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Electrical Power Line Theft Detection

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Abstract- Recently, India witnessed blackout in the north, north-eastern and the eastern region. This blackout affected 9% of the world's population and many industrial areas. This power theft detection project is attempt to monitor pilferage of power. Theft is detected and an alert with message is sent to an authorized person. This project is also attempt to improve the current power distribution scenario by using this technology. In this project, we measure and monitor power at various load points in our model. Using that data, we define the load shedding technique through controlled automation. This entire monitoring is happen using a personal computer. There is real time feedback about the faults at generation points, distribution points, and usage points. As this system is also used to measure power and used for load shedding. Hence this project will used in Indian power grid networks as well as in industrial power measurement and control systems.

Keywords- *GSM, Current Transformer, AT89S52, Relay.*

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I. INTRODUCTION

The Indian electric power supply system is most complex grid system. So efficiency and reliability of power grid system is the main factor of the supply system. These losses occur in our country in transmission and distributed system is very large. This happens due to lack of safety, inefficient monitoring and control devices present in a grid system. There is also an uneven distribution of power which is mainly in rural areas. Also, there is power theft occurs that goes unnoticed. About one-third of total 174 Gigawatts generated by grid system annually is either stolen or wasted due to dissipation in the conductor. Recently in India on July 2012 blackout is occurred on two separate dates 30 a 31st July. This blackout affected over 620 million people, about 9% of the world's population, or about half of the population of India. That outage affected the industrial, agricultural and household sectors of North-East India. The most advanced automatic control system, which performs the operations like monitoring and control. It is the application of computer in power systems. Distribution automation is a major up gradation of any distribution system.

This system uses GSM technique to transmit the signals to the main control station. Because of the installation and cost problem associated with wired system GSM module is used. Also, The main problem associated is about the rural areas where it's really very much difficult to install the wired system to convey the information.

The GSM module provides an efficient way to convey this information to the authorized official.

We did the literature survey on Indian grid network and other power grid systems. From that, we observe that in India there is a lot of factors associated with stealing the electricity. There is a common notion in people of stealing electricity. Also, there are lots of industries in India those are stealing electricity. The illegal use of electricity is common in India. In addition to this, the other factors are like-

-A weak economy situation in many countries has implied its effect directly on the common man.

-Government unemployment rate shows severe effect on the consumer economic situation.

-Higher energy prices deject consumers from buying electricity. In spite of this, rich and highly educated communities also steal electricity to escape from to huge utility bills.

We also did literature survey of 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 a distribution network.

In this existing system wireless communication system of power grid system used with Zigbee, relay control, and GPRS. The cryptographic method is used to secure the communication channel and Zigbee for the transmission of data in a serial process. The drawback of this process is to collect the readings, going in the particular range of area and manually cut power supply if needed.

II. METHODOLOGY

In the proposed system the GSM and SCADA based power monitoring system is used. GSM is used for find out the exact location and transmitting the exact meter reading to centralized distribution and control system. The overall power monitoring is done through the use of the SCADA-based system. It is used

to monitor and control using PC system. By the use of SMS service, if a fault occurs in the system the SMS is sent through GSM to centralized authority then there will be cut off power or other actions take place. SCADA system is also used for load shedding purpose.

Block Diagram:

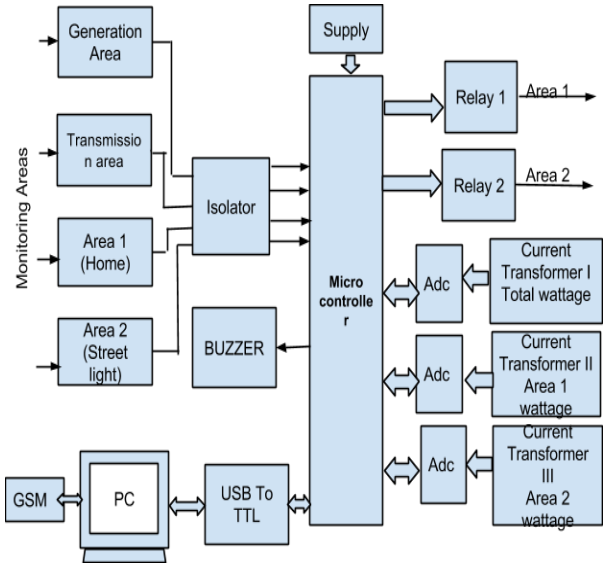

Figure 1. Power Theft Detection System

Block Diagram Description:

The basic block diagram of the electrical power theft detection is shown in the above figure.

