



Integrated Power Theft Prevention and Electrical Transmission line Load Fault Analysis

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Abstract: The increasing demand for reliable and secure electrical power distribution has highlighted two major challenges faced by utility providers: power theft and faults in transmission line loads. Power theft not only results in significant economic losses but also affects the stability of the power grid, while undetected faults in transmission lines can lead to equipment damage, blackouts, and safety hazards. This research proposes an integrated system designed to simultaneously prevent power theft and manage electrical transmission line load faults, enhancing the overall efficiency and security of the power distribution network. The system employs a combination of smart sensors, microcontroller-based units, and technologies to monitor electrical parameters in real time. Any irregularities between recorded energy usage and actual consumption trigger alerts for suspected theft, while load imbalances, short circuits, or overloads on transmission lines are promptly detected and diagnosed. The system architecture supports automatic response mechanisms, including circuit isolation and fault indication, which reduce downtime and maintenance costs.

Keywords: Power Theft, overloads, overcurrent, microcontroller, transmission line.

I. INTRODUCTION

In today's rapidly advancing world, the demand for uninterrupted and reliable electrical power has become more crucial than ever. However, two significant challenges continue to threaten the efficiency and safety of power distribution systems: power theft and faults in transmission line loads. These issues not only lead to substantial economic losses but also pose risks to system stability and safety. Power theft remains a widespread problem, particularly in regions with limited monitoring infrastructure. It typically occurs through illegal tapping of power lines, meter tampering, or bypassing energy meters altogether. Such unauthorized consumption results in unaccounted losses for power suppliers, reduces the quality of service for genuine consumers, and complicates load forecasting and system planning. Despite various countermeasures, conventional detection systems often fall short due to their lack of real-time monitoring and limited automation.

On the other hand, the electrical transmission line load fault management system must address several technical anomalies that can compromise grid reliability. Among the most critical are voltage error, which can damage sensitive electrical equipment and lead to inefficient power delivery. Overcurrent and overload conditions, often caused by excessive demand or short circuits, can result in conductor heating, insulation failure, and even fire hazards. Overtemperature, typically due to prolonged overloading or environmental factors, accelerates the degradation of transmission components and increases the likelihood of system breakdowns. This research proposes an integrated system that combines power theft detection with real-time fault monitoring of transmission lines. By utilizing sensor-based data acquisition, microcontroller processing, the system aims to provide accurate, timely alerts for both unauthorized power usage and hazardous fault conditions.

II. METHODOLOGY

The architecture and working of the proposed system is explained in this section

Hardware Module:

- Step Down Transformer
- Arduino Nano
- ACS712 Current Sensor
- 16x2 LCD Display
- LM35 Temperature Sensor
- 5v Relay
- Buzzer and LEDs
- Potentiometer
- Diodes, capacitors, voltage regulators etc

