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DESIGN OF INTELLIGENT ELECTRICITY-THEFT MONITORING SYSTEM USING MATLAB

ROHIT KUMAR[1], SUDHA ARORA[1], SUNIL SINGH[1] and ABHISHEK TOMAR[2]
[1]Department of Electrical Engineering, [2]Department of Electronics and Communication Engineering
G.B. Pant University of Agriculture & Technology, Pantnagar, US Nagar, Uttarakhand, INDIA

Abstract— Electricit-theft is a major challenge in electricity distribution system. Electricity-theft are non-technical losses in the distribution network which includes a major portion of pilferage, theft and un-authorized use of electricity. This work describes the design of Electricity theft identification system using wireless module to track and minimize electricity theft. The unit compares the incoming power from pole to the meter and power transferred from meter to the load line. The microprocessor compares the difference between the incoming and outgoing power, it activates the wireless module which then sends wireless data to nearest substation, having customer details. Each area under one sub-station is divided into several zones as per distribution transformers and sensing units are also placed at each distribution transformer. Now the utility have the zone-wise data of all the consumers and the total consumption at the zone-level. The data at the utility level is computed through compatible softwares such as MATLAB in the present system and if the difference exceeds the tolerance value, the theft is detected and notifications containing appropriated location details will be sent to the officials for proper electricity-theft rectification. The proposed system also detects the short circuit fault, ground fault, and overloading condition.

Index Terms— Electricity theft, pilferage, microprocessor, MATLAB, smart algorithm, current sensing modules, operational amplifier, meter bypassing & tempering.

I INTRODUCTION

THE demand of electricity is increasing day by day in the India and the world. Consumer dishonesty is a problem faced by all power corporations. Electricity Suppliers Companies are having large amount of monetary loss due to electricity wastage and theft by consumers. Electricity theft is defined as the use of electric power without paying the bill amount. Detection of electricity theft is very difficult and requires continuous monitoring to reduce fraud. Electricity can be fraudulently accessed through illegal hook-ups, meter tampering or bypass, billing irregularities and unpaid bills. Distributed Power utilized by consumer from electricity theft and other customer unlawful act are termed as Non-technical Losses.

Indian electricity distribution system has several un-authorized consumers, who use various methods such as meter bypassing & tampering, double feeding the meter, and missing neutral condition for domestic and commercial power theft.

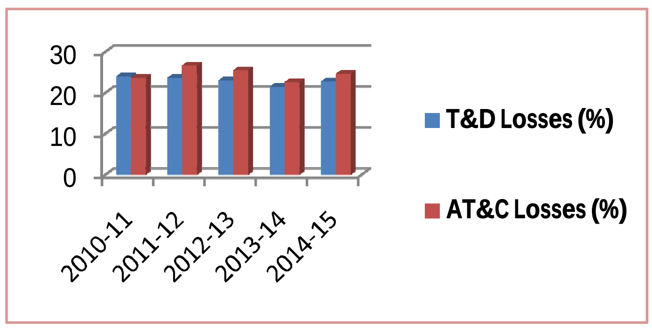

Figure 1 T&D and AT&C Losses in India(%) [14]

Electricity theft can be estimated but not measured exactly. Hoever, power-theft can be accurately estimated with a thorough analysis of the Power System. The standard method for detemining electricity theft is by analysis of transmission and Distribution losses (T&D losses). Electricity-theft can occur in the form of illegal connections , meter tampering, , billing irregularities and unpaid bills. From a economic perspective, electricity theft results in huge losses to the Utility. The impact of theft in the worst cases are important to be known for the via-

- *Rohit Kumar is currently pursuing masters degree program in electric energy systems under Department of Electrical Engineering,G.B. Pant University of Agriculture & Technology, Pantnagar, US Nagar, Uttarakhand, INDIA. E-mail: kumar_rohit31416@yahoo.co.in*
- *Sudha Arora is Professor & Head of Electrical Engineering Department, G.B. Pant University of Agriculture & Technology, Pantnagar, US Nagar, Uttarakhand, INDIA.*
- *Sunil Singh is Assistant Professor of Department of Electrical Engineering,G.B. Pant University of Agriculture & Technology, Pantnagar, US Nagar, Uttarakhand, INDIA.*
- *Abhishek Tomar is Assistant Professor of Department of Electronics and Communicationl Engineering,G.B. Pant University of Agriculture & Technology, Pantnagar, US Nagar, Uttarakhand, INDIA.*

