ENERGY THEFT DETECTION AND CONTROLLING SYSTEM MODEL USING WIRELESS COMMUNICATION MEDIA

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Abstract

The proposed work in this paper aims on the design and implementation model of electrical energy theft detection aspect in Sri Lanka. A high percentage of electricity income is lost due to power theft and improper management. However a bulk of these losses are caused by electricity theft. The illegal usage of electricity must be solved by electronic means, without any human interaction.The purpose of this work is to provide an implementation methodology for electricity theft detection and controlling which allows violators to be detected at a remote location.This design integrates effective solutions for problems faced by Sri Lankan's electricity distribution system such as power theft and transmission line fault. It includes microcontroller based embedded technology and wireless communication method to find out the electric theft and transmission line fault.Moreover collecting the meter readings for billing processes from all consumers is a difficult and time consuming task which requires a great number of labours.In the proposed method aGlobal System for Mobile communication (GSM)based technology is used to transmit the meter reading and detection alertautomatically to the authorized energy provider via an alert message which eliminates the various issues related to the meter reading and theft detection.

Keywords: Energy Meter, GSM, Microcontroller, RF Receiver, Wireless Communication

Introduction

Electricity theft is a very communal problem in many developing countries like Sri Lanka, where isa high percentage of demand on electricity.Sri Lanka power station faces loss of nearby 30% of its total distribution of electricity [7]. Electricity loss can be caused by transmission losses and electricity theft. Major portion of power loss is due to power theft. According to Smith [1], the electricity theft can be classified in the form of meter tampering, illegal connections, billing indiscretions, and unpaid bills. The evidence of the amount of electricity theft in a sample of 102 countries between 1980 and 2010 demonstrates that the theft is increasing in many part of the world[1].

In Sri Lanka, Ministry of Power and Energy saysa very increasing number of electricity thefts occurs in every year across domestic electricity utilityand industrial electricity supply, whichleads to a huge amount of revenue losses of electricity companies. During the year 2011, officials from electricity board have caught 2935 offenders and earned about Rs. 199 million by imposing penalties on offenders [12]. In anattempt to counter the trend, Electricity Board Officials are forecasting to take in tough laws such as withdrawing electricity supplies to households who are engaged in the act of stealing electricity. The economic impacts of theft reduce the income from the sale of electricity and increase the necessity of overcharging to consumers. Merely generating more power is not enough to meet present day electricity requirements. Power consumption and losses have to be closely monitored so as to the generated power is utilised in an efficient manner [1]. This illegal electricity usage may indirectly affect the economic status of a country. Also the planning of national energy may be difficult in case of unrecorded energy

usage.In this paper, authors propose an electricity theft detection system to detect and control the illegal usage of electricity therefore this wireless theft detection system model utilizes to overcome this type of electricity theft which provides more benefits to the authorized agency to control its revenue loss [11], [13].

Mainly the electricity theft happensat two places, household energy meter and pole side distribution line. At household energy meter side, the theft occurs via sidestepping the energy meter using a piece of wire, people simply bypasses the energy meter by placing a wire before and after the meter reading unit.The proposed system in this paper keeps a hidden electronic device setup in energy meters of consumer site and once an attempt is made for the theft, it sends an alert message to control unit of electricity board using GSM modem.

To identify the theft in the distribution line, input and output electricity consumption of certain poleiscompared using electricity transformer. Any negative value in the comparison means that the particular pole has drawn more electricity as theft. Here one electricity transformer is placed in input side of the electricity distribution post line and other electricity transformers are placed at the distribution points of the house lines [13]. The output of electricity transformer values is given as input to PIC microcontroller located at consumer's energy meter system which converts these analog inputs into digital signal using inbuilt ADC converter. Then PIC microcontroller compares the input electricityto the energy meter and the sum of output currents from the transformer. If the compared result has any negative value then the particular post line is identified as theft point. This compared value is transmitted to electricity board through GSM module. The GSM Moduleobtains these values and gives as input to microcontroller thatdisplays this value to the controller [13]. The obtained information will beanalyzed by the particular officials and necessary action will be made against the offenders.Also the proposed system is capable of sending the electricity meter reading automatically to the power station without visiting the customer site. It reduces the operational cost and labour cost related to metering process.

In this study authors analyzed the existing metering system of Sri Lanka and found out the various problems in the present system. We considered different technologies available in the world to produce a feasible model for Sri Lanka perspective to reduce electricity theft and associated problems.

Reference [8] proposes a design for problems faced by India's electricity distribution system such as power theft and transmission line fault. The system consists of multiple smart wireless sensor nodes and Zigbee transition module. Major drawback of this work is, it requires a sensor network implementation which leads to a high amount of initial implementation cost.