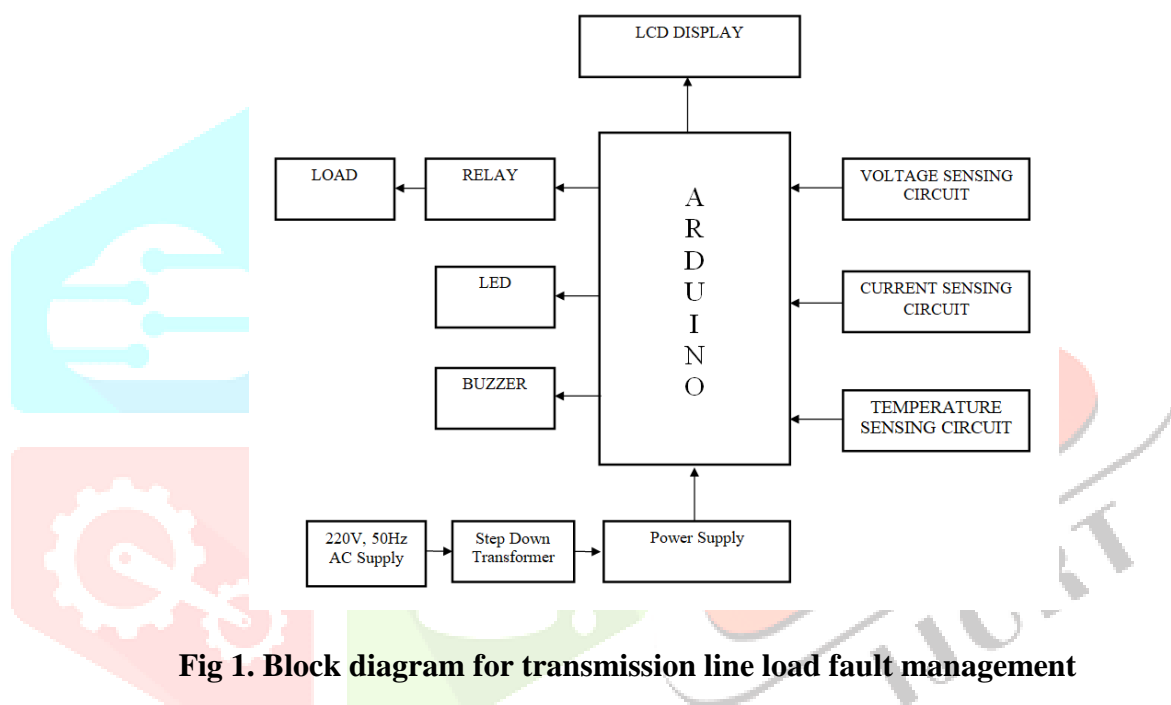


Fig 1. Block diagram for transmission line load fault management

The primary of the 230V AC transformer is connected to a variable AC input voltage (autotransformer), and the output is connected to a load which is usually electrical appliances such as bulbs, electric heater etc. At the primary side of the 230V AC transformer, a step down 12V AC transformer is rectified to a pure 5V DC and feed into the ADC pin of the microcontroller for monitoring the voltage of the transformer. At the secondary side of the transformer, a current sensor is connected in series between the load and the transformer secondary terminal for sensing, the load current, output of the current sensor is then feed to the microcontroller ADC pin for monitoring. Also there is used LM35 temperature sensor to detect the surface temperature of the transformer to prevent it from overheating. The LCD is used to display the transformer voltage, current and temperature, similarly the personal computer is used to display the transformer parameters for monitoring purpose. While monitoring the transformer parameters, whenever the load current exceeds the transformer rated current, the microcontroller detects an overcurrent faults and it sends a trip signal to the overcurrent relay, thereby protecting the transformer from blowing off. Moreover, when the autotransformer secondary is varied above the specific limit, the microcontroller detects an overvoltage faults and it sends a trip signal to the overvoltage protective relay, thereby protecting the transformer and the loads from blowing off.

