IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

MINIMIZING AND TRACKING OF ELECTRICITY THEFT

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Abstract

Electricity theft is a significant challenge faced by power companies and governments. It not only impacts the economy and growth of a country but also affects domestic, agricultural, and industrial settings where electricity is a basic necessity. Unfortunately, the prevalence of electricity theft is on the rise, and it has become a non-negligible crime. If appropriate actions are not taken to address this issue, future generations will have no scope of living in light, peace, and harmony. To minimize electricity theft, a system is designed using an Arduino Uno, ESP-01 ESP8266 serial WIFI wireless transceiver module, ACS712 current sensors, GPS Neo-6M, GSM SIM800L, and other components. The system aims to reduce the illegal use of electricity and detect any theft that may occur and triggering appropriate actions. The ACS712 detects current usage, and the ESP-01 sends the data to the Thingspeak IoT platform. This platform collects the data, which can be used to monitor and analyze electricity usage. The GPS Neo-6M helps to identify the location of the theft, and the GSM SIM800L enables communication to notify the authorities. Overall, this project aims to minimize the issue of electricity theft and ensure the efficient use of electricity, which is essential for the economic growth and well-being of a nation.

Keywords: current sensor, GPS Neo-6m, GSM SIM800L, IOT, ESP-01, Arduino uno.

I. INTRODUCTION

Power theft detection is the process of detecting the illegal use of electricity. Electricity theft is one of the major challenges faced by the power companies. It prevents the power companies from making adequate money from the sale of electricity.

The financial loss occurred to the power companies is majorly due to the unbilled electricity usage. Power companies sees two kinds of electricity losses. They are,

a) Technical losses (TL)
b) Non-technical losses (NTL).

Technical losses: Technical losses in electricity refer to the energy losses that occur during the process of generating, transmitting, and distributing electricity from power plants to consumers. These losses are a result of the resistance of the conductors used in the power system and the inefficiencies of the electrical equipment involved in the process. There are various types of technical losses that occur in the power system, including:

- Transmission losses: These losses occur during the transmission of electricity over long distances from the power plant to the distribution network. They are a result of the resistance of the transmission lines and the transformers used in the transmission process.
- Distribution losses: These losses occur during the distribution of electricity from the distribution network to the consumers. They are a result of the resistance of the distribution lines and the transformers used in the distribution process.

- Transformer losses: These losses occur in the transformers used to step up or step down the voltage of electricity. The losses are a result of the resistance of the transformer windings and the core losses due to eddy currents and hysteresis.
- Switching losses: These losses occur when electrical equipment, such as switches and circuit breakers, are turned on or off. The losses are a result of the current and voltage surges that occur during the switching process.
- Capacitor losses: These losses occur in the capacitors used in the power system to store electrical energy. The losses are a result of the resistance of the capacitor dielectric and the losses due to leakage currents.

Reducing technical losses is essential for improving the efficiency of the power system and ensuring the reliable supply of electricity to consumers. Power companies use various methods to reduce technical losses, including improving the design of electrical equipment, upgrading the power infrastructure, and implementing energy-efficient technologies.

Non-Technical losses: Non-technical losses in electricity refer to the losses that occur due to theft, billing errors, and other illegal activities that are not related to the technical aspects of the power system. These losses are a significant challenge for power companies and result in significant financial losses. Some of the common types of non-technical losses in electricity include:

- Theft of electricity: This refers to the illegal tapping of electricity from the power system by unauthorized persons. It is one of the major causes of non-technical losses in electricity.
- Meter tampering: This refers to the unauthorized modification or tampering of electricity meters to reduce the amount of electricity consumption recorded by the meter.
- Billing errors: This refers to errors in the billing process, such as incorrect meter readings or incorrect calculations, which result in overcharging or undercharging of customers.

Non-technical losses have a significant impact on the financial health of power companies and can result in higher electricity prices for consumers. To address non-technical losses, power companies use various strategies, such as improving metering and billing systems, implementing anti-theft measures, and conducting awareness campaigns to educate customers about the impact of non-technical losses on the power system.

According to sources, the annual loss due to electricity theft in Haryana is around Rs. 706.82 crore in 5 years [6]. Electricity theft also results in power outages and load shedding, which affects the reliability of electricity supply and has an adverse impact on industries and households. The power sector is a critical component of India's economy, and the losses due to electricity theft affect the country's economic growth and development.

Although there are many research works on minimizing and tracking of electricity theft, here in this chapter we have critically analyzed and summarized several research works and projects, which are more recent and relevant and similar to project. This literature survey will logically explain the system.

