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AUTOMATIC ENERGY METER USING IoT

Sanchana.R[1], Dhanush Kumar.S[2], Mohan Raj[3], Mohamed Umar[4]
[1]*Assistant Professor in Department of Information Technology, Sri Sairam Institute of Technology*
[2]*Department of Information Technology Sri Sairam Institute of Technology*
[3]*Department of Information Technology Sri Sairam Institute of Technology*
[4]*Department of Information Technology Sri Sairam Institute of Technology*

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ABSTRACT
Now, days the consumption of electricity has become a basic need in the human life. The major issue faced in consumption of electricity is increased in the past few years. The traditional system is unable to track the electric meters.in traditional system the man power needs to be employed to note down the meter readings. Monitoring and keeping track of the power consumption record becomes a tedious task. To overcome this problem automatic energy meter is introduced. The automatic energy meter uses internet of things which saves energy and time. The energy meter automatically collects the remote data. In this project Arduino based electric meter is introduced and the data are monitored using the Blynk applications. The automatic energy monitoring system uses two types of sensors they are current sensors and voltage sensors. The current sensor we have used is SCT-013 Non-Invasive Ac current sensor. The voltage sensor we have used ZMPT101B AC Voltage Sensor. The voltage sensor is the best because we can measure the AC voltage accurately with the help of the voltage transformer. The current and the voltage sensors are combined together in order to obtain the required parameters to calculate the amount of electricity consumed. The current sensor is interfaced with the voltage sensor. The data obtained from the sensors are collected and send to the Blynk application. The Blynk application dashboard views the voltage, current and the total unit of the power consumed in KWh.

KEYWORDS: *current sensors, voltage sensor, Arduino, Blynkapplication*

I. INTRODUCTION

Now a day's electricity has become a basic need for human beings. There are two major issues in the consumption of electricity one is the consumption of electricity has increased over the past few years. The second one is electricity theft where there is no control over the loss or theft of electricity. The smart electric meter is introduced to overcome the issues. The smart meter can measure the consumption of electricity and can prevent the theft of electricity.

The limitations faced by traditional electricity are meters are unreliable in nature. In order to perform the meter reading a large number of man powers along with a large number of inspectors need to be employed. The major drawback faced by the customers is payment processing. The payment processing is very expensive and it is a time-consuming process. Tariffs cannot be introduced on an hourly basis along with the meters for encouraging the customers to reduce the usage of electricity. The development of software and the related network infrastructure is really complicated.

The smart grid is the modern development technique in the electric grid. The electric grid is weaker with respect to the electric load variation. The increase in population has increased the load on the electric grid. The efficiency of the grid can be remotely controlled which in turn increases the reliability. The smart grid uses automatic sensors. These automatic sensors are responsible for sending the data to the utilities. The automatic sensor has the capability to relocate the power facilities which in turn avoids the power line failures. The concept of the smart meter is employed with the smart grid concept. The smart grid is recommended in various countries for sustainable development and infrastructure.

The smart meter uses an electric meter that is capable of monitoring and maintaining the consumption of electric power on a regular basis. A smart meter enables two-way communications. The smart meter provides communication between the meter and the central system. Smart energy is software-based which power efficient device is. The smart energy device tracks the consumption of energy accurately and performs computations. The meter reading is transmitted over the wireless media therefore we can eliminate the manual reading collection. The benefits of the system are cost efficiency, reliability, and cost savings. The smart energy meters will provide information regarding energy consumption that was not available with the previous traditional system. The system allows easy disconnection and power connections from the remote site. The smart system is used to detect the tampering power line and send signals. The billing of electricity consumption will be sent through the GSM without the intervention of humans. Theft of electricity leads to power shut down in many rural areas. The main advantage of using the smart meter is low operational cost. The second is it saves more amount of time for the customers and provides a daily report about the meter readings. The customers are allowed to pay the electric bills through the online mode. The consumption of power can be reduced during the high peak time. The major advantage is it can automatically terminate the home appliances when they are not in use.

The total amount of electricity consumed in a house is referred to as power consumption. Power consumption is an important aspect of the supply of electricity. People should be aware and should preserve the electricity for future generations. The energy patterns very slowly depend on the usage of electricity. The consumption of energy patterns may vary due to the increase in the appliances.

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The power supplied to each and every household by the energy companies is vast so people are neglecting the energy and its savings. Smart meter technology plays a vital role in managing energy utilities. The people participate in the process which in turn helps them to reduce energy consumption. Smart meter technology creates awareness among people about the level of power consumption. The consumption of power by the people is high which means the usage of devices is also high. The usage of the device is directly proportional to the number of devices used and the duration. The consumer depends on the monthly bill. The consumer does not know which appliances are consuming more energy. The understanding of people's behavior is achieved through analyzing how energy is used.

