected it shows message sms sent to the provider .We have used relay of Channel 5V Optical Isolated Relay Module which helps to cut off the current when power theft is detected[45,46]. Then

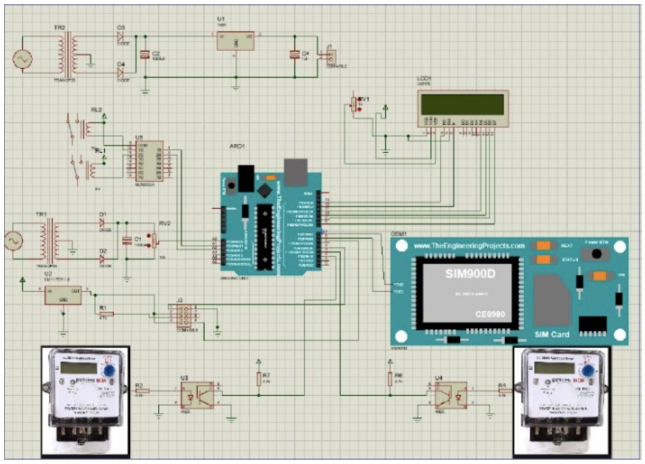


Figure 3. Circuit diagram[7].

we have used buzzer which has an operating voltage of 5V, it is used to produce sound at consumer side when power theft is detected. We have used a GSM module (SIM300) which sends a message to the provider when power theft is detected. Lastly we have used a Wi-Fi module (ESP8266) which works on 3.3V. By using this, we connect the system with a website and website shows the data in real time[47,48].

In Figure 3, we have used Proteus Software for the simulation of the system, we have provided 230V supply and we have used two optocouplers at two energy meters to isolate the energy meter circuit from other circuits. We have used a 606 step down transformer (500mA) to step down voltage from 230Vto 6V then the it passes through voltage sensor were AC is converted to DC by rectifiers and by POT (Potentiometer) we are adjusting the voltage to 5V and then giving to arduinoArduino uno analog pin A5. We have buzz which is connected to Arduino uno analog pin A1 and relay is connected to analog pin A0

and relay is in a series with master energy meter[49,50]. Now at D0, D1 digital pins of arduinoArduino uno, we have kept them for programming. D2 and D3 of Arduino are used as interrupts as to count number of pulses of energy meters and ultimately calculating units of them. D4 to D9 are used for LCD display connection and a we have used POT to control LED display brightness, D10 andD11 are used for connection of ESP8266, in that D10 is receiving pin (RX) which we didn't used as we are not receiving and D11 is transmitting pin (TX) which we need, D12 and D13 are used for GSM in that D12is receiving pin (RX) which we didn't need as we are not receiving and D13 is transmitting pin (TX) which we need[51,52]. WiFi module works on3.3V which power supply is given by Arduino uno we have used resistor so that it will not get reset, we have made connection to its VCC and ground it only transmits the data. The GSM module has an input voltage of 5V. Here we have connection made to ground pin and receiving pin (RX), which is connected to Arduino uno transmitting (TX) pin[53,54].

4.0 Results and Discussion

The supply of 230V is provided to master energy meter, as power theft condition is not present, the step down transformer will reduce voltage from 230V to 6v and by using voltage sensor and Arduino uno we will sense voltage rating and then by IOT module will send voltage rating and also units of both energy meters to the website[55,56], we don't require GSM as power theft condition is not present and the LCD display will show units at Meter 1 (U1) and Meter 2 (U2) and voltage rating (V) and difference between their units (D) as shown in Figure 4.

As we can see, it shows U1 (Meter 1) as 3 units and U2 (Meter 2) as units 4 and real time voltage rating of 233V and difference between U1 and U2 is -1. The reason it shows -1 is that when pulses of the master energy meter are missed by Arduino Uno, and slave energy meter pulses are calculated by Arduino uno due to that, it shows -1, but in most conditions, it shows a difference of zero. Now, in a power theft condition, we have used a load that is directly connected to the master meter and draws energy directly from it[57,58]. Due to that the units passed through the master are not the same as the units consumed by the slave so due to the display will show the difference between them, which will be greater than or equal to 3, as shown in Figure 5.

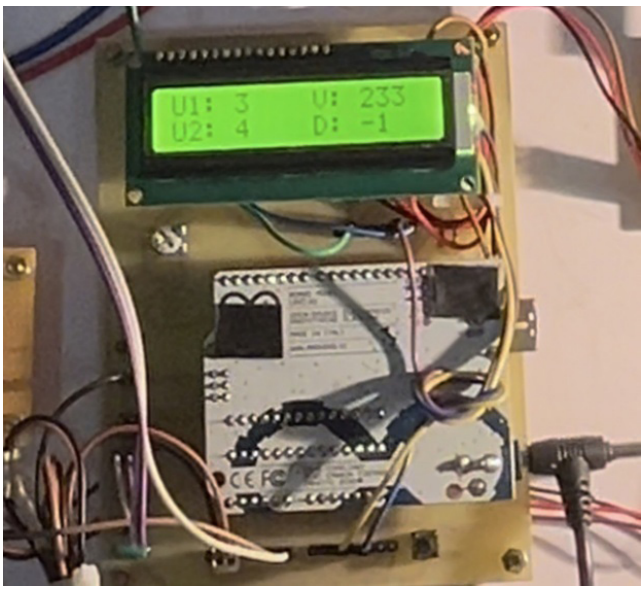


Figure 4. When the power theft condition is not detected[9].

