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Design and Implementation of Remotely Located Energy Meter with Control and Anti-Theft Mechanism using GSM

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Abstract: ***The advent of various technological innovations and techniques, there has been a tremendous increase in the usage of electricity. With the rise in infrastructural development of developing as well as developed countries , there is also a growing concern of conservation of electricity owing to its limited sources of production. Every country has a system of billing the consumers according to their monthly electricity usage. The current technique employed utilizes manual labor who visit each home individually and click photograph of the meters and then bill is generated by the service provider according to the usage. The biggest problem that arises in this system is most of the houses have electric meters installed inside their homes and the meter reading can only be taken when the consumers are at home. This causes unnecessary labor work wastage. The bills generated are then printed and circulated to each home which becomes a cause of paper wastage and eventually to a heap of bills which are a onetime use in a month. Another rising concern for service providers is the electricity thefts that are taking place and are on a constant rise due to increased number of illegal hawkers and vendors as well as slum areas. Cases of internal thefts by residents have also risen due to increased bill rates. This conventional system needs a replacement owing to its disadvantages and must be replaced by an efficient system.The proposed work presents a technique to automate the whole process of electric billing system using smart electric meters which have anti-theft as well as fast response bill generation system with GSM for transmission to the user for bill payment***

Keywords: Smart meter , GSM , Anti-theft mechanism

I. INTRODUCTION

Electricity is one of the most It serves various purposes like home appliance, laboratories equipment, industrial purposes, irrigation purposes and so on. Over-use of this energy may lead to its exhaustion. Thus to avoid this, a record about usage of electricity by the consumer is obtained using an electricity meter and maintained. The bill is generated as per the amount of energy recorded by the meter and delivered to the user who has to pay the bill. An electricity meter is a device that measures the amount of electric energy consumed by a residence user, business, or an electrically powered device. in many countries, consumed electrical energy recorded by energy meter is noted down by a human. Accordingly as per the readings, the electric bills are prepared. In today's advanced world it has become a very difficult job to collect the meter readings as the reader has to travel to each and every place to take the readings. There are also other problems of unpaid bills, human error in meter readings, electricity theft or unauthorized electric consumption. This system becomes very difficult in rainy season. If any consumer does not pay the bill, the electricity worker needs to go to their houses to disconnect the power supply. To overcome these problems automatic or smart meter reading systems have been developed [1]. A smart energy meter is electric device having energy meter chip for consumed electric energy measurement, wireless protocol for data communication (such as GSM Modem) and peripheral devices for security purpose, data showing, meter controlling etc.[4] In this system the reading is taken automatically and the consumer directly gets to know how much electricity has been used by him. The smart meter system provides bill directly to the consumers. The smart energy meter contains an energy meter, a GSM modem, a microcontroller or Arduino and a relay circuit, which is connected between the energy meter and the load. The smart meter system makes use of GSM modem integrated within it, to transmit the data over the mobile network. Thus the generated bill is send to the consumer through SMS.[2]

II. METHODOLOGY

As we know that the technology of e-metering has gone through rapid technological advancement. There is increase in demand for reliable, accuracy and efficiency. So, by this project we introduce a design of simple low cost wireless "GSM based automatic energy meter reading system". The proposed system consist of digital energy meter, microcontroller, antitheft mechanism, GSM modem, relays and current transformers. Here the connection of current transformer is at the input of the energy meter who works

