

Smart Power Theft Detection System

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Abstract—Power theft is normally done by two methods that is bypassing or hooking. So to detect it, a system (current measuring and comparing) is proposed in which the household distribution of current is done indirectly from the electric pole to an intermediate distributor box and then to the individual houses. The current is measured periodically in the distributor box and is posted to the server database for each house using GSM/GPRS module. Similarly, for each house electric meter is designed which can measure the value of the current and post the same to the server database periodically using GSM/GPRS module.

At the time of the installation of the electric meter the details of the users are stored in the database through a user friendly mobile application including the address, latitude, longitude using mobile GPS and the photograph of the user's house/area. Upon successful comparison between the current values from distributor box and electric meter in the server if we get a marginal difference between the currents then the theft is detected. Finally, the details of the user are shared with the authorized mobile application including the address and photograph of the area. The latitude and longitude are also used to show the area of theft in Google maps. And hence the required steps are taken. The same process is used for hooking but on the individual electric poles.

Keywords— Power consumption, Energy meter, Arduino UNO

I. INTRODUCTION

Theft of electricity is the criminal practice of stealing electrical power. According to a study the world loses US\$89.3 billion annually to electricity theft. The highest losses were in India (\$16.2 billion), followed by Brazil (\$10.5 billion) and Russia (\$5.1 billion) [1]. Nationally, total transmission and distribution losses approach 23% and some states' losses exceed 50% [2]. A huge amount of power is required for the Integrated steel plants To meet this requirement it is calculated that approximately a capacity of 25,000 MW power plant needs to be installed apart from the captive power & blowing stations [3]. By the help of our prototype we can detect the theft and possibly save the maximum electricity which can be effectively used in the steel plants.

II. OBJECTIVE AND BRIEF WORKFLOW

The power distribution sector has been played with distribution losses (overall 30%) coupled with theft of electricity. To minimize the theft of power by bypassing or by hooking we are proposing a web based MOBILE APPLICATION which will notify about the theft of electricity that is happening in a particular area. The main objectives of this work are,

- To detect the power theft automatically without engaging any man powers by developing a cost effective and efficient system.
- To develop a web based mobile app for the authorized officials of electricity board to keep track of all the thefts, area of thefts and the direction to reach the area under theft.
- To maintain the record of the total number of electric units consumed by users in the server database periodically and make online bill payment system.
- To develop a global website that would maintain the analytics of the thefts and the probable area under theft using multi-color graphs and pictorial representations which would make the theft analysis easier and can also predict the thefts that may happen in future.

To create this solution, work has to be done both for the hardware and software. The hardware includes the customized electric meter and the distributor box and the software includes the development of both website and mobile application. For the hardware part to be developed first, study of basics components like digital electric meter, GSM module, ACS712 module, microcontroller, ADC and their workings has to be carried out. Then the brief circuit diagrams of both the distributor box and the electric meter have to be designed (shown in Fig. 1). After that the hardware design and the PCB design of the above components should be considered. Now the PCB designs of all the components need to be integrated to a single PCB design in accordance to our customization or circuit diagram. According to our customization the PCB design of the distributor box will consist of a GSM module and more than one ACS712 module which should be connected to a microcontroller. The ACS712 module should have a series connection with live wire. The PCB design of the customized electric meter will consist the circuits of the commercial electric meter along with the ACS712 module at the input side and a GSM module such that all of them share the same microcontroller. The microcontroller will be programmed according to the desired functioning of the customized electric meter. The analog to digital conversion circuit should also be integrated in the PCB design in order to give supply to the GSM module and microcontroller from the available AC current. The above PCB designs can be obtained using PCB design software and it must be simulated using simulation tool for any possible defects. After the successful simulation, the PCB design will be fabricated on the PCB board. The above work will be carried out under a manufacturer/vendor/lab which gives training, facilitates PCB design, fabricating, licensing and