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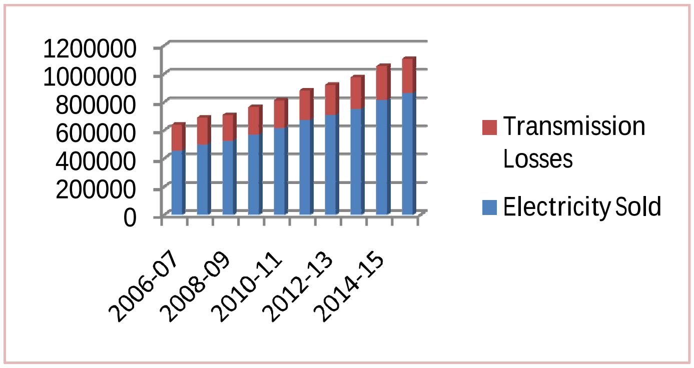


Figure 2 Electricity sold and transmission losses in India in Giga watt hours (GWh)[15]

The agregate Losses in some distribution systems have serious impacts forcing the Utilities to operate at a loss and continually rising electricity charges. Therefore, for economic considerations it is important to minimize electricity-theft.

II METHODOLOGY

The unit mainly deals with the values of current. We have installed two sensing modules one before and one after the meter. One measures the incoming current while the other measures the out coming. In an ideal case, there will be no difference in the values. If there is a considerable difference in the two values, it means there is tampering in the incoming supply and the microcontroller activates the GSM module thereby sending a message to the nearby substation giving the relevant information like meter number, site address etc. With this device it is also possible to cut the supply.

Traditional electronic meters deal with both current and voltage values while our meter deals with the values of current. Secondly we can detect the tampering instantaneously and therefore the authorities can take immediate action. Next we can also stop the supply from the particular site from the substation. Lastly and the most important our device is very much cost effective.

SYSTEM DESIGN

The design of the proposed system consists of the hardware design and software design.

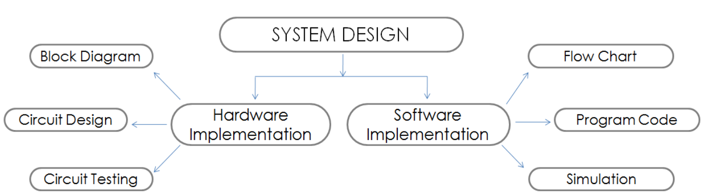


Figure 3 Design process of theft detection system

MODULE COMPOSITION

The unit model consists of the following components:

(A) SENSING MODULE: We have used two sensing modules. Each sensing module consist of one INA148 one OPA 277and one OPA177. One such module is applied at pole (from where the connection is coming to the house) to sense the total current which is coming to house and another current sensing module is applied at just after the output of energy meter in order to sense the total amount of current which is passing through energy meter. To sense the value of current we have used one 5 milliohm resistor, which is inserted at phase wire. The value of current in the phase wire is decided by voltage drop across 5milliohm resistor.

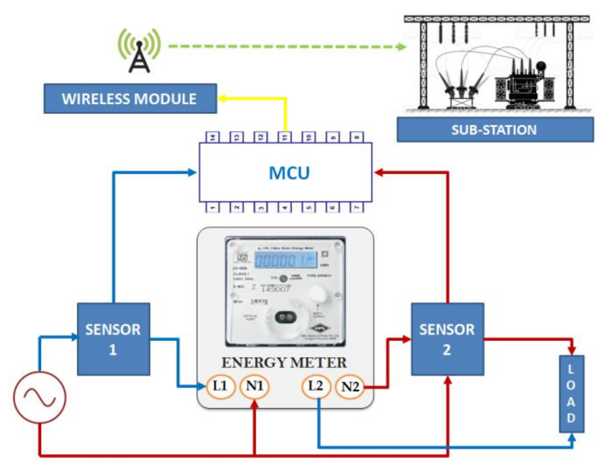
(B) MICROCONTROLLER MSP430: The output of both the current sensing modules is fed to two channels of ADC12 of MSP430. Then value of current through both the current sensing modules is calculated using appropriate logic and microcontroller activates GSM module to send further information to the Base Station.

