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Arduino GSM based Power Theft Detection and Energy Metering System

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Abstract: Electrical energy has been considered as an essential form of energy. Whether it is Industrial need or household need, electricity is a must. Nowadays, with the increasing need for electricity, power theft is also increasing. This power theft is a severe problem like load scheduling will just become a hoax because of this Theft. Also, in developing countries like India, this power theft is 30%- 40% of total generated power and the electricity board has to provide this from their funds this results in major losses to electricity boards. This paper presents a way to detect power theft, alert the consumer, and cut off the supply accordingly. When unauthorized actions are detected, and a separate message is sent back to the microcontroller to remove the illegal supply, an SMS is sent automatically to the user via the GSM module. The GSM is interspersed with a unique system energy meter with a relay to handle the non-technical losses, problems with billing, and variations in voltage fluctuations

Keyword **– GSM, Atmega328, LM2596, Arduino GSM**

Introduction

Over the last few decades, communications technology has improved through connectivity and boundaries. The use of the "Embedded Program in Communication" provides various interesting applications. Electricity is now more than necessary. The demand for electricity is increasing continuously. With increasing electricity demand, power theft is also on the rise. Power theft is a concerning issue even in the most efficient power systems like in USA and a moderately efficient system like in Malaysia [1]. It has become important to improve the system performance and to avoid Theft. The purpose of this project is to design a system to monitor any power consumed before the power meter, and that is power pilferage. If some power theft is detected, that results in penalty or disconnection of energy supply to the respective consumer, and simultaneously an SMS is sent to the control unit. In the past, numerous non-technical and scientific methods for detecting electricity pilfering have been suggested. Non-technical procedures may involve customer inspection with a suspect load profile. Although regular inspections can help reduce theft, such action calls for the massive labour force and enormous effort. In most situations, this attempt always fails due to employee dishonesty. “The use of the main observer meter at the secondary distribution terminals are some of the technological ways to detect pilferage [3], harmonic generator [6], genetic support vector machines [7], extreme learning machine, power line impedance technique [8] [3].

However, these technical approaches can be effectively implemented only if proper communication is ensured between the central control station and the appropriate test points. Recently, energy meters based on GSM network have been proposed. These meters provide the energy metering and remote load control system facility [3]. In this paper, an energy metering scheme based on GSM is introduced to deal with various aspects of electricity theft. The proposed system avoids meter abuse and bypassing irregularities.

Existing Technology

The meter is manipulated to display low readability, bypass meter, and billing irregularities. Advanced distribution automation and dynamic price models relying on automated metering (AMR) and advanced measuring infrastructure (AMI) can overcome the billing irregularities and requirements for more employees [3]. However, this system has failed to benefit the atmosphere for energy theft and requires frequent inspection by NTL. Electrical cables, coaxial cables, optical fiber, infrared, Bluetooth are also used for current communication technologies but do not have reliability, communication speed, high installation costs, and maintenance are expensive and risky.

Methodology

For successful completion of this project, the following steps were carried out in a sequential manner

- Literature Reviewing: This includes exploring various documents and books regarding this topic.
- Problem identification: identifying the problem and its consequences.
- System modelling: Combining different elements to describe the system.
- System analysis and simulation: This indicates how the system behaves using proteus.
- Proposing Solution: designing of power theft control system to use power wisely.

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Proposed System

In this paper, the energy stealing system is proposed to send the SMS using a GSM Network. The most common methods of electricity theft are to bypass the phase line, cut off the neutral line, bypass the entire meter, and distort the energy meter. The current transformer is blinded to zero current, bypassing the phase line. The voltage transformer shows zero potential by disconnecting the neutral line and giving the local ground. The entire meter is bypassed, and the energy meter is measured at zero. Faulty readings are triggered by tampering the energy meter with unauthorized modification. The main contributions of this paper as follows

- The proposed system uses only a very small number of components and a simple electricity theft algorithm.
- The customer is warned initially after several warnings, the connection of the customer is being cut, and data is simultaneously sent to the control center
- Compared to other techniques discussed, total system costs are relatively low.
- It can be integrated with existing meters and new meters of production processes.