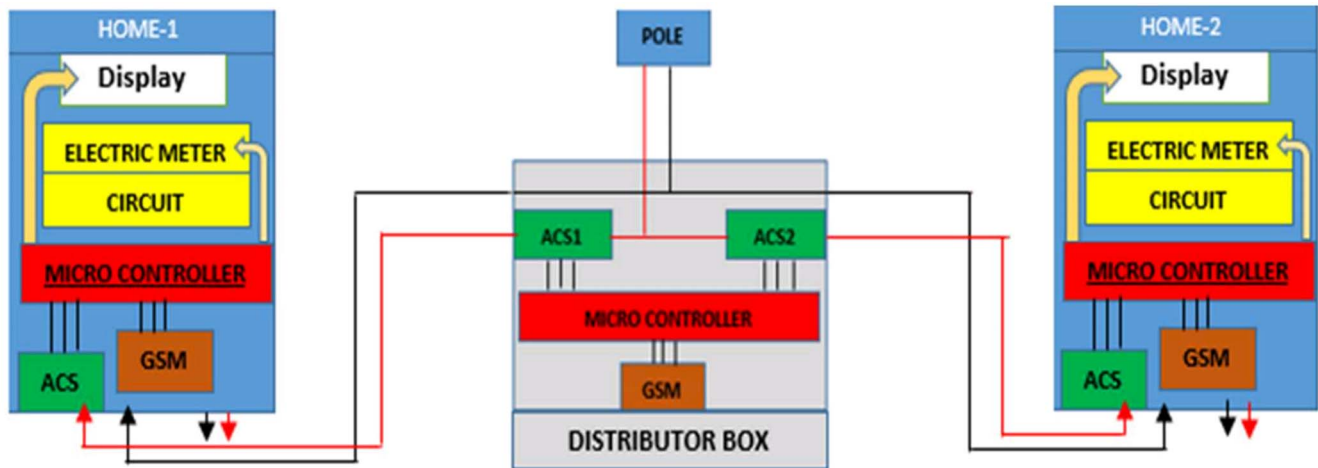


Fig. 1. Architecture of the proposed system

manufacturing related to electric meter. For the software part a global website will be developed using web development for all the users for payment system and analytics of theft and a web based mobile app will be developed using android development for the authorized officials who are in charge of detecting theft. Server side code and the database plays a crucial role in the whole system. The mobile app will be developed in such a way that the server of the app would be able to receive the values of currents from the GSM module periodically and compare them and display the area of theft along with the details of the user under theft and the directions in Google maps. Hence software part can be developed using open source software.

The novelty of the system is outlined below.

- This solution works on the principle of division of current in parallel path. So it is more efficient.
- This solution shows the exact location of area under theft along with its photograph.
- The analytic study of the thefts can predict the thefts that may take place in future.
- It can also allow the supervisor to cut out the power of a place under power theft

The solution uses a GSM sim800 module that can transmit the value of current measured to the server through GPRS technology.

III. DETAILED SYSTEM DESIGN

Current division rule has been used to detect the power theft. According to this rule, a parallel circuit acts as a current divider as the current divides in all the branches in a parallel circuit, and the voltage remains the same across them. The current division rule determines the current across the circuit impedance.

We connect a current sensing module ACS712 in both the distribution box and the meter installed in the house. The current from ACS712 is fed into a micro-controller (Arduino Uno). The data of either sides is then sent to the authorized database after the arduino is interfaced with the GSM-GPS module.

Hence the data are compared, if the difference is more than the provided threshold, POWER THEFT is detected.

The hardware and software required for our solution is:

- Arduino Uno
- Current Sensing Module (ACS 712)
- GSM (SIM 800)
- GPS Module
- Database (using My SQL)

A. Arduino UNO

Arduino [4] is an open-source electronics prototyping platform based on flexible, easy-to use hardware and software. As Arduino is open source, the CAD and PCB design are freely available. There are several different arduino boards are available on the market (both original and cloned) such as Arduino UNO, Arduino Nano, Arduino Mini and Arduino Mega.

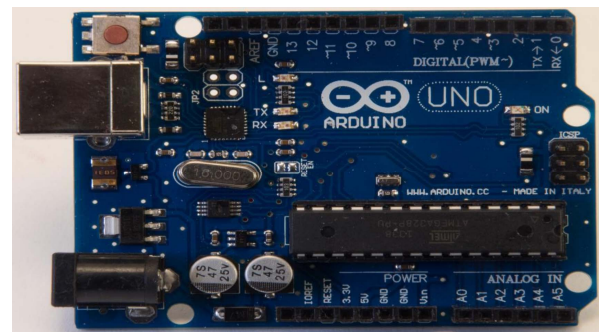


Fig. 2. Arduino UNO R3

For our work specifically we used this board (Fig. 2) due to the below specifications.

- 6 analog input ports
- Power Input connector.
- 14 digital I/O ports (of which 6 PWM)
- Standard USB for data and power and programming.
- Female headers.
- 1 hardware serial port (UART)
- Most popular board. Ideal for starters.

B. Current sensing Module (ACS 712)

The ACS712 Current Sensor as shown in Fig. 3 offered on the internet are designed to be easily used with micro

controllers like the Arduino. These sensors are based on the Allegro ACS712ELC chip. These current sensors are offered with full scale values of 5A, 20A and 30A.

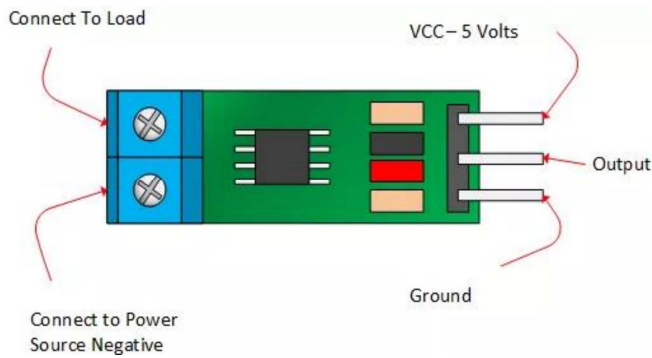


Fig. 3. Pin configuration of ACS 712

C. GSM Module



Fig. 4 GSM Module (SIM 800)

SIM800 is a quad-band GSM/GPRS module that works on frequencies GSM 850MHz, EGSM 900MHz, DCS1800MHz and PCS 1900MHz. SIM800 features GPRS multi-slot class12/class 10(optional) and supports the GPRS coding schemes CS-1,CS-2, CS-3 and CS-4; With a tiny configuration of 24*24*3mm, sim800 can meet almost all the space requirements in users' applications, such as M2M, smart phone, PDA and other devices.