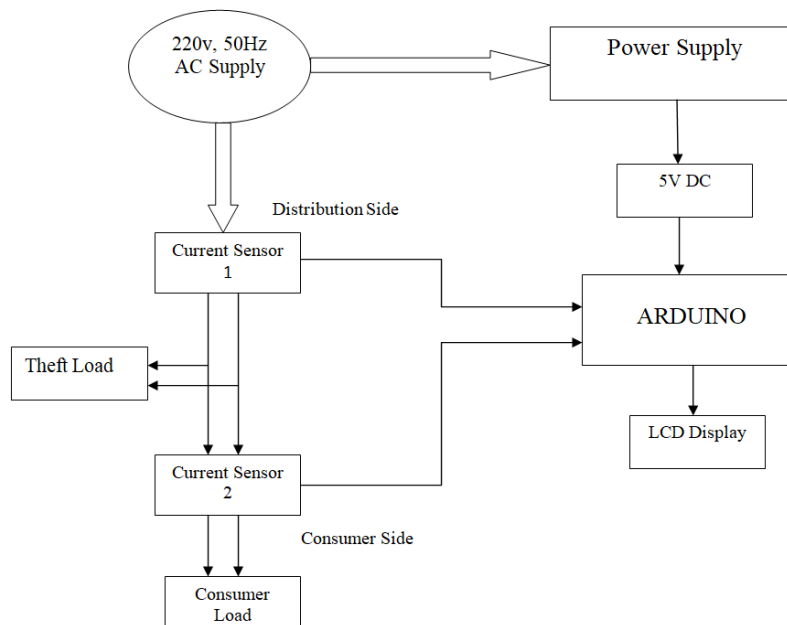


Fig 2. Block diagram for power theft detection

The working procedure of the ‘Power Theft Identification System of Distribution Lines Using Differential Power Measurement is explained below. This project is designed to find out such power theft in the normal distribution lines. In this project we use differential protection scheme. The Differential protection scheme consist of two CS’s (Current Sensors, **used here as CTs**) connected at both the terminals of the load. If there is no fault in the load then the secondary currents of both the CT’s will be same. So, by using same principle one CT is connected at the starting of the distribution line and the remaining other CT’s are connected to the different legal loads. If there is no power theft in the line then the vector sum of the all CT’s which are connected to the loads will be equal to the current in the main CT. If there is a difference then there is a power theft or any fault in the line. This can be simply understand by its Block Diagram

III. FLOW CHART

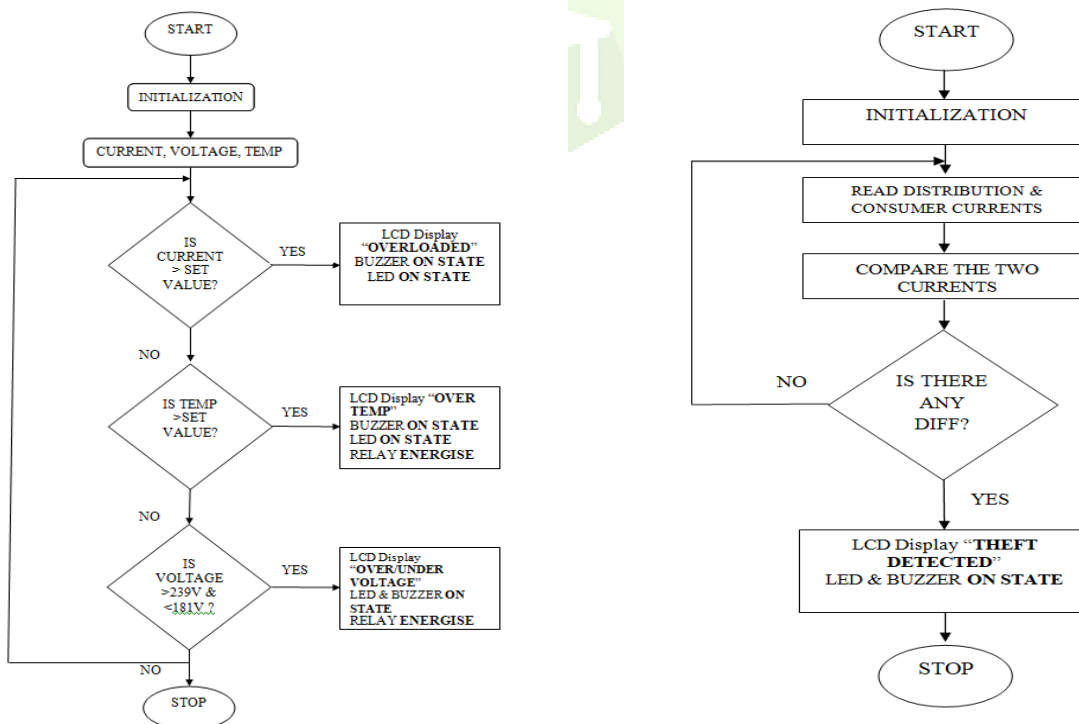


Fig 3. Flow chart for both transmission line fault management and power theft detection

IV. RESULT AND SIMULATION

1. Voltage Error

Hrs. in a day	Hardware Results	Software Results	State of Relay/Buzzer	LCD Shows
2	210.1	212.2	OFF	
4	230.4	229	OFF	
6	201.6	197.9	OFF	
8	230.2	227.4	OFF	
10	190.6	189.3	OFF	
12	180.7	180.0	ON	UNDER VOLTAGE
14	170.6	170.1	ON	UNDER VOLTAGE
16	211.8	210.7	OFF	
18	221.5	222.8	OFF	
20	241.5	242.1	ON	OVER VOLTAGE
22	245.5	247.3	ON	OVER VOLTAGE
24	249.5	251.5	ON	OVER VOLTAGE

