Advance Energy Meter With Tariff Indication, Theft Detection and Prepaid System using GSM

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Abstract— Due to electricity stealing, electricity providers in divergent territories particularly inside progressing ones are experiencing from massive losses. This work focuses on electricity energy metering technique which is prepaid with an additional function of theft detection and changing tariff time to peak time and off-peak time. The suggested system has two parts. First part is service main side which will be installed on pole and is connected to distribution lines through service line while second part is main meter which will be installed at consumer side on service main wire. The suggested meter is equipped with transmitter/receiver used for theft detection and GSM module which open the door for bidirectional communication between service provider, users, and main meter getting advantage of the pre-installed GSM framework. Electricity meter can be recharged by customers, simply scratching card and sending hidden code with the help of SMS utilizing GSM module. This work presents new techniques to cover meter tampering and bypassing. In case of theft detection, it will cut off supply, inform the service provider and will show the exact location of theft using GSM. The tariff time will be changed by service provider using SMS with the help of GSM module to meter. The bidirectional GSM communication using SMS is very helpful for user as well as service providers. In case of low balance and if remaining balance become zero, it will cut off supply and inform user as well as service provider.

Keywords— Prepaid energy meter; theft detection; transmitter/receiver; Global System for Mobile (GSM); Short Message Service (SMS); bypassing.

I. INTRODUCTION

In power sectors electricity stealing is a serious problem particularly in the succeeding countries. Due to electricity theft an enormous amount of collection is lost. This is so serious problem in some countries that governments faced losses instead of income. Government pays in some cases to energy sector to sustain a negotiable rate of electricity. Existing power capacity is not expanding due to financial losses and governments are becoming unsuccessful to fulfill the growing demand of energy. Power stealing is a serious problem in systematic energy system like USA and methodical organization like Malaysia [1]. Regardless, in under developed and progressing nations the enactment of electricity stealing is very usual that it is frequently condemn of conversation. Electricity stealing exhibits a low meter reading, stealing power by circumventing a meter, overdue bills and billing indentation. Billing deformity is caused by office employees in trade of illegitimate remittances from the costumers and meter reader recording wrong readings. Distinct technical and nontechnical techniques were suggested in[15] the former to identify energy plunder. An impractical methods approach is observation of consumers with hooks and doubtful load profile [2,11]. While recurrent investigation is helpful and appreciably diminishes theft, but this method demands immense manpower and enormous labor. But this kind of attempt also let down in many instances because of the duplicity of the employees. Some practical ways like use of principal onlooker meter at the low voltage side of residential transformer to detect thievery, genetic brace vector machines, harmonic generator, supreme learning machine, and power line impedance procedure [3, 4, 5, 6, and 7]. However, these practical methods can be efficiently executed only if genuine communication is fortified between the suitable test points and centralized station. Currently, GSM based prepaid energy meters has been suggested [8, 9]. These meters are helpful to provide solution for prepaid energy metering system and can control load consumers load locally. The pre-installed metering system and prepaid system [12] can be made more advanced for the use of electricity thievery. This project presents a suggested metering system which will be prepaid and will be pedestaled on GSM which incorporate different angles of electricity thievery like meter bypassing, meter tampering and prevents deformity of billing, disinclination of customers to reimburse bills in time and electricity theft from lines.

II. SUGGESTED ENERGY METERING SYSTEM

The suggested system has two parts. One is main meter which is installed on consumer unit and second part is service main side which will be installed on pole or may be in center of service main line. Service main side will communicate with

