IOT based Power Theft Detection and Time based Load Scheduling

N. Mohana Sundaram, J. Priyadharshini, S. Sanjitha and S. Vishnukumar

Abstract--- *Power theft is an increased problem in the world, particularly in India where electricity is illegally stealth by various intruders. This needs to be identified to avoid the unwanted power consumption and cost utility. As a solution the IOT based wireless power theft detection system is proposed in this project. The system consists of multiple smart wireless consumer sensor node and pole sensor node where the illegal use of the electricity is detected using IOT module and the information is sent to the E.B office. This design incorporates effective solutions for problems faced by India's electricity distribution system such as power theft. The presently the off peak loads & on peak loads have faced a challenge in power system operation, especially in terms of economic load control. The aim of the proposed time based load scheduling is to minimise the peak hourly load in order to achieve an optimal (balanced) daily load schedule. In this proposed scheme the load scheduling is automatically by a newly designed smart app. Which supports the TOD tariff structure based on the tariff data fed into app, the model facilitates the consumer control the load operation of desired time. This turns the electricity bill of the consumers leading to economic advantages. The overall evaluation of the proposed work is implemented in the Proteus simulation environment from which it is proved that the proposed research work leads to provide better result than the existing research methodology in terms of better identification of power theft.*

Keywords--- *Power Theft, Sensor Nodes, Electricity, Load Level, Peak Load.*

I. INTRODUCTION

Wireless electricity theft detection system using IOT module present an efficient and less costly way to adulterate the wireless technique used in this project. This wireless system is used to overcome the theft of electricity via sensors and hence it also controls the revenue losses and utility of the electricity authorized agency [1]. There is always a contract between the consumer and the supplier that the consumer will pay for the electricity consumed by him. But in India near about 32 % of the electricity is consumed but not paid for it i.e. it is being stolen by the consumer hence the need of a system arises that would overcome this theft of electricity. Mainly this system consists of microcontroller, sensors and IOT module to check for the theft of electricity and then to send a message to the authorized agency which looks after the electricity consumed. The wireless technique used in this system provides the major advantages such as low power consumption and also the low cost of the IOT module [2].

High peak demands are common occurrences in electricity market. Recently, reducing electricity demand has been one of the most common objectives for all electricity suppliers, environmental organizations and others at the national and international level. Peak demands make it difficult to meet the increased demand of electricity, to lower

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prices, to increase quality and to avoid negative impacts on the environment. A scheme that allows consumers to moderate own demand will reduce the electricity peak demands. This project describes and delineates the scheme of averting peak demands by automatic controlling of the load at consumer side through an smart app to enable electricity users to effectively manage and control own demand based on information. Adequately managing and controlling energy demands shall lead to enhanced system performance. The scheme is contributing towards achieving a Smart Grid environment.

The overall organization of the research work is given as follows: In the section 2, various related research works which are conducted towards finding the power theft are discussed. In section 3, detailed discussion of the proposed research methodology along with suitable examples and circuit diagram is explained. In section 4, simulation results are discussed with the consideration of efficient identification of power theft details. Finally in section 5, overall conclusion of the research work is given based on the simulation scenario.

II. RELATED WORKS

In [3], they said that wireless electricity theft detection system using Zigbee technology present an efficient and less costly way to adulterate the wireless technique used in this research paper. This wireless system is used to overcome the theft of electricity via bypassing the energy meter and hence it also controls the revenue losses and utility of the electricity authorized agency. In [4], they provide insight into the illegal use or abstraction of electricity in the Netherlands. The importance and the economic aspects of theft detection are presented and the current practices and experiences are discussed. The paper also proposes a novel methodology for automated detection of illegal utilization of electricity in the future distribution networks equipped with smart metering infrastructure. The necessary data requirements for smart meters and distribution substations are defined, in order to unlock this feature in distribution network.

In [5] they described that Electrical power theft detection system is used to detect an unauthorized tapping on distribution lines. Implementation area of this system is a distribution network of electrical power supply system. Existing system is notable to identify the exact location of tapping. This system actually finds out on which electrical line there is a tapping. This is a real time system.