This system mainly provides a simple real time mechanism to detect power theft.It also aims the following objectives.

- Indicate exact zone and distribution line on which unauthorized taping is done.
- Enabling remote accessibility of consumption data which reduces man power and operational cost.
- To maximize the profit margin of energy provider company.
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Methodology

Theft detection for household meter site

In this method a comparison module in Fig.1 is set to the consumer energy meter that receives meter data of the measured power consumed by a customer (Pconsumed) and delivered power data that includes meter data of the power delivered to the customer (Psent). These two data will be sent through comparator that compares the two values (Pconsumed – Psent) and determines a difference between the sent power data and the delivered power data.

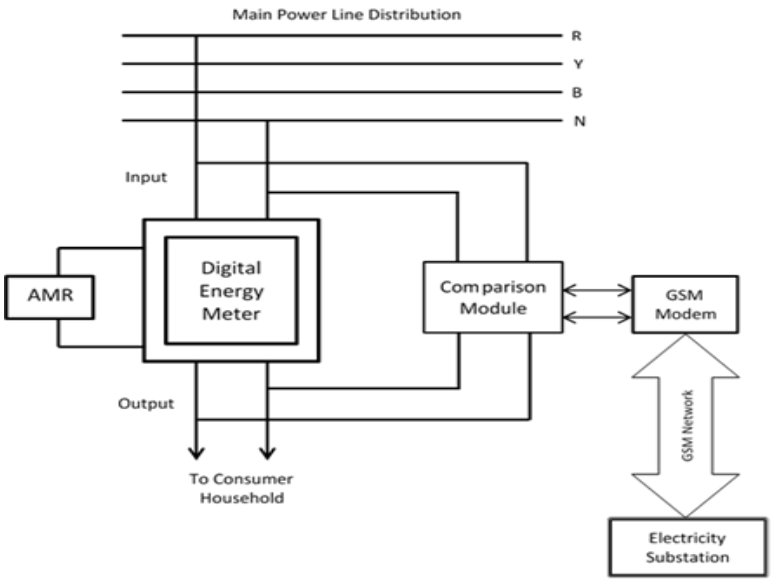

Fig.1: Theft detection model for house hold meter reading.

If the difference between the sent power data and the delivered power data is greater than a predetermined amount, indicates a discrepancy occurred. Then the microcontroller in the comparator takes the differences and customer identification ID and sends an alert message to the electricity substation through GSM based communication network. The conceptual diagram in Fig. 1 shows the basic components of the system mentioned.

Theft detection for pole site tapping

In order to detect pole site tapping following method is proposed. Consider a distribution system shown in Fig. 2 as a conceptual diagram. Two single phase loads L1 and L2 are supplied from two different phases. M1 and M2 are the energy meters that measure power consumed by these loads over a period. Pole based system (P) have been installed to detect power theft.

Suppose there is tapping done illegally on the line to connect his usage. Over a certain period there will be difference between meter reading and pole based reading. Microcontroller will compare these two values and if the measured value on pole is more than value send by meter by some tolerance then power theft is happening on line. This

theft signal generated on pole system can be transmitted to substation by power line communication technique, Tolerance should be provided for losses of line.

Because over a long period there will be difference in reading of meter on load side and pole side due to loss of line between pole and load. Therefore tolerance should be provided through programming of micro-controller.

L1, L2 - Single phase loads
M1, M2 - Digital energy meters
P - Pole based system (installed on a distribution pole)

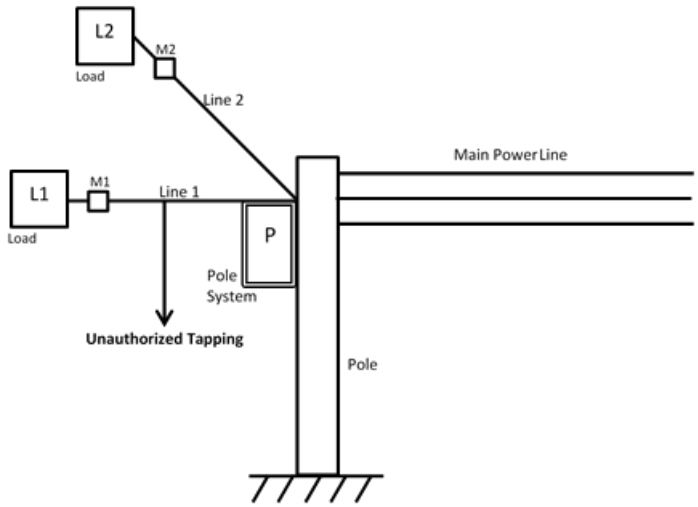

Fig. 2: Theft detection conceptual model for Pole Site Tapping

Mathematical model in comparison unit
On every occasionthe input power passes from supplier to the consumer and the total amount of power receives by the receiver are not equalindicates a possibility of theft of power. Following mathematical comparison occurs in the comparison unit of the theft detection system.