main meter to avoid meter bypassing. An energy meter is allotted to individual consumer and power utility preserves a server. The energy meter and server will utilize GSM module and modem consequently to liaise with each other with the help of GSM network. The sketch of suggested energy metering techniques is shown in Fig.1 and simplified block diagram of the suggested system is shown in Fig. 2.
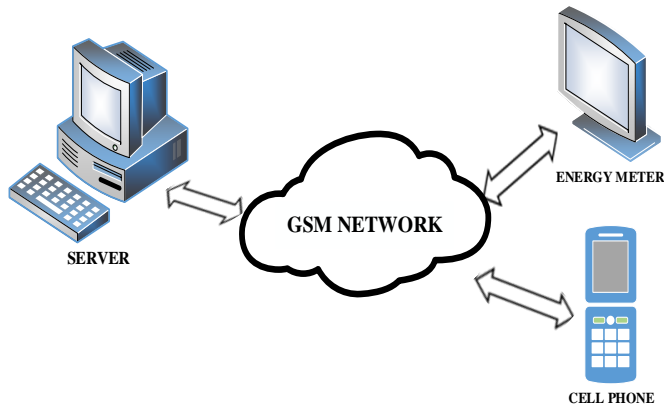

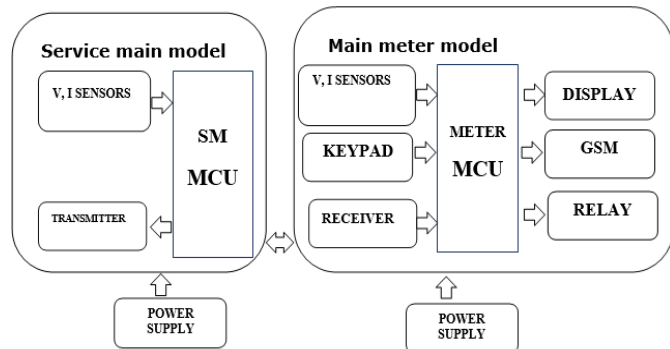Figure 1.   Sketch of the suggested advance energy metering system.

Figure 2.   Block diagram of the advance energy meter.

A. Main Meter Part

The whole block diagram of the main meter is shown in Fig. 3a. This model calculates consumed units and remaining units on the basis of V, I parameters[13]. The main meter communicates with service main part through receiver and with sever through GSM. All data to user and service provider regarding balance recharging, low balance, changing tariff time or theft detection is uploaded and controlled by the main meter. The recharging method is similar to the existing recharging techniques of mobile phones. Simply, costumers have to buy a scratch card and send the hidden code for the corresponding units. Suppose, a user wants 100 units so he will buy scratch card for 100 units and will send the hidden code if the code was registered and correct for 100 units then it will recharge the electricity meter and will inform the user with the help of SMS about the recharge of corresponding units. The recharging process can also be done by using server. As customers are consuming energy, so consumed units will be deducted from

the total units earned by customers, information about consumed units and total units will also be displayed on LCD. When remaining units reach to certain limit (20) it will send a message to user and will inform him to recharge again while if the consumer did not recharge the energy meter and consume all the units, the energy meter will disconnects the load automatically with the help of relay and will send message to inform the user about finished units and as well as service providers. The consumer has to charge again to use electricity. So, this kind of system is helpful in deformity of billing system, bribed meter readers and employees.
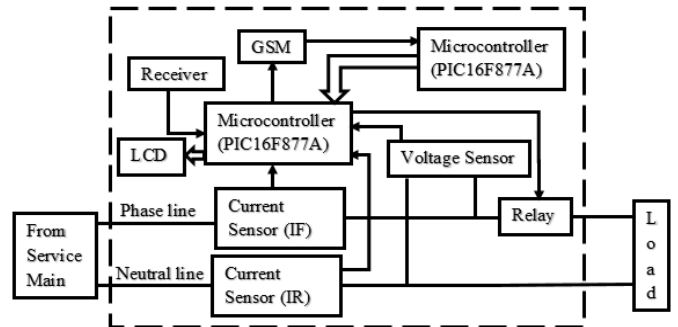

Figure 3a. Block diagram of the suggested advance energy meter. (Main meter model)