(C) GSM MODULE: It is connect to MSP430 using UART port and sends data to utility data center.

(D) USED ANALOG IC'S

- The IC INA148 is differential amplifier, which senses the voltage across 5 milliohm resistor.
- The IC OPA277 is precision amplifier, which is used for amplifying the output of INA148.
- The IC OPA177 is used as an active peak detector, which detects the peak output.

Figure 4 Proposed Module



SOFTWARE UTILIZED

We have used the following softwares for our system design:

(A) Code Composer Studio V4 to write code for MSP430

(B) TINA for simulation purpose. This software is developed by Texas instruments, used to simulate electronic circuits for real data characteristics.

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(C) MULTISIM software for simulation purpose. This software is developed by National instruments and has powerful learning features and laboratory hardware integration capabilities.

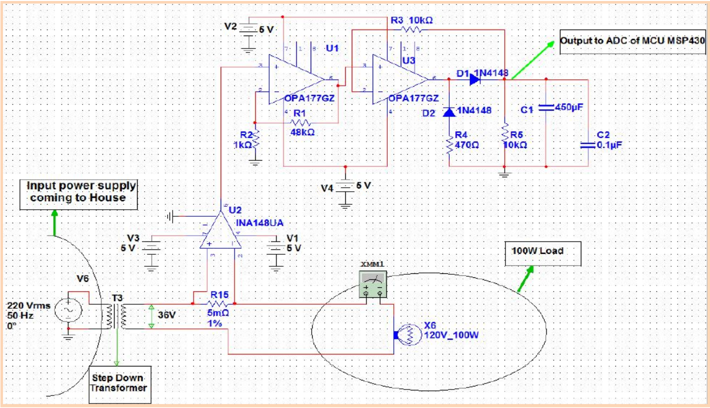

Figure 5 Software block diagram

SYSTEM SETUP

To implement the smart monitoring system the distribution system is divided into several zones containing one distribution transformer and several customer units. The prototype shall be placed both at the customers energy meter side as well as distribution transformer side. Now these units send wireless data to the utility data centre at regular time interval using wireless communication as shown in figure 6.

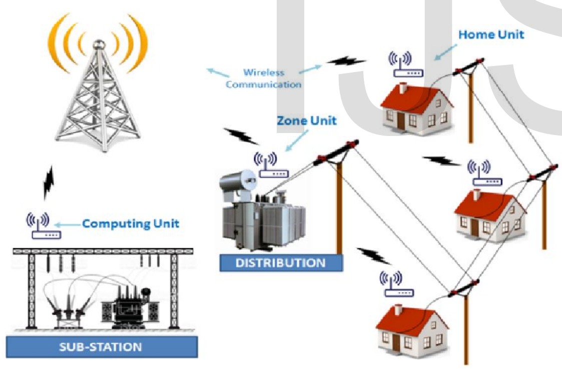

Figure 6 Data Flow Diagram

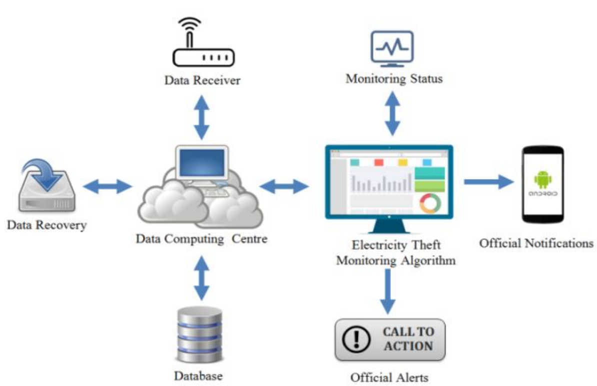

Figure 7 Proposed Monitoring System

The data received at the computing centre will be processed zone-wise and the electricity-theft monitoring algorithm will identify the theft and notify officials with location-wise theft status as shown in figure 7.