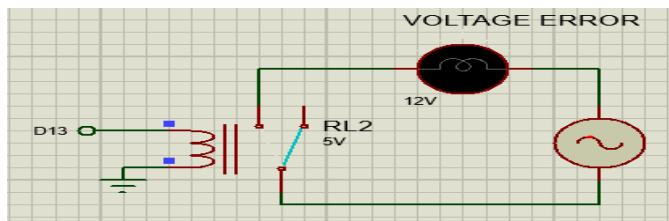
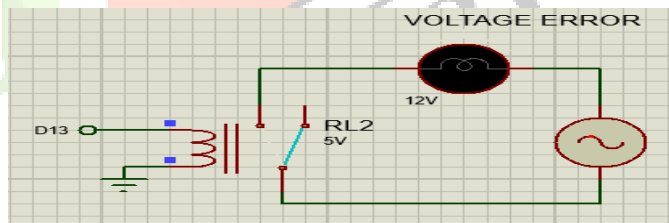
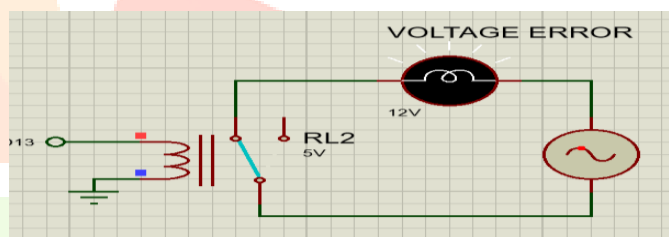


Fig 6. Voltage error Result in both Hardware and Software

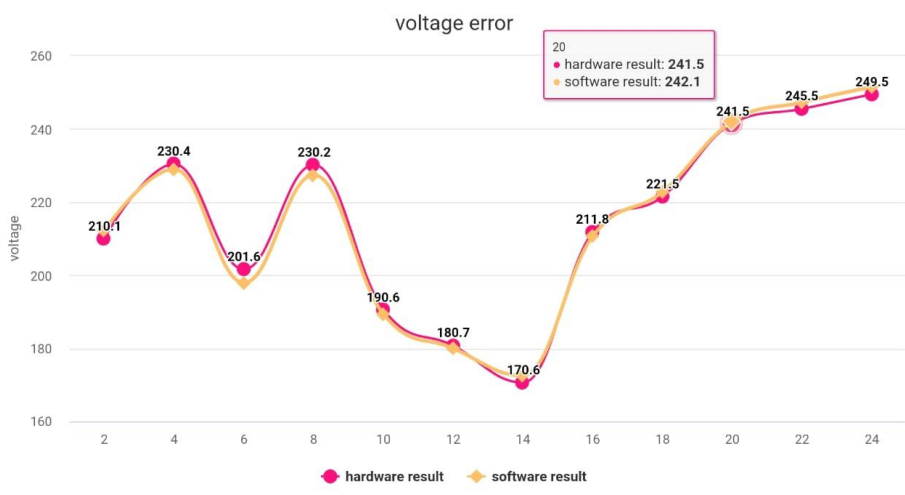


Fig 7 voltage error graph of both hardware and software

2. Overloading

No. of Loads	Hardware Result	Software Result	State of Led/Buzzer	LCD Shows
0 Watt	0.03 A	0.00 A	OFF	
9 Watt	0.13 A	0.04 A	OFF	
29 Watt	0.17 A	0.14 A	OFF	
89 Watt	0.39 A	0.42 A	OFF	
189 Watt	0.80 A	0.90 A	ON	OVERLOADED

