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DESIGN AND IMPLEMENTATION OF GSM BASED REMOTE ENERGY METERING SYSTEM USING INTERNET OF THINGS

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Abstract

Electricity is one of the basic requirements for the people and widely used for commercial, industrial and agricultural purposes. This paper presents a facility of energy consumption measurement directly to the consumer's mobile through GSM or any wireless devices. This paper demonstrates about the methods to fetch the data from energy meter to microcontroller at consumer end and also transmitting the consumption readings to consumer. This system will be beneficial for the consumer to manage power and they can recharge through accessing the android application, website, RFID tag. It is easy to operate and cost effective. Another advantage of this system is to minimize human errors in taking meter readings and preparing bills to a large extent. Using wireless communication, it is easy to monitor the energy meter reading without any manpower preventing possible energy theft.

1. Introduction

Nowadays many ideas have been made to design the energy meter with

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payment technique. But till now this type of system is not found efficient. The generation of electricity has become less due to the non-availability of resources. The production does meet the demand of customers. There is enough loss of power. It is difficult to control and maintain the power due to growing demands. Maintenance of the power is the main task. As the electricity department operator goes to consumer's house making the bill as per the meter reading, the billing process consumes more time. There will be a malfunction if the consumers are not in the house while taking readings on energy consumption and also it requires a lot of time to analyze energy consumption generating the bill. If the customers did not pay the bill, then the operator needs to go to their houses to disconnect the electricity connection. This system consumes more time and is difficult to maintain. Some of the energy meters which had been implemented are prepaid but it needs RFID card to recharge. In this paper, we propose a method which uses GSM network and Bluetooth module and RFID interface with an AURDINO microcontroller. It will be helpful to the government to control, maintain and save the electricity (example: digitalized ADHAAR card having inbuilt chip and energy meter with RF sensor). By this card, we can recharge the meter and pay the bill by placing the card on the sensor [5].

This paper consists of hardware equipment like Energy Meter and the GSM network, RFID, Bluetooth. The system provides efficient power meter reading and usage notification via GSM network. The GSM modem sends message to the consumers end and also to the provider. The message consists of details like month, date, meter number, name and power reading. In the energy provider side, this system is used to update the consumer's account in the database. We provide a method to bill through android application by interfacing the Bluetooth module with microcontroller. We can access the designed android application for the payment and also for the reading purposes. Also, we can interface WIFI module and a database linked with website. The measured reading directly appears in the website and stored in a database. The database is updated monthly, weekly in accordance to our adopted convention. The user can directly access the website and pay the bill through online to get the electricity connection [7].

2. Functional Methods

2.1. By using light dependent resistor as a sensor

In this method, the energy meter reading is calculated according to intensity light falls on the LDR. Light Dependent Resistors can sense especially in light/dark situations. Basically the resistance of a resistor is very high. But when the light intensity is high, the resistance drops suddenly. When the light intensity decreases, then the resistance of the LDR increases. The current flowing through the 555 timer decreases. We know that continuously the LED does not light because of the load. Whenever the light falls on the resistor, it decreases its resistance and the current flow will be through the 555 timer. This 555 timer provides the digital data of number of blinks by the LED. LDR is used to count the pulses for every unit. The count of the consumed unit is 1, when the LED blinks for 3200 times. This data is further connected to microcontroller .The microcontroller counts the number of blinks according to the program written or burned into the microcontroller. The obtained units are texted through to the customer via Bluetooth or GSM. The customer can recharge the meter for the electricity connection by smart card from the nearest dealers.

2.2. By using OPTO isolator

In this method the energy meter reading is calculated according to the number of pulses generated by the OPTO isolator from the meter. The programming made is such that if the number of pulses is equal to the actual number of pulses generated by the OPTO isolator, then the microcontroller increments the unit. The real time clock is connected to microcontroller to store data according to our convenience like monthly, weekly or yearly. The Bluetooth module is connected to the ports of the microcontroller to transmit the reading to the consumers mobile. The consumer must be paired with the Bluetooth module. Then the message will be transmitted to the consumer mobile. The message consists of name, meter number, reading, location etc. The android application like PAYTM, MOBIWIK is designed for the user to know the details of the consumer about the reading and recharge payment.

The consumer can easily use the android application for payment. The data from the Bluetooth is directly linked with designed android application. It can store the details of the reading monthly, weekly by Programming the Real Time Clock with microcontroller. The block diagram is shown in Figure 1.

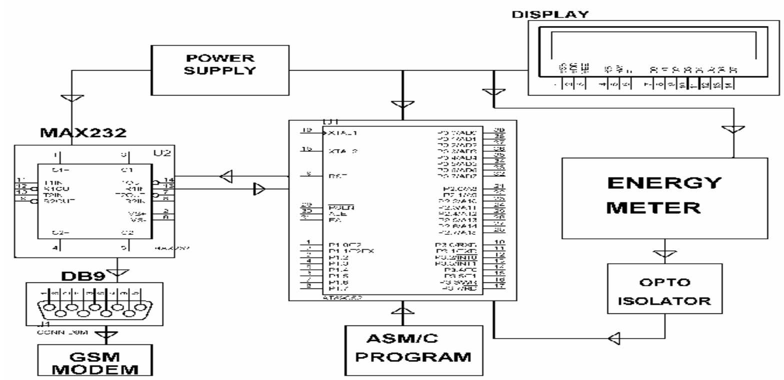

Figure 1. Block diagram using opto-isolator.