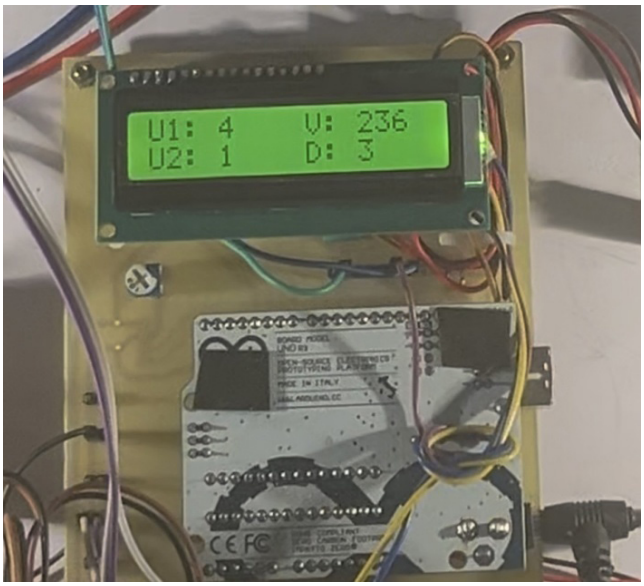


Figure 5. When power theft condition is detected[10].

As we can see, U1is 4 units U2 is 1 unit, and the difference D is +3 The voltage rating is 236V by observing this data, we can say that the external load, which is connected to show power theft condition, is consuming that 3 units, thus power theft condition has been detected. After that display will show the message as shown in Figure 6.

By using the GSM module message will be sent to the provider regarding power theft, and LCD display will show the message saying SMS TO MSEB SUBS.



Figure 6. When power theft condition is detected[11].

This message will be sent to the provider by a particular time interval and by using the relay current will be cut off and the buzzer will blow at the consumer's place. By this consumer will also get to know that power theft is detected[59,60].

Using Think-Speak website to show real time data of system to consumer and provider, we help provider to see difference between the both of the energy meters units by showing them graph, then we display consumer location through map, voltage level through meter and a theft indicator which lights up when theft is detected, as shown in Figure 7.

Provider also has authority to check voltage level at different time by analyzing the graph of a particular consumer, as well as they can have data of units gained by meter 1(Master) and units consumed by (Slave) meter 2 of a particular consumer, they also have data of difference between units of meter 1 and meter 2 as shown in the Figure 8. The graph goes to zero when we reset the system or theft is detected so that system stops itself and system has to restart again[61,62].

On the consumer end the Think-Speak website shows the voltage rating of consumer end's (Slave Meter) meter, then by using numeric display we are showing units gained by energy meter 1 (Master) and units gained by energy meter 2 (Slave) and also we have given theft indicate or which glows when theft is detected in the system as shown in Figure 9. This overall website helps consumers and providers to see the data of the system in real time.

4.1 Advantages

This system provides data in real-time, and it also works fast and automatically when power theft is detected. This system minimizes the cost by reducing human intervention in the system, as well as reducing the maintenance of the system. It also helps providers as well as consumers to analyze data on a timely basis, which helps to improve energy management. A provider finds