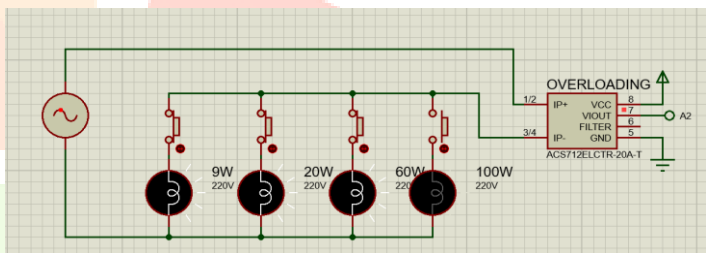


Fig 8. Overloading Result in both Hardware and Software

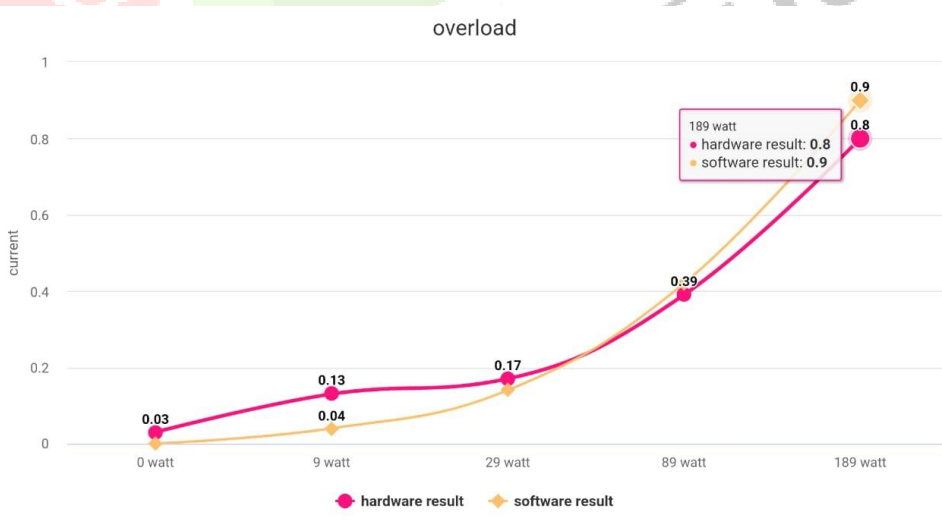


Fig 9 overloading graph of both hardware and software

3. Over temperature

O/P Voltage	Hardware Result	Software Result	State of Relay/Buzzer	LCD Shows
0.20 V	22.7	20	OFF	
0.25 V	25.8	25	OFF	
0.35 V	35.9	35	OFF	
0.45 V	45.8	45	OFF	
0.52 V	52.1	52	ON	OVER TEMPERATURE