Many named and unnamed manners for theft of electricity are also available. The use of a single household meter cannot detect and control these types of theft. An observation meter is used in the proposed system to identify such unrecounted theft. Figure 1 shows the observer meter. Measure the overall household energy consumption at agreed time intervals. For example, outside an apartment building, this type of meter can be installed. In this case, all the apartments in this apartment building measure the energy consumed. The household meters communicate their measured units via SMS to the central meter. The central meter detects the theft of electricity when both values are significantly different. Since the observer meter can be read individually, households in which theft occurred can be calculated based on zero or low power consumption. The central meter informs the server of potential theft locations via SMS. The authority may send technical personnel to check the households reported and detect the dishonest consumer [3].

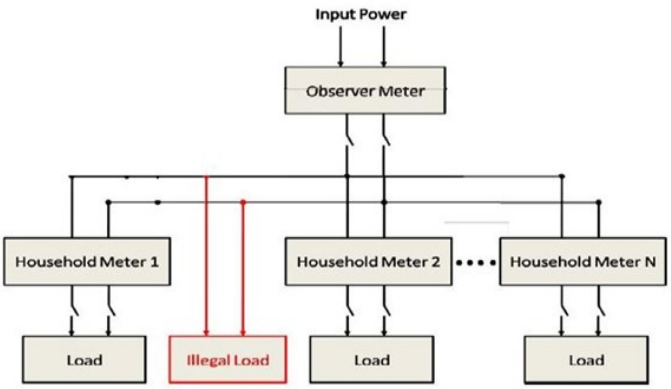

Figure 1: Block Diagram

Block Diagram

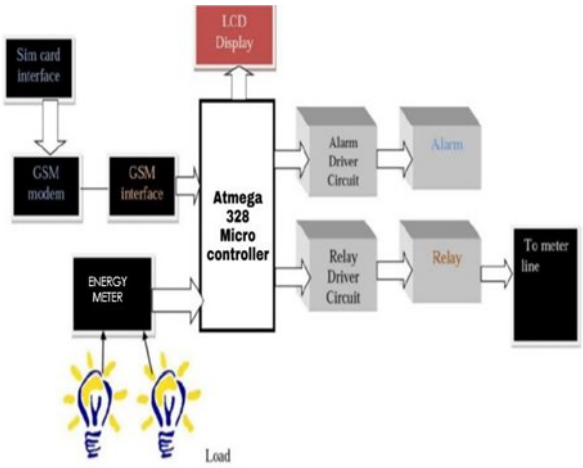

Figure 2: Proposed Architecture

The aims of the proposed program are mainly to monitor electricity theft through enhanced GSM communication features. Figure 2 shows the block diagram of the prototype. The most important components included power meter, GSM module [10], LM2596 voltage regulator, Arduino UNO [9], PC817 optocoupler, and LCD. The prototype model is a device that uses energy to link a variable load. The PC817 optocoupler and the CAL (calibration) energy meter LED is attached for the detection of consumed units. At 3200 imp/kWh the pulse rate of the power meter is. The LED blink rate is, therefore, directly proportionate to the load. To record consumed units, the output of the optocoupler is forwarded to the microcontroller.

Proposed Circuit

In the circuit first, a power supply block i.e. IC LM2596, which is made by TEXAS INSTRUMENT is introduced. This is used to get a constant 5v DC output, that is used to power 16*2 LCD, Microcontroller, Relay Module.

Data pins of the LCD display are connected to digital pins of the microcontroller (pin-6,7,8 & 9) which is used as output pins. GSM module is also interfaced with the microcontroller through digital pins 2 and 3(in the software part this is defined as transmitter and receiver pins). A buzzer is also connected to pin 11 of the microcontroller which functions in case of theft. Also, a relay is used to trip the load in case of theft, this is connected to pin 10 of the microcontroller.