Mainly this block diagram consists of the following essential blocks.

1) AT89S52 microcontroller
2) ADC 0804
3) Opto Coupler
4) Current Transformer
5) Relay
6) GSM Modem
7) Buzzer
8) TTL to USB Cable

AT89S52 Microcontroller:-

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

AT89S52 Features:

- Full duplex serial port
- 8K Bytes of In-System Programmable Flash
- 256 Bytes Internal SRAM
- 32 Programmable I/O Lines
- 4.0 to 5.5 Operating Range
- 40-pin PDIP package

ADC 0804:

There must be something that translate the analog inputs to digital output, and so Analog to digital converters come to play. These A/Ds appear like memory locations or I/O ports to the microprocessor and no interfacing logic is needed. Differential analog voltage inputs allow increasing the common-mode rejection and offsetting the analog zero input voltage value. In addition, the voltage reference input can be adjusted to allow encoding any smaller analog voltage span to the full 8 bits of resolution.

Opto isolator:

An optoisolator (also optical coupler or optocoupler) is a component that uses light to transfer electrical signals between circuits to keep them electrically isolated from each other, preventing surges.

Current Transformer:

The Current Transformer (C.T.), is a type of “instrument transformer” that is designed to produce an alternating current in its secondary winding which is proportional to the current being measured in its primary. Current transformers reduce high voltage currents to a much lower value and provide a convenient way of safely monitoring the actual electrical current flowing in an AC transmission line using a standard ammeter.

Relay:

A relay is an electrical switch that uses an electromagnet to move the switch from the off to on position instead of a person moving the switch. It takes a relatively small amount of power to turn on a relay but the relay can control something that draws much more power.

GSM:

The GSM module is used to send a SMS when electricity theft or any line problem is generated in a transmission line. The microcontroller detects any power theft or fault in transmission line and give the command to GSM module to send a respective massage The GSM Modem consumes a lot of current during transmission, make sure your power supply can handle large currents without giving substantial voltage drops at the output. If the GSM Modem is unable to connect to the network, try coming to a place with clear.

USB to TTL:

The cable is easiest way ever to connect to microcontroller/Raspberry Pi/WiFi router serial console port. Inside the big USB plug is a USB<->Serial conversion chip and at the end of the 36" cable are four wire - red power, black

ground, white RX into USB port, and green TX out of the USB port. The power pin provides the 5V @ 500mA direct from the USB port and the RX/TX pins are 3.3V level for interfacing with the most common 3.3V logic level chipsets.

Buzzer:

The buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers used as alert a user of an event corresponding to power theft fault occur or not.

Flow of working:

A single microcontroller consists of 32 I/O ports, but in our system, I/O port is more than 32 i.e. 3 eight bit data of ADC given to microcontroller. So 24 I/O lines used by ADC, 1 I/O line for the buzzer, 2 I/O line for relay circuit, 2 I/O line for serial communication, 4 I/O lines for monitoring areas. Here the different areas are monitored for power failure, power consumption, theft and load shedding depending upon which the following actions takes place. For power failure: whenever a power failure occurs, the area where it has occurred is displayed on PC itself and buzzer will ring for indication purpose along with a message is send via GSM module about the fault location to the predefined mobile number. For power consumption: Current transformer is used for calculating power consumption in area1 area2 which is done completely on PC. For power theft: Here we need to add one more bulb source which will act as an extra unauthorized load which used for power theft process. For load shedding: VB 6.0 S/W is present in PC through which the GUI can be made in PC in order to allow admin to control the amount of load shedding in different areas either manually/time control. Depending on which relay circuit turns on/off the bulb of area 1 & 2.

MATHEMATICAL MODEL:

Whenever input power is passing from supplier to the receiver, at that time if the total amount of power is not received by the receiver then there is a possibility of theft of energy.

ΣPsent = Pconsumed + Loss .....No Theft
ΣPsent $\neq$Pconsumed + Loss .....Theft Occurred
Psent = Power measured by pole side energy meter
Pconsumed = Power measured by load side energy

SOFTWARE REQUIRED

- Programmable notepad - coding
- Diptrace- PCB layout
- Visual Basic 6.0-PC Display

FLOWCHART.