$\Sigma P_{sent} = \Sigma P_{consumed} + Loss$ → No Energy Theft

$\Sigma P_{sent} \neq \Sigma P_{consumed} + Loss$ → Energy Theft Occurs

Where, Psent = Meter data of the power delivered to the customer

Pconsumed = Meter data of the power consumed by a customer

Flow chart- comparison module

Fig. 3shows flowchart of the comparison module inthe theft detection and controlling system.When the main line power distribution is switched on, input and outputsignals of the energy meter is compared to checkfor any discrepancies. When there is no discrepancyrecorded, the flow will start comparison again after a given time.

When a discrepancyrecorded, the consumer data will berecorded including the meter identification number,the time of theftunderway and the meterlocation. The recorded data will be sent to the energy provider through GSM based wireless communication channel. When all the data has been taken, thenearest substation will be notified and the operation will beterminated. After, the authorized substation will take the necessary action against opponent.

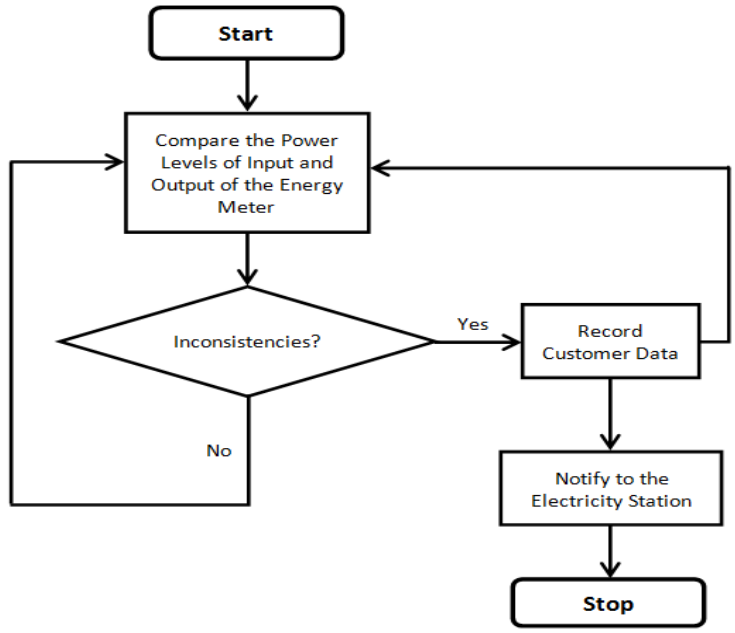

FIGURE. 3: FLOWCHART OF THE COMPARISON MODULE

Automatic meter reading

In the most of the developing country like Sri Lanka a personnel from utility company goes at every house to take the readings of meters for billing purpose [6]. It is a time consuming task which requires a great number of labours.

This system of automated wireless meter reading is based on the same principle of wireless data transmission that is used in power theft detection and controlling system. In the proposed method GSM technology used to transmit the meter reading data from customer meter site to the utility company. The automated wireless meter reading system (AMR) shown in the Fig. 1installed in the consumer site meter counts the meter reading data using the microcontroller and sends to the utility company with some identification parameter once in a month or on request of the operator. The internal structure of the AMR is described in Fig. 4.

Utility company consists of GSM based wireless data receiver device with microcontroller and display.When the device is in the range of data response it receives the data transmitted by the consumer side meter. Each consumer is identified using subscriber identification module(SIM) identification number installed in the AMR [3].

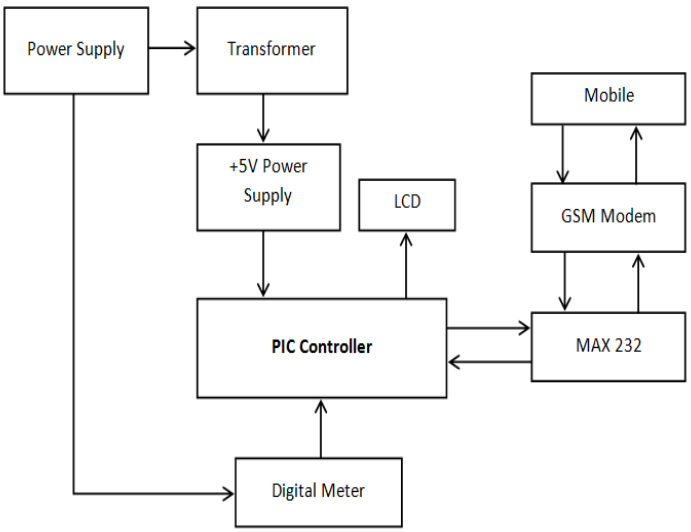

FIGURE. 4: BLOCK DIAGRAM OF THE AUTOMATED WIRELESS METER READING SYSTEM (AMR)

Discussion

In the proposed model, every consumer is provided with an automated meter reader with inbuilt microcontroller to monitor the data consumed at regular intervals, the PIC microcontroller can be employed at consumers end and ARM microcontroller can be employed on pole station.