Two energy meters are used one is named as master energy meter and other as a house energy meter. These meters are connected to pins A0 and A1(Analog input pins) of microcontroller through PC817(optocoupler). Optocoupler's input terminals are connected to calibration LED of Energy meter and output is connected to pins A0 & A1

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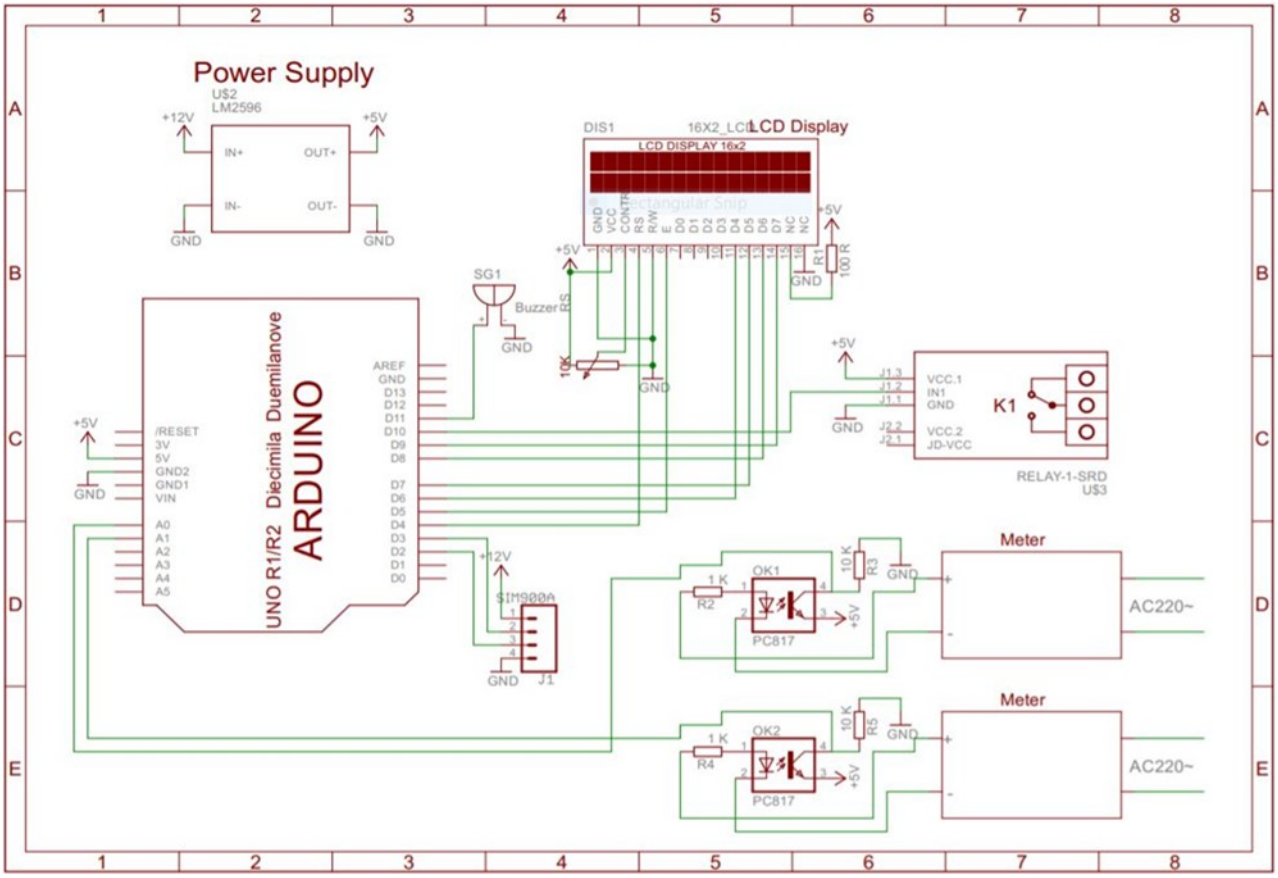

Figure 3: Circuit diagram

Hardware Design

The 230V AC power supply is given to energy meter and then connected to the load through the relay. The input of 5V for Arduino is given by a voltage regulator LM2596 from the 12V supply. The output pin of optocoupler PC817 is given to Arduino through A0 and A1. The interfacing of GSM and Arduino is made. The input 12V GSM is given through a 220 to 12V AC to DC adaptor. The corresponding message is sent through GSM.