ELECTRICITY-THEFT MONITORING FLOWCHART

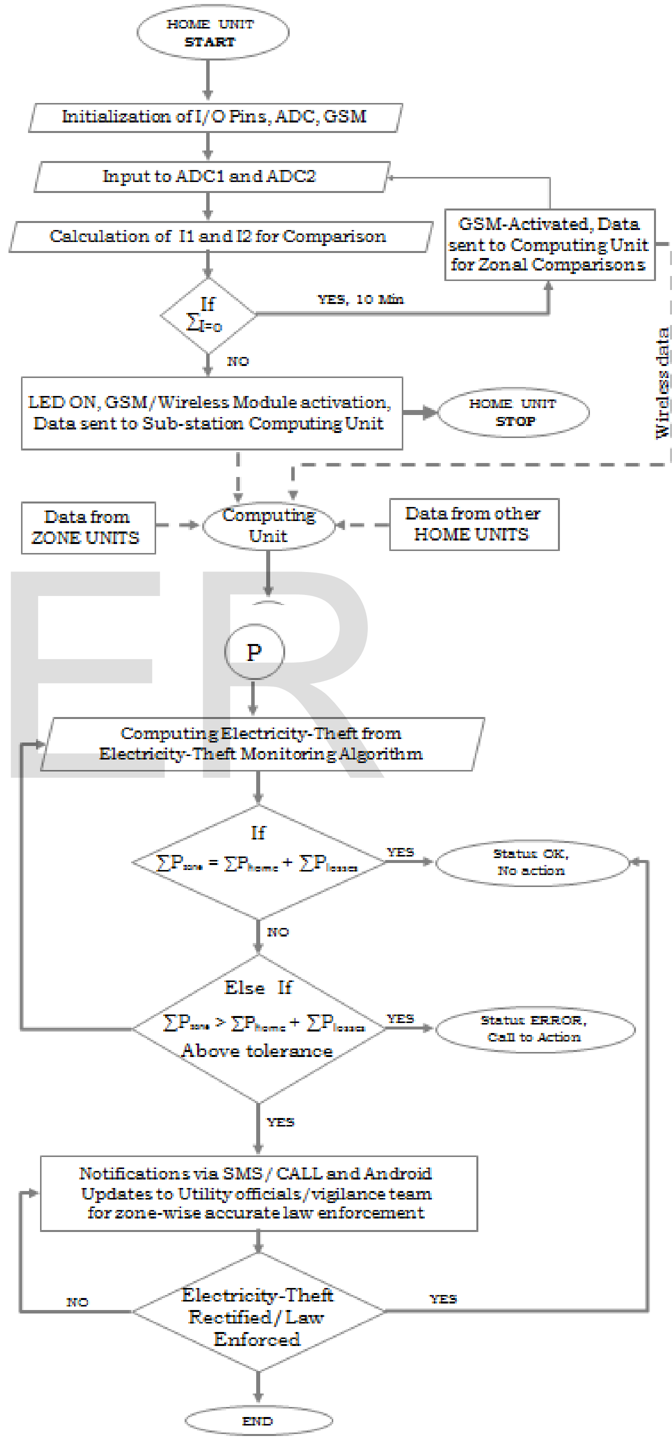
HOME UNIT START
Initialization of I/O Pins, ADC, GSM
Input to ADC1 and ADC2
Calculation of I1 and I2 for Comparison
GSM-Activated, Data sent to Computing Unit for Zonal Comparisons
If ∑I=0
YES, 10 Min
NO
LED ON, GSM/Wireless Module activation, Data sent to Sub-station Computing Unit
HOME UNIT STOP
Wireless data
Data from ZONE UNITS
Computing Unit
Data from other HOME UNITS
P
Computing Electricity-Theft from Electricity-Theft Monitoring Algorithm
If
∑P_zone = ∑P_home + ∑P_losses
YES
Status OK, No action
NO
Else If
∑P_zone > ∑P_home + ∑P_losses
Above tolerance
YES
Status ERROR, Call to Action
YES
Notifications via SMS/CALL and Android Updates to Utility officials/vigilance team for zone-wise accurate law enforcement
NO
Electricity-Theft Rectified/Law Enforced
YES
END

Figure 8 Monitoring system flowchart

The proposed algorithm compares data at each consumer level

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and also the cumulative data at the distribution transformer level to ensure that every means of electricity theft shall be rectified.