B. Service Main Part

Service main part has transmitter which communicate with the main meter for theft detection. When load is sensed by current sensor, transmitter will be activated by microcontroller and will continuously transmit the signal which will be received by receiver of main meter part. Main meter part compares the data received from transmitter [14] with load data sensed by sensors installed at main meter. Theft is detected if this difference exceeds the threshold limit. It will be installed on pole or on service wire. The complete block diagram of the service main is shown in Fig 3b.
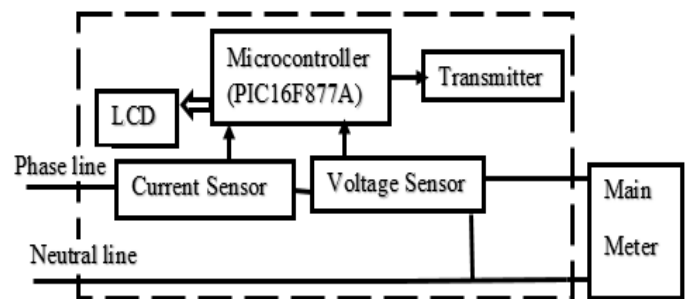

Figure 3b. Block diagram of the suggested advance energy meter. (Service main model)

III.   SIMULATION MODELS FOR CONNTROLLING ELECTRICITY THEFT

The software's for simulation is Proteus and Proton IDE compiler.

A. Protection Against Shorting the Phase or Neutral Wire

Fig.4 shows bypassing the phase wire which is a favored technique of circumventing normal electricity meter. If one current sensor is installed in energy meter on phase wire so it will record zero energy consumption. Similarly, another technique of circumventing is detaching of the neutral wire which is illustrated by Fig.5. In this scenario zero energy consumption will be recorded because the consumption observed will be zero by the step-down transformer. To protect this kind of thievery, in our suggested system two separately current sensors are used in the phase and neutral wire. Both sensors are connected on ADC pin of microcontroller. If any of the wire, phase or neutral is disconnected then it will record difference among the out of both sensors. The output of both current sensors will be compared in microcontroller and if there is significant difference, it will disconnect the load immediately with the help of relay and inform the service providers about corresponding bypassing. In such cases the service providers will block the electricity meter and will take legal action against the costumers. The simulation result is shown in figure 6.
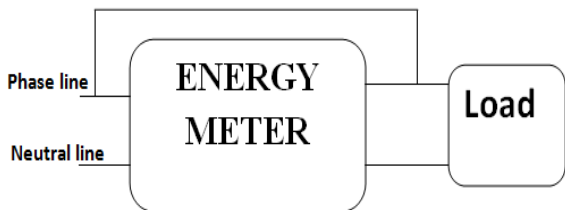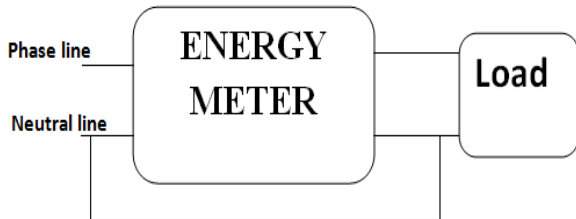

Figure 4.   Shorting the phase line.
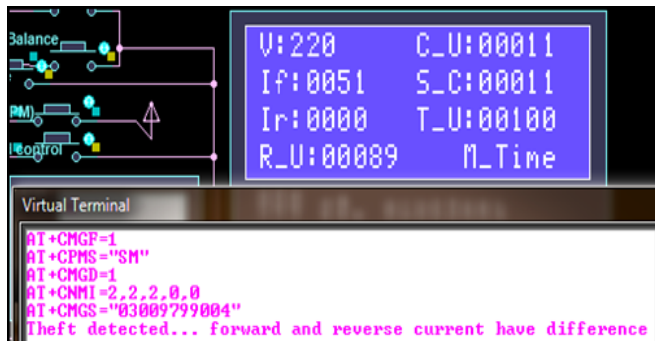

Figure 5.   Shorting the neutral line.

Figure 6.   Shorting the neutral line.