To program a microcontroller to detect a power theft on one line following flowchart is used. First of all initialize ports of microcontroller as input or output as per required. Set the tolerance in program depending on the loss of line for which this system is installed. Set the delay time (say 10min) which is depending on after how much time interval system scan the line for theft detection. . Take the data from relay by the means of current transformer at preset time interval (10min). It represents power consumed by load over given time. Take the data from generation and transmission circuit. It will represent the power sent over that line for preset value (10min).

If power sent on line is not same as power consumed by that load over a given time considering tolerance the power theft is occurring on that line. Send the signal of power theft with its area to utility company. For this purpose GSM is used. If power theft is not occurring on that line then again take the data after say 10min. It's an endless program.

The flowchart for power theft detection is as follow in fig 4.1

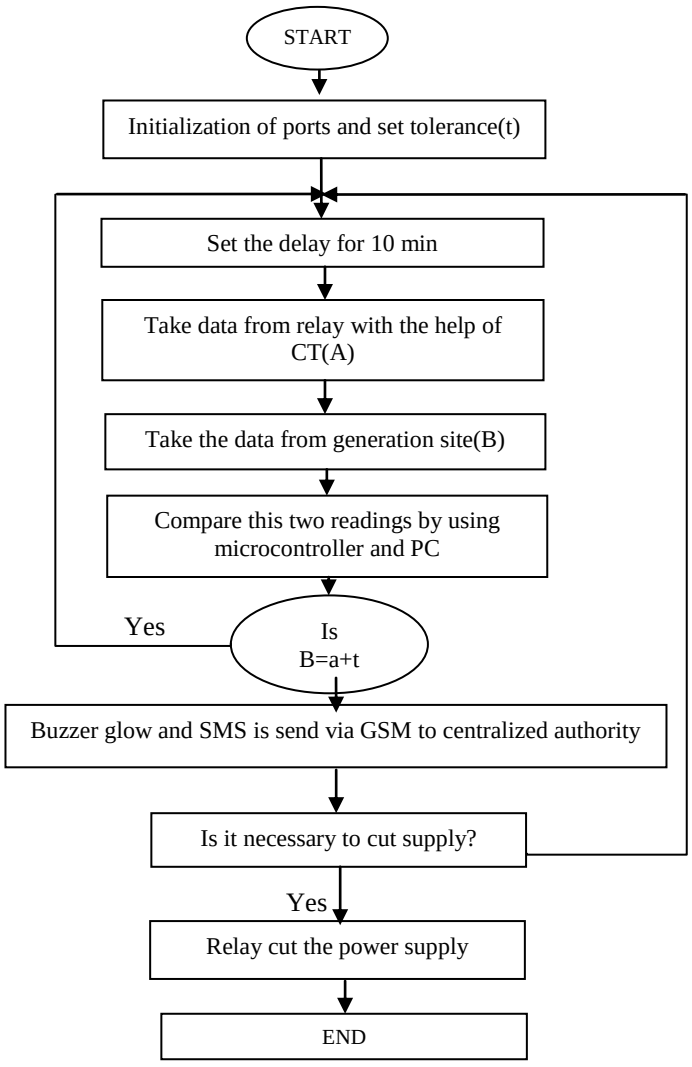

Figure 4.1 Power Theft Detection System Flowchart

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III. RESULTS

The basic purpose of this system to detect power theft fault. This is done by using following method. By the use of current tracer circuit we have monitored transmission line current, so the power is calculated.

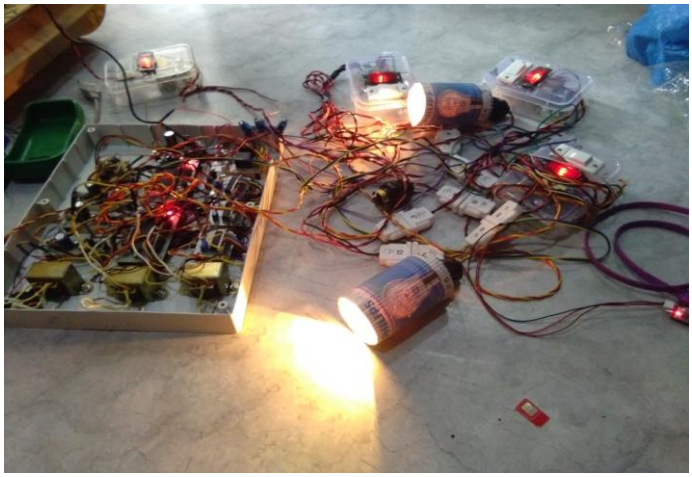

Figure Assembly of Hardware for power theft detection system

This circuit finds out the exact power on generation, transmission and receive area. Microcontroller compared these values. If the power send is equal to power receive on terminal is nearly same then there is no fault detected on transmission line. And if the power send is not nearly equal to the power receive on other terminal then there is power fault on transmission line. Thus faults detected on exact line. Hence we have finded the transmission line theft faults.