1.**Power Theft Identification Using GSM Technology**: Rhea Prakash, E. Annie Elisabeth Jebaseeli, and Y.S.U.Sindhu have proposed a theft detection system that utilizes PIC microcontroller, sensor, GSM module, and LCD display. Meter bypassing is a common method of electricity theft, which this system aims to prevent. The core component of the system is the Arduino controller, consisting of two microcontrollers. The project involves the use of two CTs; one is fitted on one end of the pole, while the other is connected to the other end: the voltage pattern of the area is studied by providing the output of the two CTs to the Arduino controller. When the voltage drop exceeds the permissible calculated value given by utilities, it means that the theft load is connected to the system, and this is detected by the Arduino controller, which sends a message to the utility using the GSM module fitted with the Arduino kit. The data collected by the Arduino is analyzed using MATLAB, and the area of theft is identified to take action. This theft detection system operates in real-time and does not require any human intervention.[1].

2.**Distribution Line Monitoring System For The Detection Of Power Theft Using Power Line Communication**: A system for detecting power theft via power line communication is proposed, which involves adding a high frequency of between 3 kHz to 500 kHz to the power frequency, following Indian electrical standards. When power is illegally tapped, the system frequency varies, allowing detection of the area where theft has occurred using Matlab System. The inclusion of a high frequency ensures that equipment connected to the theft load will fail to operate. This project aims to detect and respond to power theft autonomously, without requiring human intervention. [2].

3**. Electrical theft detection and Wireless meter reading**: In this proposed system given by Sagar Patil, Gopal Pawaskar, Kritikumar Patil, they are using digital meters, wireless data transmitter and power line communication to detect the theft in the power line. Basically in this system one digital connected on the pole and other is connected in the consumer premises or at load side. Digital meter on the load side collects the data and send it continuously to the pole side digital meter on which microcontroller is fitted with the help of wireless transmitter. The microcontroller receives both the data from source side and load side, with the help of wireless receiver and compares the data, if the difference is under tolerance band then there will be no theft occurring on the power line. In other condition if the difference is beyond tolerance then it means that theft is happening on the line that is detected by the microcontroller and the required information is sent to the substation by using power line communication, and further actions are taken, so the power line theft is detected and line is protected from the theft using this system. And by using same data given by load side meter consumer's meter reading is taken out meter is [3].

4**.IoT Based Power Theft Detection**: R Giridhar Balakrishna, P Yogananda Reddy, and M L N Vital have proposed a system to prevent power theft using IoT technology. Their system utilizes Arduino, GSM, LCD, ESP module, and current transformers to detect power theft. One CT is connected to the source side, and the other is connected to the load side. Both CTs' signals are sent to Arduino for analysis. Arduino compares the data received from both CTs and alerts if there is a difference beyond tolerance levels, indicating a theft load. This information is then transmitted via IoT and ESP modules through the internet to the substation. In case of internet failure, a GSM module will send a message to the substation where the theft was detected. This system employs both IoT and GSM technology to prevent power theft, which is a major threat globally.[4]

5**.GSM Based Electricity Theft Detection**: In the system proposed by Nilesh Mohite1, Rinkuraj Ranaware2 , Prakash Kakade 3 They presents the solution for the detection of the different methods of power theft. To limit this global threat of power theft, this project provides good provision to reduce the illegal usage of electricity and also reduce the chances of theft. This project contains the automatic reading collection and detection of theft without any human interference. In this system the provision is mainly done by using GSM, current transformer, PIC 18F4520 and energy meter. As we know the common methods to do theft are by bypassing the meter using a piece of wire before or after connecting to the meter. In this system two CTs are used, one is connected to the input side and other is connected to distribution point of the house line, both signals from the two CTs are given to the PIC18F4520 in the case of bypassing the meter reading from input side will not match to the consumer or load side beyond the given tolerance for losses then it simply means that there is power theft takes place by meter bypassing and the message is given to the utility using GSM module. In other case if there is meter tampering, an IR sensor is connected to the meter so that the indication is given to the utility by using GSM fitted on the PLC kit and theft is detected without any manual interface. So, in this project the power theft detection is done in simple way without any manual manipulation.[5]