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on the principle that the difference between incoming current and outgoing current is equal to zero and the connection of relay is at the output of energy meter for proper working.The proposed design intends to implements a system which can read the meter read the meter reading electronically and transfer it automatically through the GSM modem to the energy provider side for billing purpose. The communication between these two sections is done through wireless GSM network. This system monitors the load by microcontroller, monitoring means to calculating the power supply consumed exactly by the user at a given time(say 30 days) i.e. microcontroller based system continuously monitors and record the reading on the LCD display of energy meter and the live reading send to electricity department. And the SMS containing monthly bill along with the due date and reading is send to meter owner. For the antitheft mechanism, when current supply comes from the poles of energy provider side to energy meter through the current transformer then the system starts working. If incoming current is equal to outgoing current then the system is okay. If the difference comes then the message goes to energy provider side that "theft detected" through the GSM modem and at the same time the power supply is cut by the relay and the same message is displayed on the LCD display of microcontroller. This is done by relay as it work as a switch for this system. This is for the external theft detection. It is an electrical switch operated by an applied magnetic field. It consist of contacts which is normally closed and opening when the magnetic field is applied

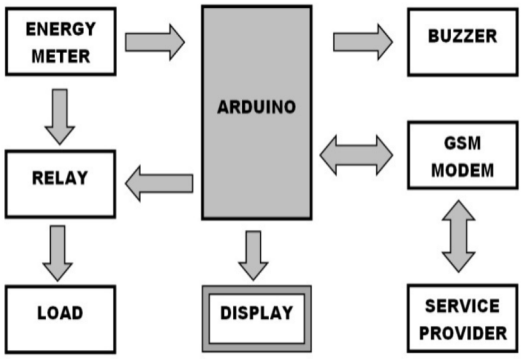


Fig.1Block Diagram of GSM based

III. HARDWARE AND SOFTWARE REQUIREMENTS

A. Hardware Description

1) Liquid Crystal Display: A Liquid crystal display is interfaced to arduino unit to display the meter reading, date time, power factor, power status, total load used etc. LCD continuously displays the present date and time and consumer usage of power in terms of units.



Fig.3.1: LCD display

2) GSM Modem: Quad-band intelligent GSM/GPRS modem is suitable for long distance data transmission. To implement smart metering system, a GSM modem is connected to a arduino kit which would transmits data from a meter to mobile phone and also receives message from mobile phone to energy meter. The modem will sent unit or pluses (power consumption) on a regular interval or on a request. AT commands set which stands for attention terminal are used by energy meter to communicate with GSM modem.[4]

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Fig.3.2: GSM modem

3) *Energy Meter:* An energy meter is a device that measures the amount of Electrical energy supplied to or consumed by home or building. The most commonly used energy meter is kilo watt hour meter. [3].The instantaneous power is then integrated against time to give energy used by the consumers. The meters are classified into two basic categories, electromechanical and electronic. The energy consumption is calculated by using the output pulses of energy meter.



Fig.3.3:Energy Meter

4) *Relay:* A relay is an electrically operated switch.

Relay is used where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. In this project a relay is used as a switch which is used to ON and OFF the power supply. It is done by sending the message through GSM modem.

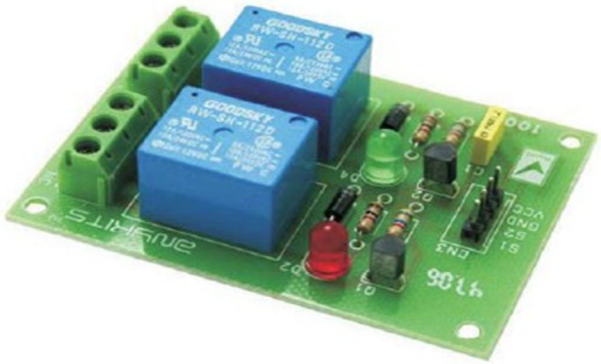


Fig.3.4: relay

5) *Arduino Nano:* Arduino is a small microcontroller board originally based on the ATmega328P intended for use on the breadboards and when space is at a premium. The arduino nano is programmed using the Adriano software (IDE-integrated development environment). It has fourteen digital input/output analog pins, six along inputs, and six are considered to PWM pin and remaining is digital pins, a sixteen megahertz quartz crystal, a.