Wireless data transmission and receiving technique is used. This will protect distribution network from power theft done by tapping. In the recent past, several techniques were proposed for detecting the location of direct tapping on a feeder and identifying illegal consumers. [6]

The paper uses the approach based on power line communication principle which is use for detecting theft in electricity. A high frequency signal is introduced in the distribution network which changes its amplitude and frequency as the load in the lines increases or decreases.

The changes will be detected through the gain detectors if any illegal connection is made between the poles then there will be modification in the values of gain and through which the illegal connection in the electricity will be discovered and proper action will be taken by the authorities to neutralize such connection but this approach is not tried for the theft detection for the customers illegal use and it is infrastructure based.

[7] Uses the concept of customer's historic usage pattern of electricity to create the user load profiling information which is used to detect the unusual flow of electricity and thus provides the class of customers which could be further synthesized to detect possible fraud customers. The paper uses many concepts like Extreme Learning Machine, Support Vector Machine. [8].

States the idea of computational techniques to classify the electricity consumption profiles of users. The paper uses two-step process to reach to the results.

Firstly the c means based on fuzzy clustering, is performed to find customers with similar usage profiles and then fuzzy classification is executed on the fuzzy cluster values and fraud matrix values using distance based approach. Then the gradation is done on the bases of the deflection. [9] The paper uses the Atkinson index approach for measuring the ill outcomes. As Atkinson index is mainly associated with the distribution of quantities over a spread in terms of income.

This approach with the help of the concepts like relative Lorenz curve is used to apply the Atkinson index efficiently to measure the values like pollution. [10] The paper shows that the Atkinson Index is still the best way to find out the in-equality in distribution of the particular values. The Gini index is also a nice method but it has flaws like in inequality interpretation there are values where calculation of Gini index is not convenient and causes computational problems

III. POWER THEFT DETECTION USING SENSOR BASED SYSTEM

In practice, Wireless detection of power theft is available at consumer end, but the transmission of data is slow and the wireless communication over very long distances is not possible.The existing method of power theft can't be find exact location of power theft.

It can be used to detect only the power theft. The power theft monitoring is an important research in electric power system and electricity stealing prevention became a big problem to the electricity. In the proposed research methodology power theft detection is concentrated which attempts to detect the power stealing using sensor nodes and as well as concentrate on load level to avoid the system failure.

The modules involved in the proposed system are listed as follows:

1) Power theft identification
2) Load balanced scheduling

3.1. Power Theft Identification

Electricity stealing is a long term problem; however each power supply department has me huge investments of manpower and material, the phenomenon of defending stealing electricity has increased and not abated and the method of electricity stealing is continuously improved. The behaviour of electricity stealing not only makes the power industry suffering huge financial losses but also threatens the main power supply security and reliability. In this proposed system sensors such as consumer sensor and pole sensor is employed to detect the power theft at the exact location and the information such as energy consumed by the consumer and the power theft status is sent to the E.B office through IOT so that the data transmission is at high speed and regular update of the data is possible.

The block diagram of power theft module is listed as follows:

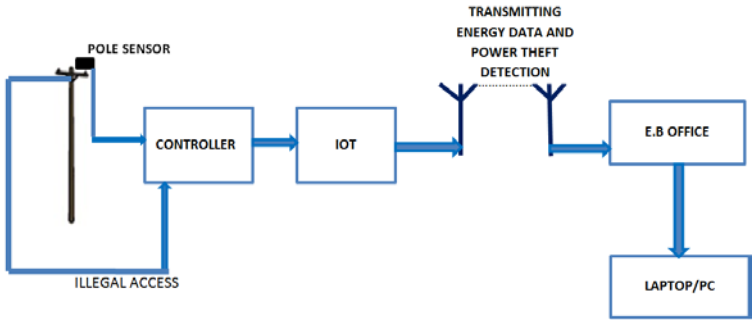

Figure 1: Power Theft Detection

In the above figure 1, pole sensor is used to sense the current distributed to the pole from E.B office. The controller at pole sensor node is used to compare the reference current with the actual current consumed at that time and the information is sent to E.B office. The information from the controller is sent to the E.B office by means of serial communication through IOT