II. PROPOSED MODEL

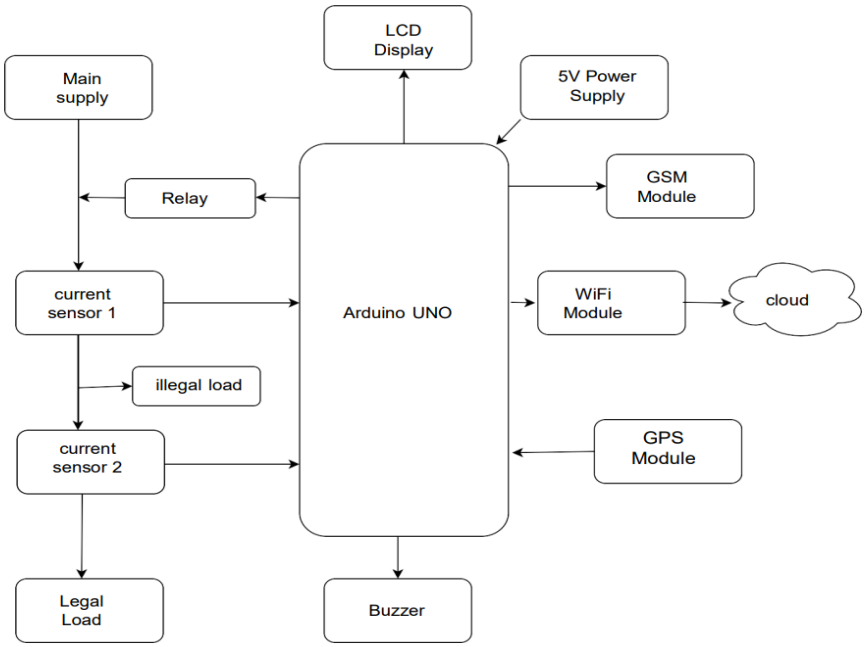

Fig – 1: Proposed Block Diagram

Fig-1 is the proposed model for minimizing and tracking electricity theft. The block diagram includes all the necessary elements to complete the project. On the left side of the block diagram, the flow of current from the main supply to the legal load is shown, along with the process for acquiring readings from both the main supply and legal load.

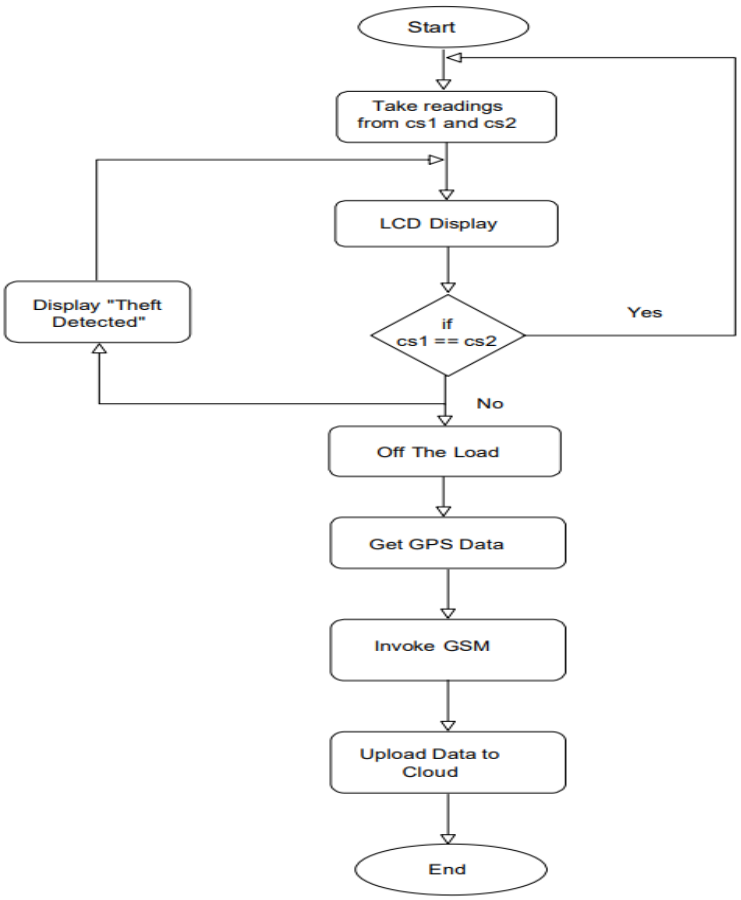

Fig – 2: Flow chart

The proposed model's flow chart is presented in Fig-2 and includes all the steps necessary to detect and track electricity theft. First, we obtain readings of the main supply (cs1) and the legal load (cs2), which are displayed on an LCD. If the difference between the two readings is minimal, we assume that no theft is

occurring. We repeat the reading process and display the results on the LCD. If the difference between the readings is significant, we conclude that theft is occurring between the main supply and the legal load. The relay opens the circuit to prevent further theft, and the controller uses a GPS module to determine the location of the theft. The system then notifies local authorities about the theft via GSM and uploads data, such as current values, the relay's status, and the coordinates of the theft location, to the cloud via a WIFI module.

1.Current sensor:

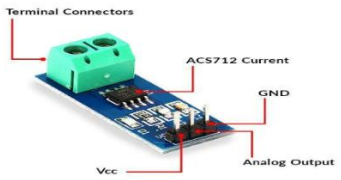

Fig-3: ACS712 current sensor

ACS712 current sensor detects and generates an electrical signal proportional to the electrical current in a wire or network, whether it is high or weak.