D. GPS Module

To get the information of the device's geographical position, a GPS navigation device (Fig. 5) is needed that is capable of receiving information from satellites. Using suitable software, the device may display the position on a map, and it may offer directions. SIM800 has 68 SMT pads, and provides all hardware interfaces between the module and customers' boards.

So to detect this we have to make the following arrangements: Firstly we will use a GPS module to store the latitude and longitude of every pole and house on the 1st day of installation of the meter.

Connection and arrangements at the distributor box

- The live wires from the POLES should be fed into a distributor box block wise.
- The distributor box has the capability of distributing the power among the houses of particular locality.

Accordingly, subsequent distributor box will be setup for a cluster of houses.

- Hence the AC current is measured in the distributor box separately for each house using the ACS712 module and the magnitude of this current is fed into the microcontroller.
- A server side database is maintained and the measured value of current is transmitted with the help of GSM/GPRS module and is updated into the database table containing the user-id at a regular desired period (referring timestamps).

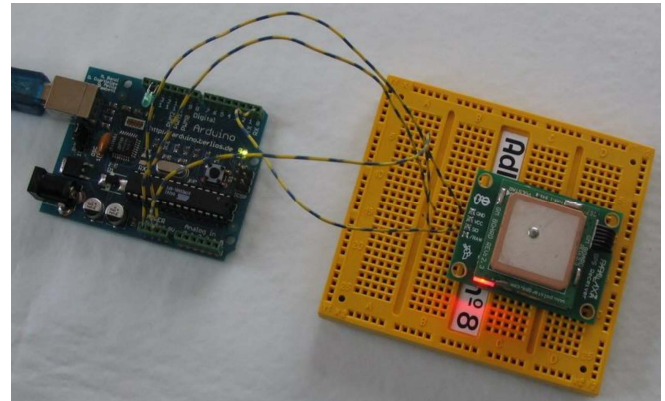


Fig. 5 GPS module

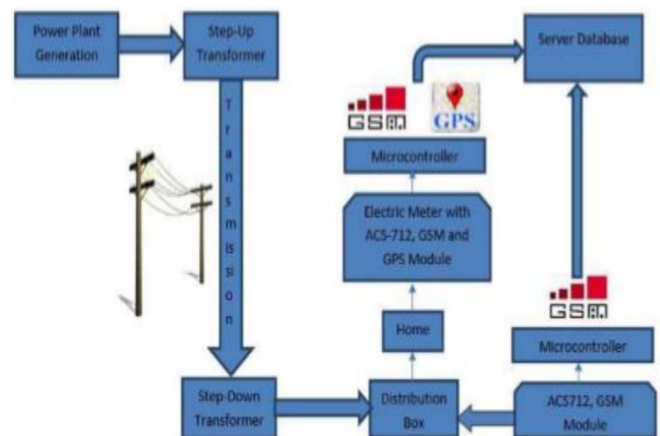


Fig.6. Block level demonstration of the system

Connection and arrangement at the electric meter installed in each house

- The main objective of this connection is to measure the total current actually entering the electric meter. So a fixed connection is made at the inlet terminal of the electric meter in such a manner that tampering of this connection is made void with the help of laser sensors and microcontroller.
- The respective connection too consists the ACS712 module to measure the AC current and fed into the microcontroller.
- Hence now the same measured current is transmitted with the help of GSM/GPRS module and is updated in the same database table for same user-id that was maintained for the distributor box at regular desired period (referring timestamps).

Google map API/ Google street view

- At this stage the theft table of database has the exact location of the theft.
- Hence the location from the database is transmitted to the satellite through satellite communication.
- And now the satellite is programmed to take the image of the location of theft accessed from the GPS of that place.

Mobile Application

- Mobile Application has been made for authorized people to get access to the area of theft and take suitable actions.
- This application has a direct access to the database of theft table.
- The images taken by the satellite are directly sent to this application with the location and the electric meter's unique id.
- The user of the mobile application gets pinged when the theft is detected.

Comparison among this and previous related work has been carried out in Table I. It can be seen that in our work both the use of mobile app and location detection has been adopted which is a clear advantage over the other systems.

Table I Comparison of this work with existing systems

Work done	Location detection	Use of mobile App
[5]	No	No
[6]	Yes	No
[7]	Yes	No
[8]	No	No
This work	Yes	Yes

IV. CONCLUSION

This method reduces the heavy power and revenue losses that occur due to power theft by customers. By this design it can be concluded that power theft can be effectively curbed by detecting where the power theft occurs and informing the authorities. The proposed system will be hidden in electric meters in such a way that as soon as the difference between current crosses the threshold value, an automatic message and email will be sent to the concerned authority along with its location and image of that particular area.

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