2.3. By using the infrared sensor

According to Figure 1, the OPTO isolator is replaced with IR sensor in this method. The energy meter reading calculated in accordance with the number of pulses generated by the meter is sensed by IR sensor placed opposite to led. The programming made is such that if the number of blinks is equal to the actual number of pulses generated by the meter, then the microcontroller increments the unit. The real time clock is connected to microcontroller to store data according to our convenience like monthly, weekly or yearly. The GSM module is connected to the ports of the microcontroller to transmit the reading to the consumers mobile and also to the local electricity office. The message consists of name, meter number, reading etc.

3. Designing a Hardware

In this hardware the single phase power supply load is connected to the energy meter. According to the load the LED will blink to produce a digital signal which may be used to be processed further connected to microcontroller ports. The MAX 232 convertor is used to prevent from high voltage fluctuations when the GSM and RFID module is interfaced with the microcontroller. GSM module transmits consumed data to provider's mobile phone. Each house meter has a different meter number which is provided by the Board of Electricity Department.

3.1. Power supply

The microcontroller and other digital can operate through dc supply. So to get dc supply we use rectifier. The output voltage of a rectifier is non-regulated 12V DC. The 7805 IC voltage regulator is used to convert 12 V into 5V DC. We can get 9 V by 7809 voltage regulator by connecting a single pole single throw switch is shown in Figure 2.

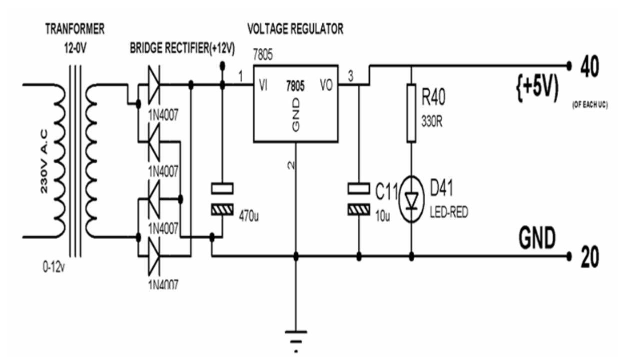

Figure 2. Block diagram for power supply.

3.2. LCD display

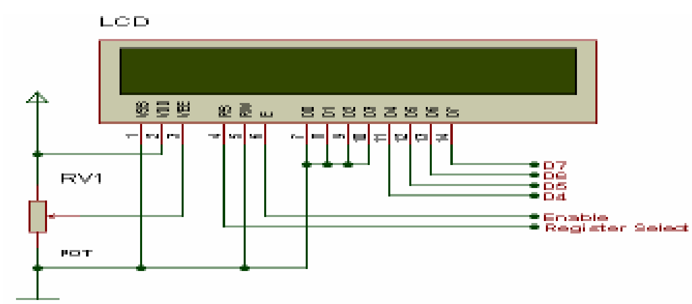

Figure 3. Pin diagram of liquid crystal display.

Most of the LCDs (Liquid Crystal Display) are connected to the microcontrollers and are 16×2 and 20×2 displays. This represents 16 characters line to line for 2 lines and 20 characters line to line for only 2 lines, respectively. The LCD in built consists of controller chip HD44780U, which receives information by an external device and displays information directly on the LCD. Pin diagram is shown in Figure 3.

The three control command pins are invoked as EN, RS, and RW.

EN = Enable this pin used to inform to LCD that the data is sending.

RS = Register Select (When RS is low (0), data is treated as a command).

(When RS is High (1), data has been sent in a text). R/W = Read/Write

When RW is low (0), the data written to the LCD

When RW is low (0), the data reading to the LCD

In this project the LCD display is used to show the balance units and the recharge amount when the RFID is placed.

3.3. MAX 232

The MAX232 is an integrated circuit which converts signals to TTL digital logic circuits through an RS-232 serial port. The MAX232 is a dual driver and also the receiver. It converts the RX, TX, RTS and CTS signals. When a microcontroller is interfaced with MAX232 IC, it receives a TTL level to convert and regulate a TTL Logic 0 in between $+3$ and $+15\text{V},$ and TTL Logic 1 in between -3 to $-15\text{V},$ and vice versa for conversion from RS232 to TTL logic level. The pin diagram is shown in Figure 4.

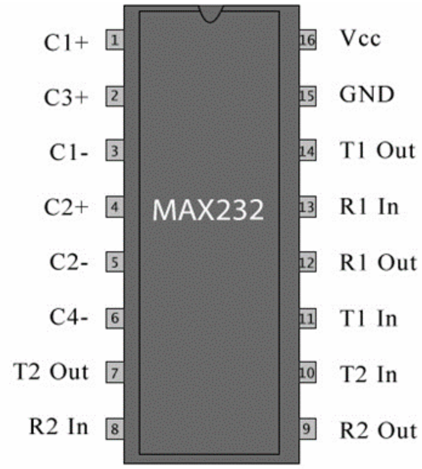

Figure 4. Pin diagram of MAX232.