3.2. Proposed Method for Load Scheduling

We are implementing the peak time load based app setting. It can be operate the heavy load automatically under normal condition of power. Real-time scheduling allows managing the execution of tasks on processors under timing constraints. In more general terms, real-time scheduling can be seen as the discipline of allocating resources over time to a set of time-consuming tasks, so that given timing constraints are satisfied. However, in this more general formulation, resources may not necessarily be processors or computing devices. In fact, real-time scheduling techniques are also applied to communication systems, where real-time algorithms are used to schedule sets of messages over a communication channel.

In this case, an analogy holds between computing tasks and messages, as well as between processors and communication channels. The meaning of “available bandwidth” changes depending on the particular context, referring to the channel capacity in communication systems, and to processor’s computing time in computing systems. Finally, timing constraints are enforced on the execution times in one case, and (typically) on message’s end-to-end latency in the other. In other words, a real-time task must be guaranteed to terminate its execution before its deadline, while a message must be delivered to the receiver within the given time limit. This analogy allows extending to communication networks many results that have been originally developed for real-time computing systems, and vice versa. The block diagram of load balanced schedule is depicted in the following figure 2.

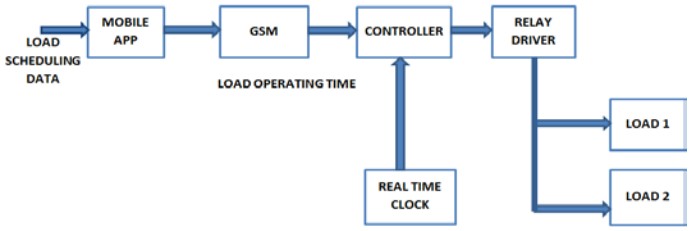

Figure 2: Load Scheduling

In the above figure 2, mobile app is designed to set the load operating time to control the load at peak hours. Global System For Mobile Communication (GSM) is used to receive the data from the smart app over very long distances and sends it to the controller. Controller compares the data received from the GSM with the RTC and based on the results it sends signals to the relay driver. After receiving the signals, relay driver switches the load at the consumer end.

3.3. Circuit Diagrams for power Theft Detection

In this section circuit diagram proposed sensor modules are depicted with detailed explanation.