PIC microcontroller sends data continuously and ARM processes data, it already has the record of amount of power sent to each line and it compares this to received feedback, if the difference between these two values exceeds the prescribed limits then the ARM microcontroller understands that power theft was happened and raises an alarm, also sends this information to local authorities via GSM modem.

There is a prescribed limit because, we have to keep track of all general power losses other than theft and PIC was employed at consumers end, while ARM at pole station.

This is because both has inbuilt ADC and RISC architecture but PIC is 8-bit and cheaper it serves the purpose perfectly, while on pole station ARM receives data from various PIC's and need higher Random Access Memory (RAM) and architecture to process data quickly, so ARM with 32-bit architecture is most suitable for this model.

Conclusion

In developing countries electricity theft is acommon practice especially in remote areas, involves tampering with meters to distort the billing information or direct connections to the power system. The electricity losses are nearly impossible to measure using traditional power system analysis tools. To solve these problemsgovernments must think of an idea to provide help in termsof subsidy to manage this issue. The project model proposed in this paper was tested in a simulated environment and the results shows that the system helps to identify electricity theft. Furthermore, the metering microcontroller system ensures the accurate and reliable measurement of power consumed. Also, it reduces the manual manipulation works. However, the installation of this system will cost an extra amount compared to the traditional system.

References

[1] T.B. Smith, "Electricity Theft: a Comparative Analysis, Energy Policy". 32(18), pp. 2067 – 2076, 2008

[2] S.Nunoo and J.C. Attachie, "A Methohology for the Design of an Electricity Theft Monitoring System", Journal of Theoretical and Applied Information Technology, Vol. 26 No 2,pp. 112-117, April 2011.

[3] S.patil, G.Pawaskar, K.patil., "Electrical Power Theft Detection and Wireless Meter Reading", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, issue 4, pp. 1114 – 1119, April 2013

[4] "AntiElectrical Thefting and Trouble Shooting Through Mobile",International Journal of Advancements in Research & Technology, vol. 3,issue 5, pp. 193 – 200, May 2014

[5] G.L. Prashanthi and K.V. Prasad., "Wireless Power Meter Monitoring with Power Theft Detection and Intimation System Using GSM and Zigbee Networks", IOSR Journals of Electronics and Communication Engineering(IOSR - JECE), vol. 9, issue 6, ver I,pp. 4 – 8.

[6] N.P.Wandhare, S.D.Kondra, K.H . Gulhane and K.J.Dave, "Automatic Load Balance and Theft Detection System",International Journal of Application or Innovation in Engineering & Management(IJAIEM).

[7] F. Jamil," Comparison of Electricity Supply and Tariff Rates in South Asian Countries." Available at: http://www.efsl.lk/reports/electricity_supply_south_asian_countries.pdf[Accessed 18th July 2014], 2011.

[8] P. Ranjan, N.Mehra, T.A.More and S.Bokand,"Wireless Design for Power Theft Monitoring", International Journal of Computer Technology and Electronics Engineering(IJCTEE),Vol. 2, Issue 2,pp. 119-122.

[9] P.R. Malhotra and R.Seethalakshmi, "Automatic Meter Reading and Theft Control System by Using GSM", International Journal of Engineering and Technology(IJET),Vol 5, No 2, pp.806-810, Apr – May 2013.

[10] R. Kalaivani, M. Gowthami, S. Savitha, N. Karthik and S. Mohanvel, "GSM BasedElectricity Theft Identification in Distribution Systems", International Journal of Engineering Trends and Technology(IJETT),Vol 8,No 10, pp. 512 – 516, Feb 2014.

[11] 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,Issue 4,pp. 364 – 367, Mar 2013.

[12] Viva Lanka News,"Electricity theft on the rise. VivaLanka [online]". Available at: http://www.vivalanka.com/newspage/272265ai-[Accessed 18th July 2014], 2012.

[13] S.Anusha,M. Madhavi and R. Hemalatha,"Detection of Power Theft Using GSM", International Journal of Advanced Research Trends in Engineering and Technology(IJARTET),Vol. 1,Issue 3,pp. 15 – 17,(2014)

[14] X. Li and Z. Qing–An," Design and Implementation of a Wireless Security System RF Technology", International Journal of Computing Science, Vol. 1, No. 1, pp. 8 – 11, Jan 2012.