3.4. Working in detail

Digital pulses from the energy meter are counted by using the inbuilt timer of AURDINO mega 2560 r3. The microcontroller is programmed to read pulses or data from the meter every second. The microcontroller increments the units consumed, according to the program written into microcontroller. In this paper, an energy meter is sequenced such that for every 1 unit of energy (kWh) consumption, it generates 3200 blinks or pulses in LED. By interfacing the Bluetooth, GSM, RFID the consumer can get a text message and he can recharge the meter for electricity. This system overcomes the human errors and makes payment of bills easy. If the units are less than the programmed units, then the microcontroller will send a message to consumer about the meter reading and balanced units, and if the user consumed all the units, then the microcontroller will sent a signal to relay to operate. The relay will cut-off the power supply from the main. By using the RTC, we can obtain the power reading weekly, monthly or yearly. At the department side the monthly data is stored in the database [6].

The RFID smart card is interfaced with the microcontroller to recharge the smart card. The smart card can be recharged through online, near dealer (ICASH card). To access the electricity he or she can place the smart card at the sensor. The microcontroller can match the amount in the programming and sent a message to the customer through GSM about the recharged amount. The relay will operate when the meter is updated with recharge amount. For online recharge they can login to website or in android mobile application. The block diagram is shown in Figure 5.

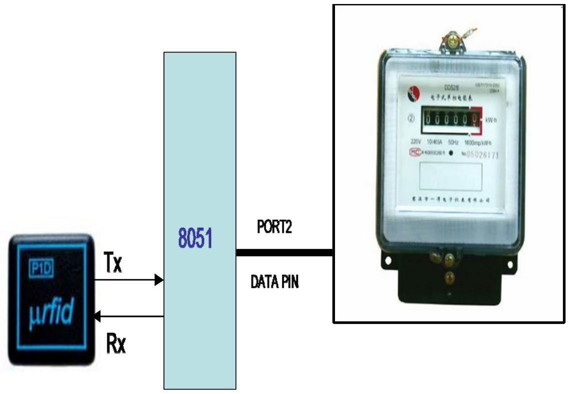

Figure 5. RFID interfacing with a microcontroller.

4. Microcontroller Programming

Microcontroller coding has been done in AURDINO IDE Compiler. At first count the number of blinks or pulses according to the load consumption, increment the number of units consumed by load according to the meter requirement. The number of units consumed is stored in the EEPROM and that is updated as per time. To recharge, the RFID tag writes another program to recharge the Tag. As we know that the operating voltage of the microcontroller is about 5V, if the voltage level is exceeded the IC will be damaged. For the serial communication (UART) use the MAX 232 IC. It works on the TTL the operating voltage $+15\text{V}$ to -15V, so it is Step down to voltage when it is connected to microcontroller. For Bluetooth communication the separate code is written to communicate the Bluetooth module and transmit the data to consumer mobile through wireless. For GSM communication, a separate code is written to communicate the GSM module and transmit the data to consumer mobile. At consumer end a GSM module is placed which consists of one SIM to communicate with others just like mobile communication. The recharged amount and the balance units are shown on the LCD display. The WIFI module is interfaced with microcontroller and by using AT commands for serial communication the data is transmitted through wireless being updated onto the database.

5. Website Designing

A website is created by using Microsoft Visual Studio 2015 and also android application to the consumer in user friendly nature. In this website are available the name of the consumer, model number of the meter, location, electricity board, pin code, units, amount to pay, balance in the account. The consumer can easily recharge the meter or can pay the electricity bill through online. The database is linked with website. The monthly reading is stored in the database. For every month the data will be updated according to the energy consumption [7].

6. Conclusion

According to this paper the efficient functional method to fetch the reading from the energy meter is by using infrared sensor. This technique is easy to install for electricity board. This project overcomes the cost, human errors, over running of the meter, overload. This leads to the reduction of outstanding dues. This design improves maintenance and energy monitoring. In this paper, the RFID is used for recharge purpose and GSM is used for monitoring, updating and also for remote access. This system reduces the time and human effort. In this paper, prepaid energy meter system can be designed to monitor the meter reading continuously. And it also cut-off the power supply from electricity department, whenever the balance units of the meter becomes zero. It avoids the human interference, efficient meter reading, billing error and it overcomes the maintenance cost. It displays the meter reading information on mobile for user notification. Using GSM, it is easy to monitor the energy meter reading via wireless without any manpower preventing possible energy theft.

7. Future Work

Nowadays the internet and the high speed technology have much significance. This paper was mainly based upon the internet of things. The data gets updated into the website daily or monthly. In addition, we are entering the world of big data analysis, where a lot of data is transferred from the sources to the given computing centers for furthering processing. All the data we fetch from the meter is analyzing in such a way that we can point out the peak demand of consumption of power of a particular city or state. By using the data analysis techniques, we can improve the performance and efficiency of the distribution system and also the generation. We can generate the power according to the load consumption through the analyzed data.

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