MERITS OF PROPOSED WORK

Proposed system not only detects the electricity theft but also precisely locate its occurence. Technically our unit checks both the incoming and outcoming electricity parameters and sends this data through wireless communication to the utility data centre. For an ideal case both the currents should be nearly same. Also the sum of total metered power consumption by the customers under a distribution transformer is equal to the power supplied from the transformer. If a major difference comes, it simply means that there is theft.

III RESULTS

The module was designed successfully with wireless data transmission capability. Design of electricity theft monitoring syatem is as per flowchart shown in fig. 8. The MATLAB program has been implemented and successfully tested for computing the electricity theft for demo electricity-distribution data. The results include delivered email notification and auto-update of electricity-theft status in the database of electricity-theft monitoring web-application.

IV CONCLUSION

The design of theft identification module has been achieved. Proposed algorithm for remote monitoring of the meter reading is tested and the developed system may be able to help Utilities reduce the incidences of electricity theft efficiently and accurately. The proposed system identifies the electricity theft with the following merits:

- Automatic detection with web-application and MATLAB
- Improves field inspection team's productivity
- Helps reduce operating and administrative costs.
- Makes regularly checks with short duration.
- Safer identification method, with fewer risks for field staff.
- Also useful in analysing and improving voltage stability.
- Detection of short-circuit, ground fault, and overloading.
- Reduces the customer's embarrassment in cases where no irregularity is found.

V ACKNOWLEDGEMENT

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References:

[1] A. H. Nizar, and Z. Y. Dong, “Identification and detection of electricity customer behavior irregularities,” in Proc. of IEEE/PES Power Systems Conference and exposition, Seattle, Washington, United States, Mar. 15-18, 2009, pp. 1–10.

[2] Texas Instruments, MSP430FE42x Mixed Signal Microcontroller Data-Sheet, 2008.

[3] Michael Anderson, “How to Identify Electricity Theft in Apartments without Hardware or Software Investments,” BluTrend, LLC 770-800-9767, www. Csasecure.com

[4] Devidas, A. R and Ramesh, M. V, “Wireless Smart Grid Design for Monitoring and Optimizing Electric Transmission in India”, 2010 Fourth International Conference on Sensor Technologies and Applications (SENSOR COMM), pp. 637-640, 2010.

[5] Shoeb S. Sheikh, et’l, “Design and Implementation of Wireless Automatic Meter Reading System”, International Journal of Engineering, Science and Technology, Vol. 3, No. 3, pp. 2329-2334, March 2011.

[6] Amit Jain and MohnishBagree, “A Prepaid Meter using Mobile Communication”, International Journal of Engineering, Science and Technology, Vol. 3, No. 3, pp. 160-166, April 2011.

[7] Hong. L and Ning. L, “Design and Implementation of Remote Intelligent Management System for City Energy Resources based on Wireless Network”, Study of Computer Application pp. 237-239, 2004.

[8] Malik S. H, Aihab. K, and Erum .S, “SMS Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security”, Issue in informing Science and Information Technology, pp. 887-894, 2009.

[9] T. B. Smith, “Electricity theft: a comparative analysis,” Elsevier Journal Energy Policy, Vol. 32, No. 18, pp. 2067-2076, Dec. 2004.

[10] K. Jubi and J. Mareena, “Prepaid Energy Meter with GSM Technology”, American International Journal of Research in Science, Technology, Engineering & Mathematics, Vol.3, No. 2, pp.195-198, August 2013.

[11] N. Mehmood, Z. A. Ali, A. A. Sidiqui, M. Asif and S. Wasi, “Electronic Meter Reader and Data Base Management System”, IEEE, 2011

[12] T. Chandler, “The technology development of automatic metering and monitoring systems”, in IEEE International Power Engineering Conference, December 2005

[13] Minimizing Household Electricity Theft in Nigeria Using GSM Based Prepaid Meter, American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-4, Issue-1, pp-59-69.

[14] Executive summary (Power Sector Dec-2016), CEA New Delhi, Ministry of Power, Government of India

[15] Energy statistics 2017, Central Statistics Office, MSPI, Government of INDIA, New Delhi

Web references:

[1] http://www.eetindia.com

[2] http://www.slide.net