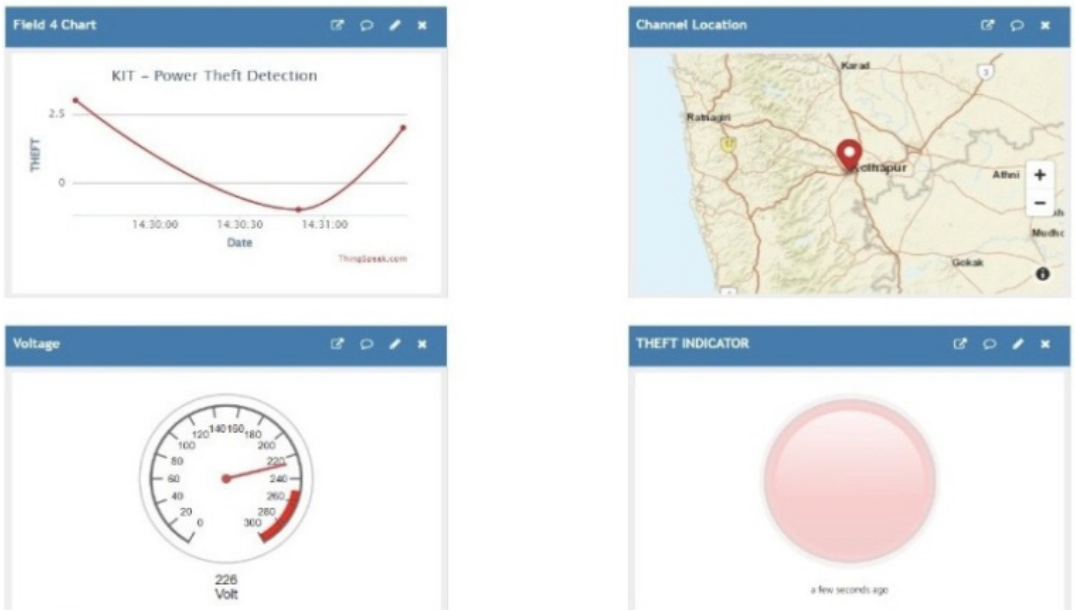


Figure 7. Provider side website interface[13].



Figure 8. Provider side website interface[14].

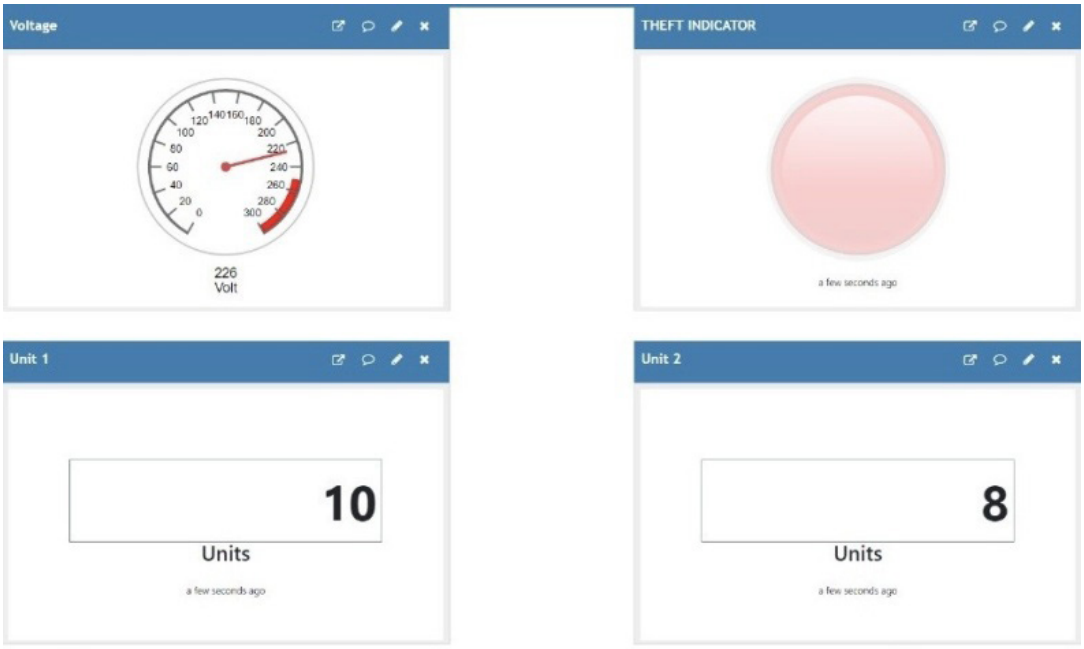


Figure 9. Consumer side website interface[15].

out the exact power theft location quickly by using this system, which this system reliable and efficient.

4.2 Future Scope

As technology is improving with time, the usage of IOT in day-to-day life is also increasing, which helps to reduce our maintenance costs as well as human intervention and helps with energy management. Grids are also moving forward to becoming smart grids, where IOT can play a crucial role in developing these smart grids. Moving forward by using AI and data analysis, we can predict the usage of energy and help with energy management. Power theft is a crime, and it also affects a country's economy, so

many governments want to reduce power theft. This is a cost-saving solution that reduces revenue losses. Shortly, IOT will be more affordable, which will help to build systems on it easily. The main advantage of IOT is it can be used remotely, which helps both providers and consumers. By using GSM technology in this system, it can send a message to the provider, which will be helpful to solve the problem quickly and efficiently. Using blockchain technology in this can be an added advantage as data can be safe and cannot be tampered with by cyberattacks.

5.0 Conclusions

The use of the IOT in the system can help to reducepower theft and revenue losses, it also helps to send a message to the provider using GSM technology which helps the provider to know that power theft is detected and IOT which helps the consumer and provider to see the system data in real time on the Internet, which helps for energy management. IOT helps to solve problem sufficiently and by reducing human intervention in the system, which also helps to minimizing the maintenance of the system and make the system cost effective, and will help to build smart grids which are reliable and scalable.

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