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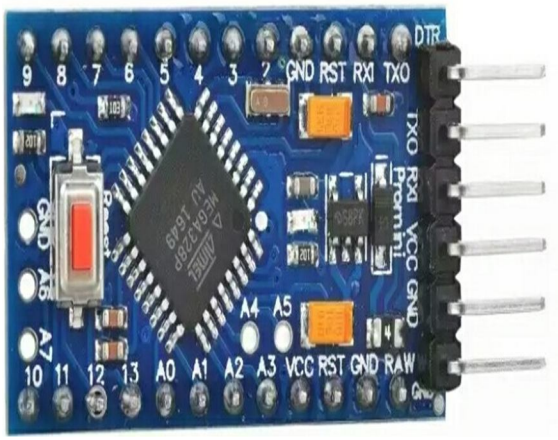


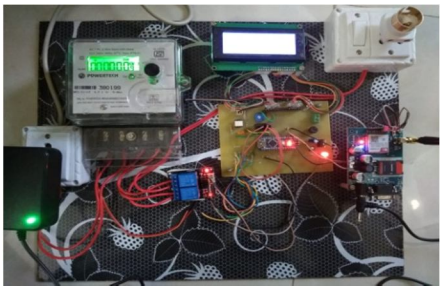
Fig.3.5:arduino nano PCB

B. Software Description

1) Arduino IDE: The Arduino IDE is used to execute arduino program and convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

IV. DESIGN AND IMPLEMENTATION

A. Hardware Implementation


Fig.4.1: Implemented set-up

The GSM module receives data from the consumer energy meter. This received data will then be uploaded to the server. After a month, the Bill is received by consumer through SMS. It provides information to the consumer regarding the amount of energy consumed and the cost. If the bill is not paid within due time, operator of the server could isolate consumer load with the help of remotely operated relay.

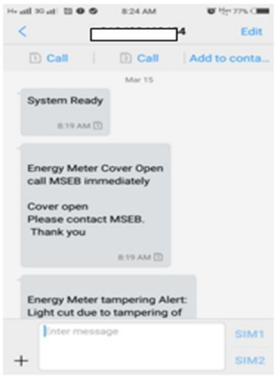
V. RESULTS

Fig 5.1 shows total reading calculation and also a warning message of cover open which is also a sign that any tampering to the meter can be done. Fig5.2 a and b represent an sms being sent through a gsm module to the user and service provider which may lead to power supply failure. Figure 5.4 shows a message to the consumer about electricity bill details which results in reduction of printed bills

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Fig. 5.1: system showing total meter reading and cover open message



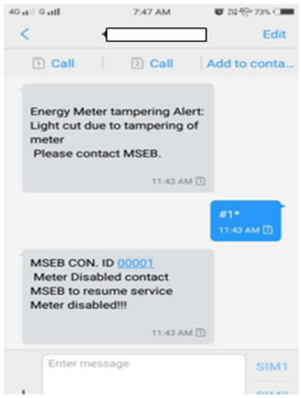


Fig. 5.2 a Fig 5.2 b

Figure 5.2 a and b SMS alerts

The results indicate an efficient anti-theft and billing mechanism which can replace the existing technology in efficient manner and remove the disadvantages of existing systems. As the load is directly disconnected in case of any theft i.e, internal or external theft thereby indicating strict action which shall result in reduced thefts and also remove the unnecessary arguments and disputes that occur when staff from service providers start cutting the lines.



Fig5.3: set up showing the total units consumed

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Fig. 5.4: message showing total units Consumed