Working

The power supply from the distributor is given to the system. This supply consists of 230 volts. The transmission lines are used to provide power supply to the consumer using electric poles at a particular distance. The system has an Arduino Atmega328, energy meter, and GSM module attached to it. Here the power supply is step down from the 230-volt power supply into 5 volts by the power supply circuit because our system uses a 5-volt power supply. The 230-volt power supply is stepped down 12 volts via a 12-volt step-down transformer so now the power supply will be 12 volts. It uses an LM2596 voltage regulator to get a 5-volt power supply which is given to our system. This 5-volt power supply given to an Atmega328 and GSM module. The system has Arduino, Energy meter, and GSM module. The master energy meter tracks the quantity of the energy units supply through it then it sends the unit consumed to Atmega328. Now Atmega328 stores this data in memory. As the supply reaches to slave energy meter it will count the number of energy units consumed. The data at the slave energy meter will be transfer to Atmega328. The Atmega328 will analyze the two data present. If the number of energy units reached varies. The Atmega328 will trigger the GSM module. The GSM module sends the SMS to the consumer about the amount of difference occurred in the transmission cable. The distributor will track the amount of loss happen and puts a penalty to the consumer. The distributer is informed about the energy loss happen to them by the system's action.

Programming

The code for the program is done in Arduino IDE and then it is burned into the Arduino. For the simulation part, Keil software is used to convert the program into .hex file. The programming logic followed is depicted in the flow chart.

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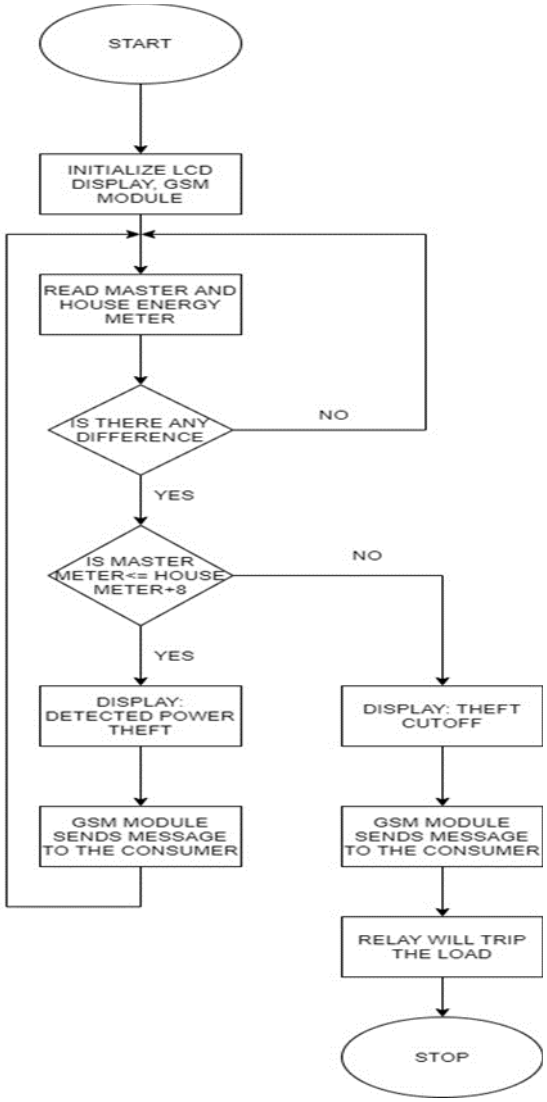

Figure 4 -programming flow chart

Simulation Results

Normal condition-Both the meter shows the same readings

NO ALERT as no theft observed.

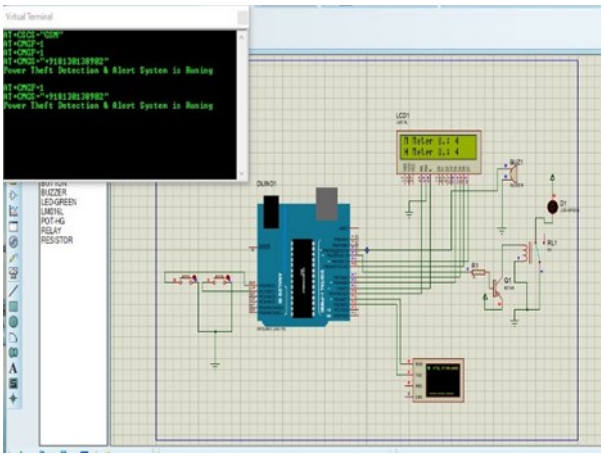

Figure 5-Normal condition

Alert stage: - When theft is observed. master meter reading and house meter readings have a difference of 3 units. alert message is sent in the message screen that power theft has been observed.