3.3.1. Consumer Sensor Node

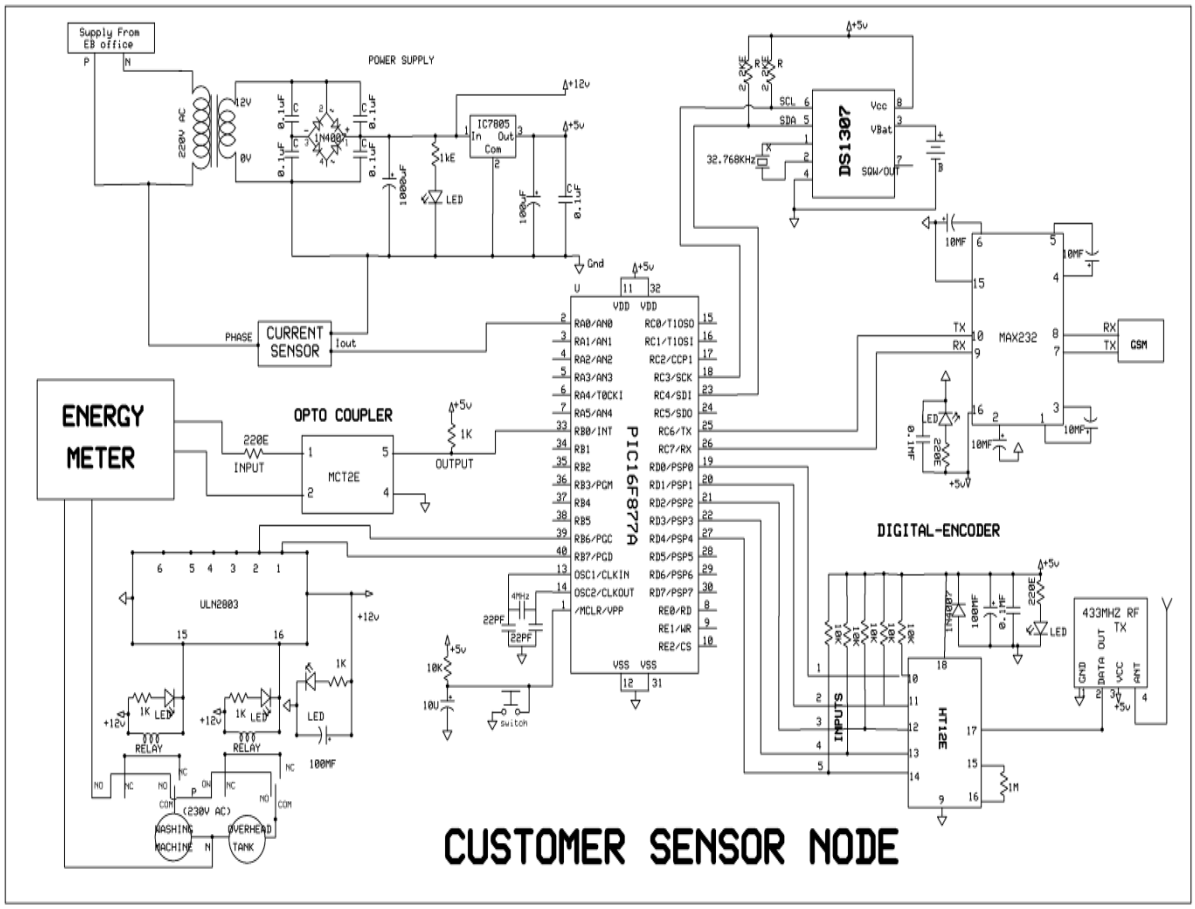

Figure 3:Circuit Diagram for Power theft Detection

The two input data such as current and energy is given to the microcontroller in the consumer sensor node. Current in the analogue form is given as input to the microcontroller and it converts the analogue data into the digital form by means of inbuilt A/D Converter. The energy consumed by the consumer is gives as input in the digital form to the controller and the opto coupler is used to provide the electrical isolation between energy meter and controller. The data received in the microcontroller is encoded in the 4 bit encoder and a serial data is transmitted to the RF Transmitter. Through the RF Transmitter the data is sent to the pole sensor node.