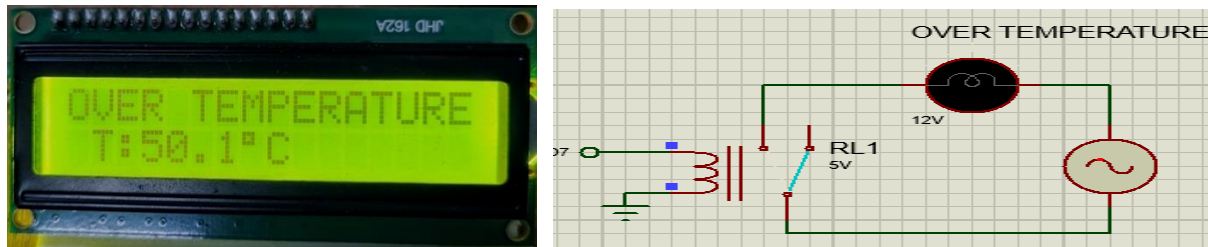


Fig 10. Over temperature Result in both Hardware and Software

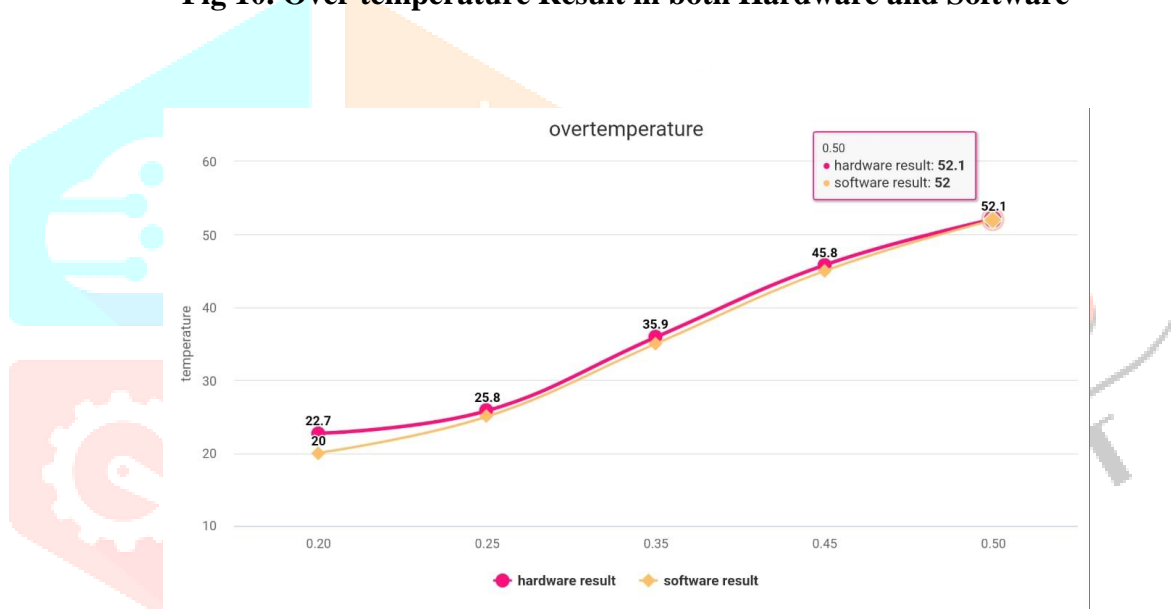


Fig 11. Over temperature graph of both hardware and software

4. Power Theft

No of Loads	Hardware Result		Software Result		Theft Load	Distribution Current		State Of Buzzer/LED	LCD shows
	Dist	Cons	Dist	Cons		Hardware	Software		
0 watt	0.00	0.00	0.00	0.00	OFF	0.00	0.00	OFF	Normal Loaded
0 watt	0.00	0.00	0.00	0.00	20 Watt	0.09	0.09	ON	Theft Detected
20 watt	0.10	0.10	0.09	0.09	OFF	0.09	.0.9	OFF	Normal Loaded
20 watt	0.10	0.10	0.09	0.09	60 Watt	0.34	0.36	ON	Theft Detected
60 watt	0.27	0.27	0.27	0.26	OFF	0.27	0.26	OFF	Normal Loaded
60 Watt	0.27	0.27	0.27	0.26	100 Watt	0.68	0.69	ON	Theft Detected
100 watt	0.44	0.44	0.45	0.45	OFF	0.44	0.45	OFF	Normal Loaded
100	0.44	0.44	0.45	0.45	200	1.17	1.18	ON	Theft

watt					watt				Detected
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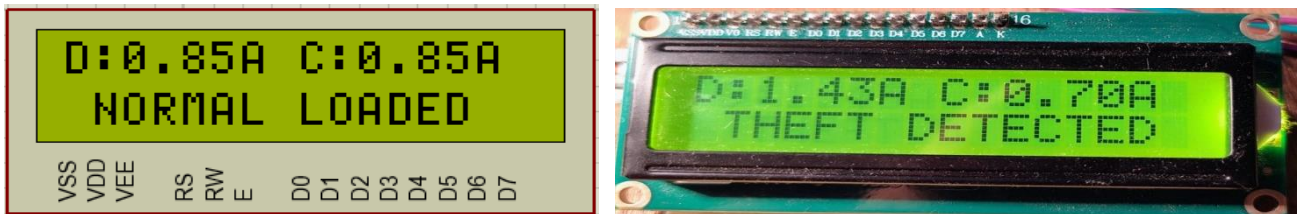