Tolerance is provided for losses of line. Because over a long period there will be difference in reading of meter on transmitter side and receiver side due to loss of line between transmitter and receiver. Therefore tolerance is provided through programming of micro-controller

When there is fault like broken cable or grounding the system informs the center observer about that fault, same as in the case of illegal tapping this module sends intimation center observer about the theft with proper location and amount of energy is stolen in terms of units.

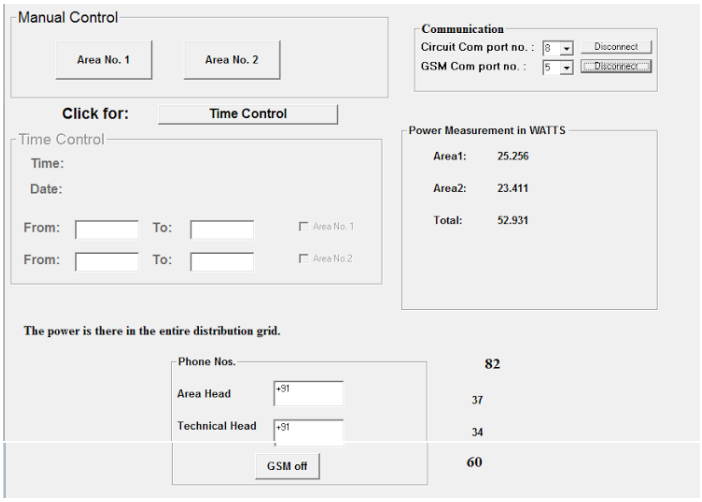

Figure PC based power theft monitoring and load shedding

Confusion Matrix:

Table 1 Confusion Matrix

N=40	Predicted= YES	Predicted= NO
Actual=YES	TP=31	FN=04
Actual=NO	FP=03	TN=02

This **matrix**, also known as an error matrix. To calculate the various parameters of the circuit we have tested the circuit by this method. We have observed the output as power theft fault is correctly detected or not. So, We have predicted the operation and we compared with actual output we got. We put power theft fault occurs as condition positive and no power theft fault occurs as condition negative. After that, we compared the results and final output TP (true positive), TN (true negative), and FP (false positive and FN (false negative) values in this matrix, then important parameters like accuracy, sensitivity, and specificity are calculated. Out of 40 readings, 25 times power theft fault occurs is detect as corrected output, 7 times fault occurs but not detected. Also 5 times there were no fault occurs but detected that gives incorrect output. Finally 2 times we got no fault occurs and not detected is true negative condition.

Accuracy is the number of all correct predictions divided by the total number of the dataset

$$\text{Accuracy} = TP+TN/ (TP+TN+FP+FN)*100$$
$$= 28+2/40 = 0.825$$

Sensitivity is the number of correct positive predictions divided by the total number of positives, also known as recall or true positive rate

$$\text{Sensitivity} = TP/ (TP+FN)$$
$$= 31/31+4 = 0.885$$

Specificity is the number of correct negative predictions divided by the total number of negatives.

Specificity= TN/ (TN+FP)

= 2/ (2+3) = 0.40

IV. CONCLUSION

The project of ours is aimed at reducing the heavy power and revenue loss that occur due to power theft by the consumers. This system provides on which line unauthorised tapping is occurs.

This system is also used to measure power and used for load shedding. Hence this project used in Indian power grid networks as well as in industrial power measurement and control system.

This project gives the accuracy of 82.5%, sensitivity 88.5% and specificity is of 40%. The system accuracy can be increase by using minimizing current leakage losses and by using proper circuit design to calculate exact power.

If we use GPS system to respective areas then exact fault location will find out. The proposed system will be hidden in such meters and as soon as an attempt is made for the theft, it will send a SMS using GSM-GPS modem, by displaying the respective consumer meter number to control unit of electricity board.

Also by using solar panel we will reduce system's power requirements.

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