3.3.2. Pole Sensor Node

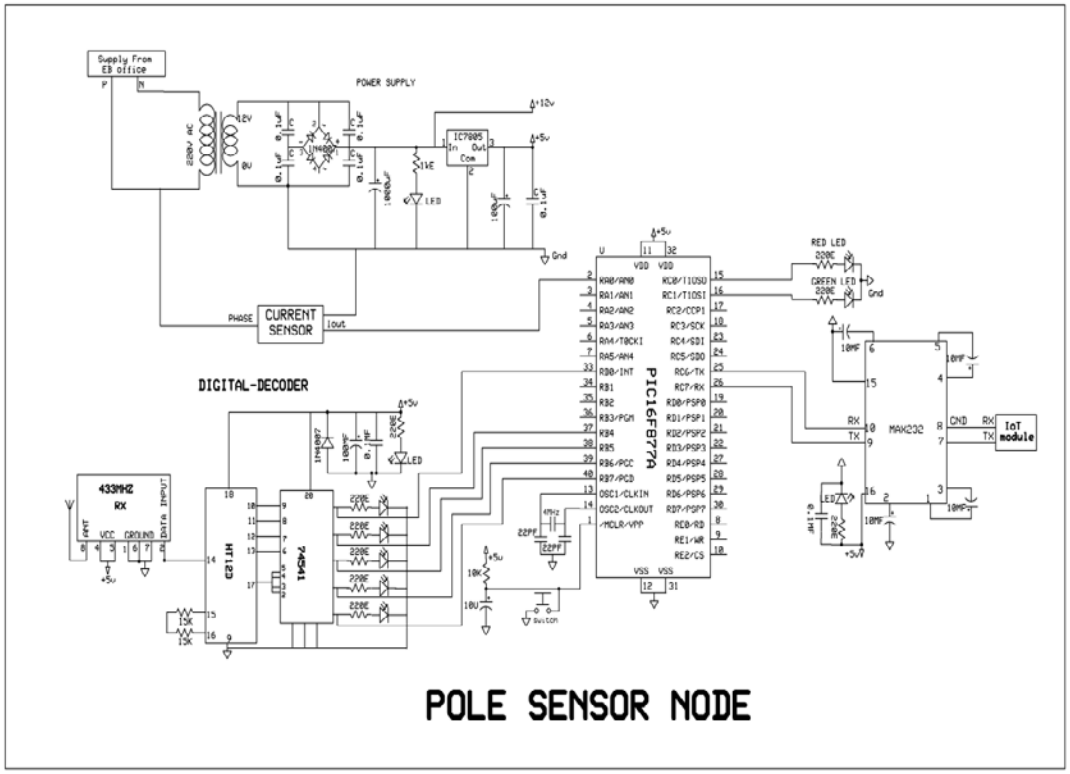

Figure 4: Pole Sensor Node

In the pole sensor node, the data from the consumer sensor node is received through the RF receiver in the serial form and it is given to the 4 bit decoder. The decoder decodes the serial data into the original data and the information is sent to the controller.

A current sensor is used at the pole to sense the pole current and it is given as input to the controller. The information of illegal access data is also sent to the controller. Based on the input data the controller compares the pole current with the actual current consumed. If the pole current is higher than the actual current then microcontroller will indicate there is no power theft and if the actual current is more than the pole current then it will indicate power theft. All the information from the pole sensor node and the consumer sensor node is transmitted to the E.B OFFICE through IOT by means of level translator.

IV. SIMULATION RESULTS

Proteus (processor for text Easy to use) is a fully functional, procedural programming language created in 1998 by Simone Zanella.Proteus incorporates many functions derived from several other languages: C, BASIC, Assembly, Clipper/dBase; it is especially versatile in dealing with strings, having hundreds of dedicated functions; this makes it one of the richest languages for text manipulation. Proteus owes its name to a Greek god of the sea (Proteus), who took care of Neptune's crowd and gave responses; he was renowned for being able to transform himself, assuming different shapes. Transforming data from one form to another is the main usage of this language.

The proposed method namely IOT based Power Theft detection and Time based Load scheduling (IOT-PTD-TLS) is implemented in the proteus simulation environment. In the following figure 5 and 6 hardware view of pole sensor node and simulation view of mobile app user interface is depicted.