II. LITERATURE REVIEW

The authors in the paper [2] explain the behavior of the people towards the smart metering system. The services that are provided by the smart metering system like viewing the consumption of electricity, turning the electrical appliances, estimating the amount of the electric bill, and finally receiving the message from the smart metering devices. The paper mainly focuses on the consumption of electricity during the nights and the weekends.

The quantitative survey among various household appliances where presented in the paper [9]. This paper mainly focuses on the mapping of the customers' perception with the household appliances. A framework TAM is used for monitoring the household appliances. The TAM framework calculates the mean score and the standard deviation.

The authors in the paper [8] describes about the smart metering system which involves several meters which continuously monitors the appliances. The data is collected on a regular basis and send as a feedback to the customers. The smart meters helps the customers to reduce the energy consumption, safe and secure energy and reduce the emission of the carbon.

The authors in the paper [13] have developed an energy management system that is capable of controlling the transmission capacity and rate generation. The energy consumption is represented in the pictorial form which includes the details about energy prices, consumption of electricity, and cost of electricity under different circumstances.

The authors in the paper [14] have developed a smart meter for the market with respect to the customers and business organization. The paper mainly focuses on energy efficiency and the awareness created among the customers about energy consumption. The different feedback is collected and proposed to save energy and to improve energy efficiency.

The authors in the paper [15] discuss the smart metering system in Hungary. The meters have two ways of communication. The communication depends on tariff-based operations. For the purpose of communication tools such as Zigbee, WIMAX, and home area network are used.

The authors in the paper [10] describes about the consumption pattern in the household and office. The paper mainly focuses on the time reporting which is done through the web. The setup comprises of equipment's along with the related soft wares. Graph is observed on 2h hour's cycles. The analysis of the appliances mainly focuses on the water heater, printing done using the laser printers. The feedbacks are collected and send to the customers based on the application which consumes more power. The authors in the paper [12] have developed a home energy management system. The client interface model is constructed using the XML. The graph is plotted against the actual price and the predicted price and maximum power utilization. To evaluate the energy management model test bed is designed. The result obtained during the experiment has resulted in saving of 22% of electricity expenditure on daily basis.

The authors in the paper [6] have developed a simulation model. The simulation models generate a load profile for the household appliances. The model is evaluated against the impact of smart appliances vs the variable price of the electricity bills. The power consumption of the household appliances is sent to the user in order to reduce the usage of the appliances. The load curves are demonstrated on the working days Saturdays and Sundays. The result obtained during the analysis is variable prices have affected the behavior of the customers under the environmental changes.

The authors in the paper [1] have mainly focused on the connection between the meters and the household appliances. The connection between the appliances is carried out in a different ways. The connection can be a dedicated connection, wireless, web based and power line connection between the home appliances and the meter. In order to improve the security the connection is made by connecting the meters to the data centers. The smart meter provides the complete information about the power consumption of a device through the mobile phones [5].

The authors in the paper [3] provide a scientific advice on how to consume the energy. The paper is worked against the set of question they are how the concept of feedback is useful for the energy consumption, how the feedback can help the users in the behavioral change, whether the feedback collected is good and effective. The implement the concept of security and privacy the authors in the paper [4] has implemented a smart metering system. The smart metering system works without the involvement of third parties. The smart metering concepts advantages are discussed in the paper [7]. The paper mainly focuses on the concept of reducing the metering cost, efficient use of energy system and finally detection of fraud.

III. ARCHITECTURE

The current and the voltage sensors are used in order to measure the power consumption and total power consumed. The current sensor we have used is SCT-013 Non-Invasive Ac current sensor. The sensor is mainly used to measure the AC current up to 100 Amperes. The non-invasive is connected along with the supply line which is capable of measuring the load up to 30 Amps. The non- invasive allows us to calculate the amount of current passed through the devices. The main advantage of using this model is light weight equipment and can measure the amount of current passed through the devices. The voltage sensor we have used ZMPT101B AC Voltage Sensor. The voltage sensor is the best because we can measure the AC voltage accurately with the help of the voltage transformer. The current and the voltage sensors are combined together in order to obtain the required parameters to calculate the amount of electricity consumed. The current sensor is interfaced with the voltage sensor. The data obtained from the sensors are collected and send to the Blynk application. The Blynk application dashboard views the voltage, current and the total unit of the power consumed in KWh. The following figure 3.1 represents the circuit diagram of the automatic metering system.