B. Protection Agianst Whole Meter Bypassing

In utmost cases the consumers disconnect both the neutral and phase wire from meter, shown in Fig. 7. In such scenario zero energy consumption the meter will be recording. To avert such kind of thievery, we have divided our suggested energy meter into two parts one is service main part and other is main meter part. The service main side have transmitter and main meter have receiver. If no load is connected, then the transmitter will not transmit signal. If load is connected so service side sense the load and continue transmission while on the receiver side the receiver, receives signal and give to microcontroller so there is counter for the service main side in the main meter. The counter increases its value as the consumer units consumed means at the same time the service main units also change as the consumer unit's count by the main meter. If the whole meter is bypassed then the consumed unit will stop and the service counter will increase its value because load is sensed by service main part so it will continuously transmit signal which will be received by receiver and continues counting in main meter part and if the difference between consumed units and service count increase than threshold valve, it detaches the load instantly with the help of relay and the electricity meter alerts the service providers about bypassing through SMS. The simulation result is shown in figure 8.
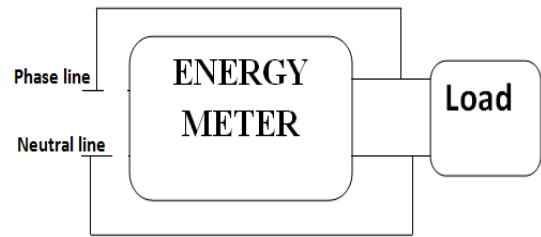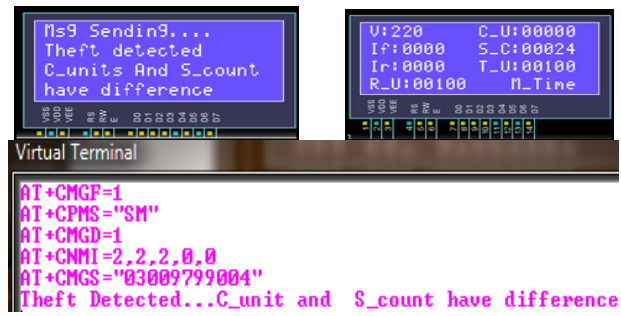

Figure.7.   Whole meter bypassing.

Figure 8.   Simulation results of whole meter bypassing.

C. Protection in Case of Tampering

Some consumers are proficient, may attempt to unbolt the electricity meter and dabble it to show zero energy consumptions or manifest. To relive such case, push buttons are installed at each side of the suggested energy meter which is normally closed. So, these buttons are opened by pushing with the sides of electricity meter. One end of every button is given to the pin of microcontroller and second end is given to 5Vdc power supply. If a customer attempts to unbolt the meter the push button will be closed and 5V will appear at input pin of microcontroller. In such case, the microcontroller promptly informs the service providers and detaches electricity from the load. Result is shown in figure 9.
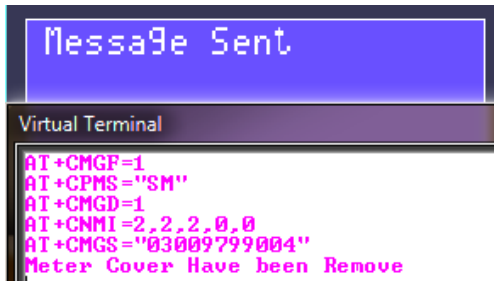
Figure 9. Protection against tampering

D. Changing Tariff Time

The tariff time is controlled by server because tariff time change with respect to weather or months. The tariff will change when the server sends a specific code to meter. When it is received by GSM module it will be recognized by microcontroller and will change the tariff time with respect to code received. These are shown in figure 10.
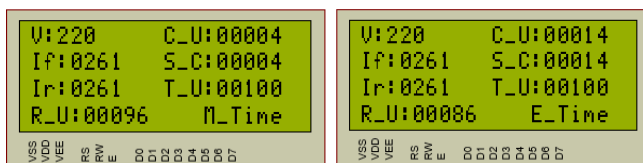

Figure 10. Changing tariff time

IV. EXPERIMENTAL SETUP

The laboratory prototype of suggested model is shown in figure 11.The service main model contain one microcontroller (PIC16F877A), voltage and current sensor and transmitter TX2B. Transmitter is activated when load is sensed by microcontroller using output of current sensor.