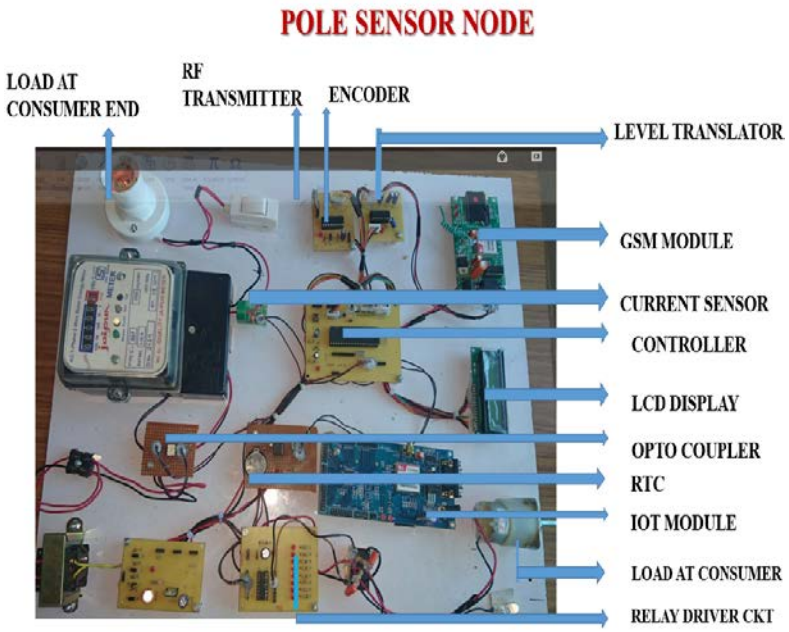

Figure 5: Picture of Hardware Prototype

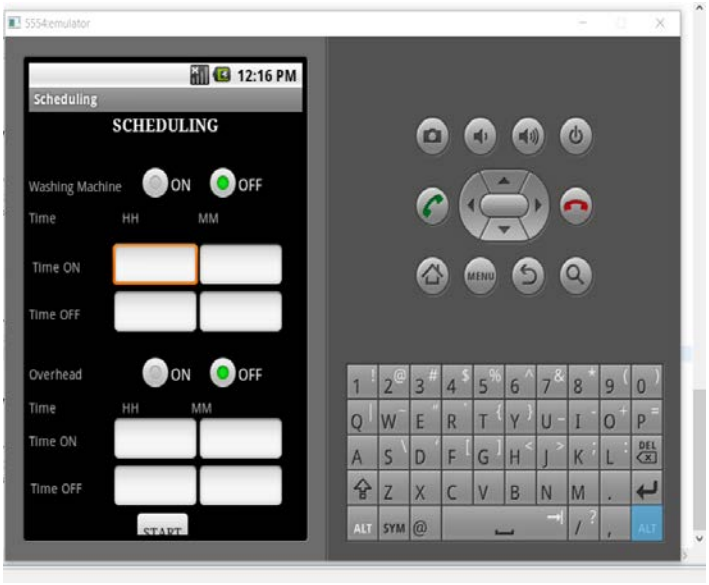

Figure 6: Mobile app simulation

The performance measure that are considered in this work for evaluation of the simulation results are detection time and detection accuracy which is good in proposed research methodology than the existing research methodology. The existing methods that are considered in this work for comparison are, “Residential load Monitoring (RLM) [11] and electricity distribution efficiency (EDE)” [12].

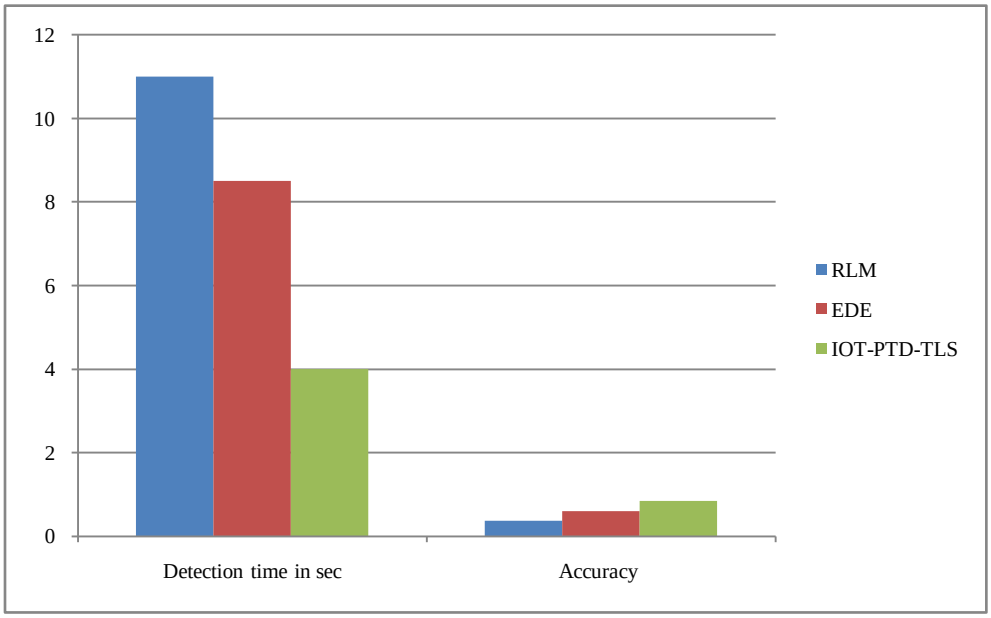

Figure 7: Performance Comparison

In figure 7, comparison evaluation of proposed an existing research methods in terms of detection time and accuracy is given. From this figure it is proved that the proposed method is better than the existing methods in terms of reduced detection time and the increase accuracy rate.