2.GSM SIM800L:

Fig-4: GSM SIM800L

A customized Global System for Mobile communication (GSM) module is designed for wireless radiation monitoring through Short Messaging Service (SMS). It provides two-way communication for data transmission, status query, and configuration setup. The module hardware consists of GSM module, voltage level shifter, SIM circuit and Atmega328P microcontroller. The firmware is responsible to handle task related to communication between device and host server.

3.Wi-Fi Module:

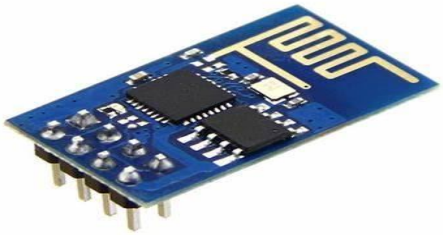

Fig-5: ESP-01 wifi module

The ESP8266 The ESP8266 ESP-01 is a Wi-Fi module that allows microcontrollers access to a Wi-Fi network. Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network.The ESP8266 module is an extremely cost-effective board.

4.GPS Module:

Fig-6: NEO-6M GPS module

GPS makes use of signals sent by satellites in space and ground stations on earth to accurately determine its position on earth. USART communication is used by the GPS to communicate with the micro controller. GPS receives information like longitude, latitude, UTC time etc. GPS receives information from the satellite in the form of NMEA string.

III. RESULT

Proposed minimizing and tracking of electricity theft system is designed using Arduino uno, WIFI module, GSM module, GPS module and current sensors. Many results has been extracted from the system to ensure the proper working and safety of the system. The below shown figures are the results that has been extracted for the implemented design

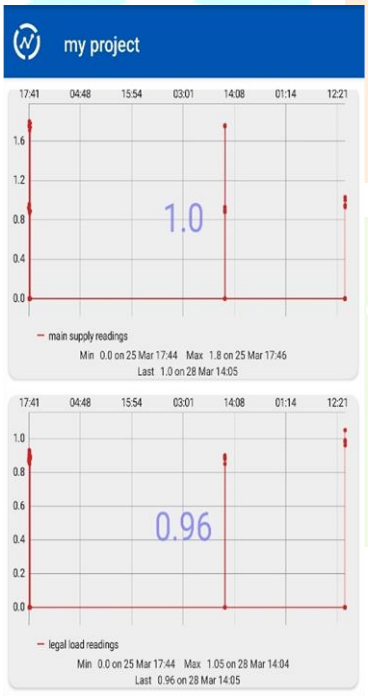

Fig-7.1: Results during legal load only load (1.0 is the reading of main supply(cs1) and 0.96 is the reading of legal load(cs2)

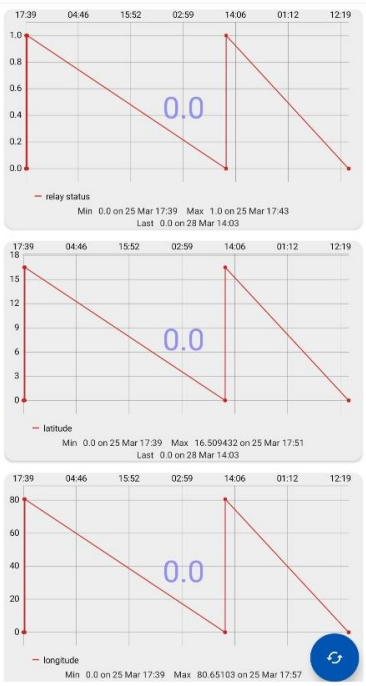

Fig-7.2: Results during legal only (Top graph shows the status of relay, middle shows latitude and bottom shows longitude)

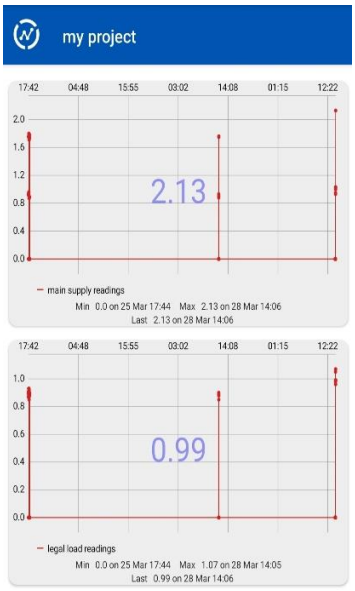

Fig-8.1: Results during legal load only
(1.0 is the reading of main supply(cs1) and 0.96 is the reading of legal load(cs2)

Fig-8.2: Results during legal only (Top graph shows the status of relay, middle shows latitude and bottom shows longitude)

IV. CONCLUSION

The main aim of the project is a minimizing and tracking of electricity theft system has been designed and developed with proper integration of the hardware. Without any human interface this system provides an effective and easy way to detect electrical theft. The use of IoT helps in achieving the numerous advantages of wireless network communications. Power theft is actually bypassing the energy meter but in our project we have indicated the theft by increasing the load also and this method is cost efficient.

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