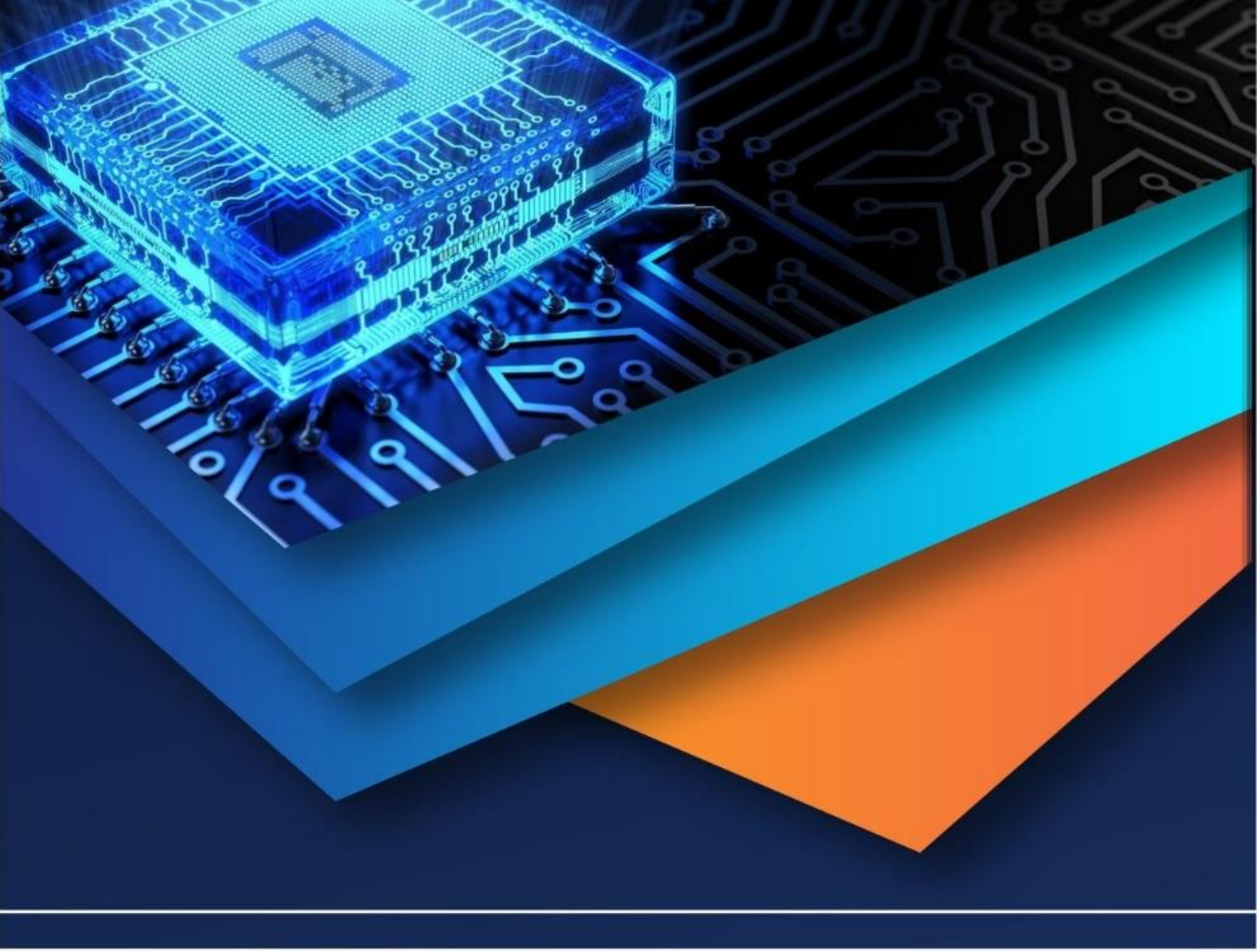
VI. CONCLUSION

Smart electric meter using GSM technology is a reliable and efficient system. Since this is a fully automatic system, the energy consumed by the users is regularly monitored. This reduces the error occurred while manual note down of readings making the system more accurate. Thus the system helps in reducing man work, providing more efficient readings, avoid the billing error and reduce the maintenance cost. GSM based energy meter is easy to install. It provides digital billing system and the generated bill will be available to the consumer through SMS. The smart meter provides various other features such as tempering alert, power cut alert, power disconnect due to outstanding dues, power reconnect after paid dues

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