V. CONCLUSION

The proposed system of power theft detection weighs more advantage than other existing methods, owing to its smart and wireless implementation. In this project, the concept of power theft detection is done using Customer Sensor Nodes and Pole Sensor Nodes, placed at the desired poles. These sensors in combination with IOT Module, senses any excess current drawn from that location and sends a warning information to the EB office immediately. This idea has been simulated and tested using PROTEUS Software and the hardware model is also designed for the same. For load scheduling automation, a novel and user-friendly app has been created. This app, when fed with the load controlling data, controls the load from remote end. This kind of automation system, results in efficient controlling of load during peak hour demands and also helps for electricity bill saving. In the further scenario following actions can be carried out, “The IOT based power theft detection can be further extended to detect the power theft at the exact location to reduce the revenue losses, The Time Based Load Scheduling with the TOD tariff structure can be combined with automatic billing system”.

REFERENCES

[1] V. Pandey, S.S. Gill and A. Sharma, “Wireless electricity theft detection system using ZigBee technology”, International Journal on Recent and Innovation Trends in Computing and Communication, Vol. 1, No. 4, Pp. 364-367, 2013.

[2] P. Kadurek, J. Blom, J.F.G. Cobben and W.L. Kling, “Theft detection and smart metering practices and expectations in the Netherlands”, Innovative Smart Grid Technologies Conference Europe (ISGT Europe), Pp. 1-6, 2010.

[3] S. Patil, G. Pawaskar and K. Patil, "Electrical power theft detection and wireless meter reading", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, No. 4, Pp. 1114-1119, 2013.
[4] A.V. Christopher, G. Swaminathan, M. Subramanian and P. Thangaraj, "Distribution line monitoring system for the detection of power theft using power line communication", IEEE Conference on Energy Conversion (CENCON), Pp. 55-60, 2014.
[5] D. Dangar and S.K. Joshi, "Electricity Theft Detection Techniques For Distribution System In Guvnl", International Journal of Engineering Development And Research Ijedr (Two Day National Conference), 2014.
[6] E.W.S. Angelos, O.R. Saavedra, O.A.C. Cortés and A.N. De Souza, "Detection and identification of abnormalities in customer consumptions in power distribution systems", IEEE Transactions on Power Delivery, Vol. 26, No. 4, Pp. 2436-2442, 2011.
[7] G. Sheriff and K. Maguire, "Ranking Distributions of Environmental Outcomes Across Population Groups", National Center for environmental economics, 2013.
[8] J. Creedy, "Interpreting inequality measures and changes in inequality", New Zealand Economic Papers, Vol. 50, No. 2, Pp. 177-192, 2016.
[9] S. Rengarajan and S. Loganathan, "Power theft prevention and power quality improvement using fuzzy logic", Vol. 1, No. 3, Pp. 2231-5284, 2012.
[10] S. Sahoo, D. Nikovski, T. Muso and K. Tsuru, "Electricity theft detection using smart meter data", In Innovative Smart Grid Technologies Conference (ISGT), IEEE Power & Energy Society, Pp. 1-5, 2015.
[11] A.H. Mohsenian-Rad and A. Leon-Garcia, "Optimal residential load control with price prediction in real-time electricity pricing environments", IEEE transactions on Smart Grid, Vol. 1, No. 2, Pp. 120-133, 2010.
[12] A. Pyasi and V. Verma, "Improvement in electricity distribution efficiency to mitigate pollution IEEE ISEE", IEEE International Symposium on Electronics and the Environment, Pp. 1-1, 2008.

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