The main meter part consists of two parallel connected microcontrollers (PIC16F877A). One controller is used as energy measuring chip having receiver RX2B which communicate with service main part. GSM module (Sim900d in our work) is connected serially to energy measuring chip while RX output is given to energy measuring chip. Current sensors, step down transformers, LCD and a relay are also connected to energy measuring chip. The energy metering chip calculates the energy consumption on basis of the outputs of current and voltage sensors and display V, I parameters on LCD. The microcontroller is in continuous communication with GSM module. To record data of consumed, remaining and total units and detect thievery a battery backup is also installed.
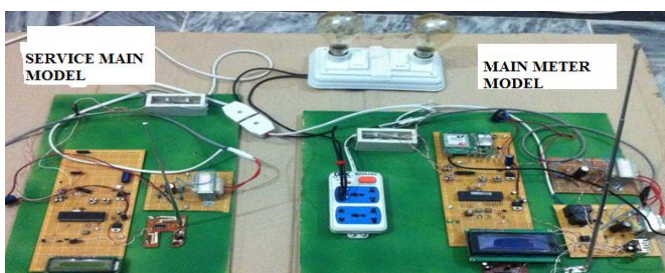

Figure 11. Prototype of the suggested advance energy meter.

V. EXPERIMENTAL SETUP

The experimental results are shown below.

A. Result of Shorting the Phase or Neutral Wire

Threshold is defined between forward and reverse current forward current is measured on phase line while reverse current is measure on neutral line. If any one bypass neutral or phase line so the differnece of forward and reverse curent will exced throshold hence theft will be detcted and a message will be sent to inform utility (service providers) against theft. The results are shown in figure 12.

Figure 12 Experimental results of shorting phase or neutral line.

B. Result of Whole Meter Bypassing

If phase and neutral lines are bypassed so current sensed by both current sensors will be zero and no unit will be consumed. To detect this kind of theft transmitter and receiver are used. When load is connected and meter is bypassed the load will be sensed by the current sensor of service main model and continuously transmit signal to main meter, service unit will count when exceed threshold value it will inform utility (service providers) against this theft by sending message. The results are shown in figure 13.

Figure 13 Experimental results of whole meter bypassing.

C. Card Recharging

The user have send the hidden code A1 from the scratch card to meter. When card recharge the user will be informed accordig to the card he have rechaged by sending messge to user and server. The results are shown in figure 14.
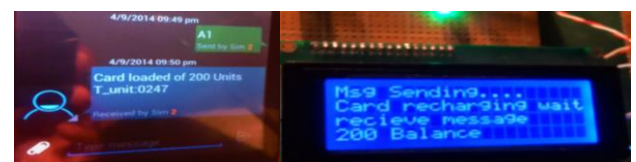

Figure 14 Experimental results of card recharging process.

VI. CONTROLING THEFT OF ELECTRICITY FROM POWER LINES USING SPECTATOR METER

Electricity steal may happen from power lines if someone is using hooks on power lines or illegal load which is shown in Fig. 15. Power theft from power line can be controlled by using

transceivers DRF7020D13 instead of transmitter and receiver. The DRF7020D13 can be used point to point or point to multi point applications. User need to set one module as host and other as client module. Each module must have unique ID. The client module should be present in meter which will send the consumed units to host or observing meter. The host is located in observer meter which is installed on power line. The observer meter will calculate all the power consumed on power line and will compare with the received power from all clients of the hosting meters or observer meter if any significant difference is found, it warns the service providers of the corresponding illegal load through SMS.
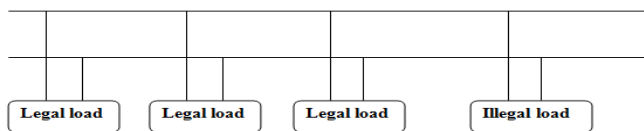

Figure 15   Illegal load

CONCUSLION

In this work, we have suggested advanced electricity metering techniques which utilizes the advantage of existing GSM infrastructure which has implicit approach to every customer house and covering disparate nations. The installation of GSM module not only covers the idea of making electricity meter prepaid but also play role in detecting electricity thievery. Information of the electricity theft is reported instantaneously to service providers with the help of GSM module and it will show the exact location of thievery whether it is done by consumer or in the form illegal load from power lines. So, it will be easy find such thievery for service providers and can take legal action immediately, hence suggested system is very helpful for service providers to diminish electricity plunder and ensuring revenue collection.

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