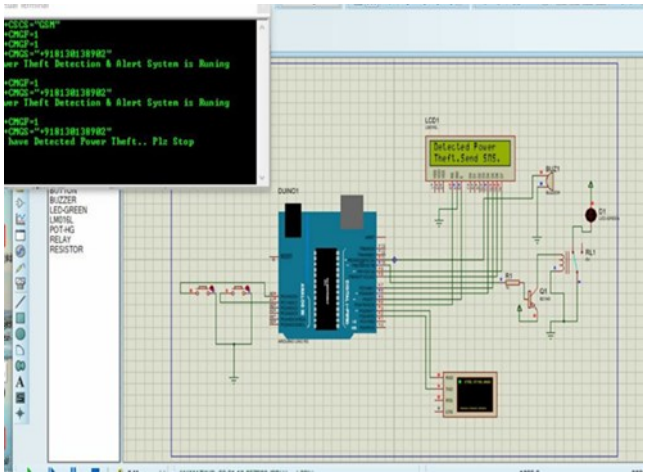

Figure 6-Alert condition

Cut off stage- when the difference between master meter reading and house meter reading is more than 8. Relay is tripped and the corresponding message of cut off is sent in the message screen.

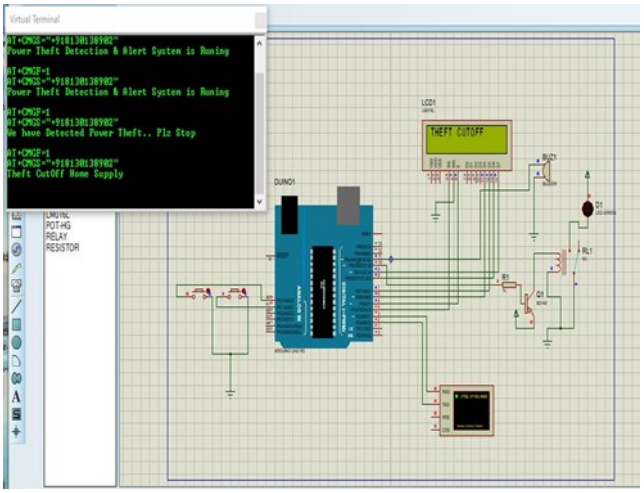

Figure 7-Cut-off condition

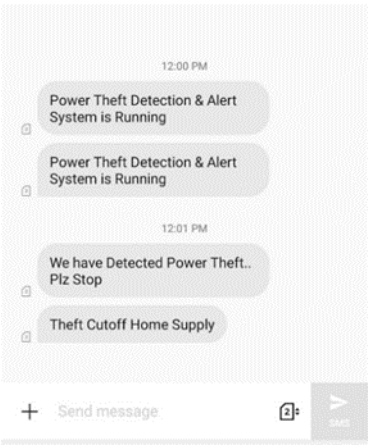

Figure 8 - Message Screenshot

Hardware Results

Under normal condition i.e. house meter reading is equal to master meter shown in figure-9. Alert stage: - when theft is observed. Master meter reading and house meter readings have a difference of 5 units, an alert message is sent inside the screen that power theft has been observed as shown in figure-10. Cut off stage: - when the difference between

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master meter reading and house meter reading is more than 10. Relay is tripped and the corresponding message of cut off is send as shown in figure-11

Figure 9-Normal condition

Figure 10-Alert condition

Figure 11-Cut-off condition

Conclusion

The proposed method of power theft minimizes the heavy power and revenue loss that results from the theft of power by customers. With the completion of the project, it is concluded that power theft can be effectively reduced by detecting when does the power theft occurs and simultaneously informing the authorities to disconnect the power to the house or customer trying to steal the power supply by an integrated automatic breaker that is attached to the unit. The system is used to send or communicate data to the consumer domain as well through a GSM wireless network. The proposed system will reduce energy waste and save more for future use.

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