Fig 12. Power theft detection Result of both hardware and software

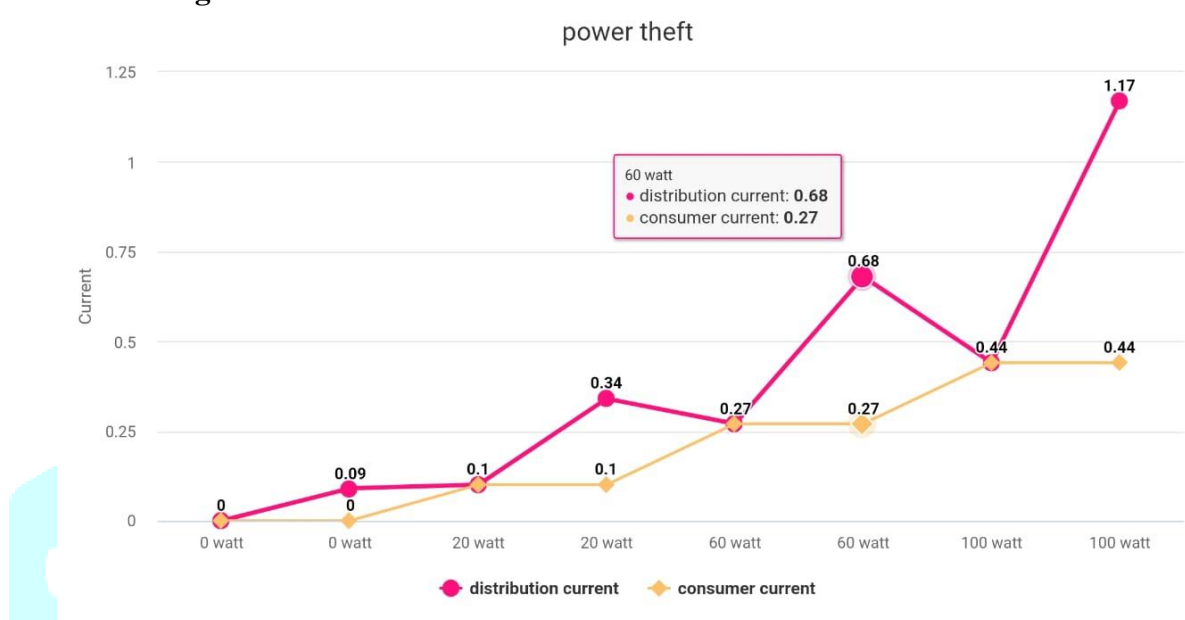


Fig 13. Power theft detection graph of both hardware and software

V. CONCLUSION

This project has successfully demonstrated the feasibility and effectiveness of a comprehensive transmission line load fault management system specifically designed to address the critical challenges of Transmission Line Protection conditions. The system incorporates a robust power theft detection mechanism, which plays a crucial role in enhancing the overall security and reliability of the power distribution network. By continuously monitoring the transmission line operating parameters and promptly detecting and responding to fault events, the system effectively mitigates the risk of equipment damage, service interruptions, and potential safety hazards. The integrated power theft detection capabilities not only deter unauthorized energy consumption but also contribute to significant financial savings for the utility provider. The successful implementation of this protection system demonstrates a significant advancement in ensuring the safe, efficient, and reliable operation of transformers within the power grid.

VI. ACKNOWLEDGMENT

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REFERENCES

- [1] Power Theft Indication using Smart Transformer Protection System.
By: PrajaktaDambhare, ShivamNalamwar, Prof Mayur Pote
- [2] IoT based-Transformer power theft detection and protection
By: Sridhar S, Bharath H, Vishvesh V, Gowtham K V
- [3] GSM based transformer theft protection and monitoring system
By: Abrar Fahim, Muhtasim Alam Choudhary, Md. Ferdosh Alam, Fazle Ehali

[4] IoT Based Electricity Theft Detection and Monitoring

By: Aaditya Nandrekar, Amar Pawar, Prachoday Sutar, Aakanksha Kadam, Amit Jadhav

[5] IoT Based Single Phase Distribution Line Monitoring and Theft Detection

By: Santosh Kumar, Anurag Singh, Mayank Sharma, Sumit Singh, Shivrani

[6] Principles of power system by VK Mehta, Rohit Mehta

[7] Electricity sector India, En.wikipedia.org/wiki/theft_of_electricity.

[8] Tariff details domestic:

<https://www.bijlibachao.com/news/domestic-electricity-lt-tariff-slabs-and-rates-for-all-states-in-india-in-2015.html>

Tariff details commercial:

<https://www.bijlibachao.com/news/commercial-electricity-tariff-slabs-and-rates-for-all-states-in-india-in-2015.html>