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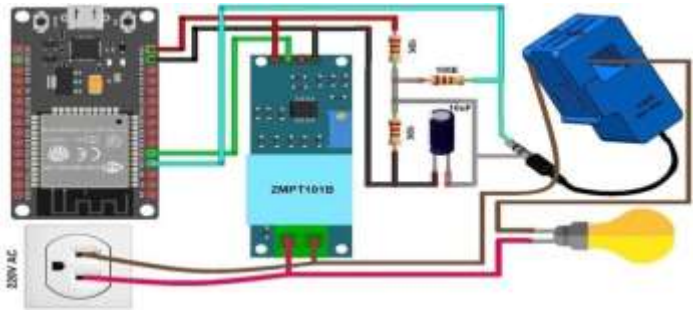
Figure 3.1 Circuit diagram of automatic metering system



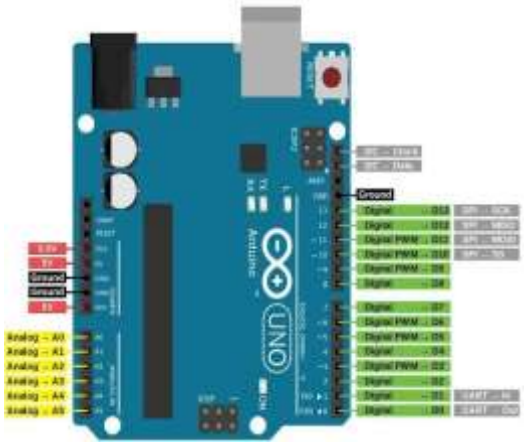
IV. MODULE DESCRIPTION

The software requirements are Arduino IDE. It is a text editor mainly used for compiling the code to check if any errors whether any errors are present. Finally, the code is uploaded to the Arduino. The hardware requirements are Arduino UNO, Current sensor, voltage sensor, and jumper wires.

4.1 ARDUINO UNO

The following figure 4.1 represents the pin diagram of the Arduino UNO. There are 32 pins available. The 22 pins are associated with input and output. The 14 pins are IO pins which are configure to the application. The application is connected using the pin mode, digital write and digital read functions. There are 6 analog input pins. The analog pins provides 10 bit resolution where the data can be read using analogRead () function. The analog pins convert the analog value into digital value which can be read form the processor. The digital IO pins are capable of producing 8-bit PWM signals. The crystal oscillator helps the Arduino in handling the time issues. The voltage regulator helps the Arduino in controlling the voltage and stabilizes the Dc voltage used by the processors.

Figure 4.1 Pin diagram of Arduino UNO



4.2 Current sensor

The current sensor is mainly used for the purpose of power calculation and management of electricity-based applications. The current sensor can measure both direct current and alternating current. The voltage isolation is 2.2 kVRMS. The voltage isolation is integrated with a low resistance current conductor. The current sensors have mainly three pins. They are VCC, Ground, and Out pins. The working method of the current sensor can be direct or indirect sense. The direct sensing method uses ohms law to calculate the voltage. The indirect sensing method uses Ampere law to calculate the magnetic field in order to measure the amount of current being used. A Low effect hall sensor is used to measure the amount of current being transmitted. The current sensor is placed on the IC on a copper conduction path. Initially, when the current flows through the copper conductor it generates a magnetic field. The Hall Effect sensor senses the magnetic field generated through the copper wires. The voltage which is generated is proportional to the magnetic field sensed through the copper conductor which in turn measures the current. Figure 4.2 represents the current sensor.

Figure 4.2 Current Sensor

4.3 VOLTAGE SENSOR

The voltage sensor is a voltage sensing device that is capable of dividing the resistive voltage. The voltage sensor reduces the input voltage by a factor of 5. Once the voltage is reduced it generates the corresponding analog output voltage. In the initial stages, we used a 0-50 v DC voltmeter which is capable of measuring the output voltage. The 0-25 v voltage sensor uses analog input of the microcontroller. The analog input is used to monitor the voltage which is capable of sensing higher voltages. There are two types of voltage sensors they are capacitive voltage sensor and resistive voltage sensor. The resistive sensors have a voltage divider and bridge circuit. The voltage divider has two resistors so that any voltage change can be amplified. The bridge circuit has four resistors. The bridge circuit is mainly used when there is a change in the voltage. The voltage sensor has 5 pins. They are VCC, ground, S, +: -:. The VCC pin is a positive terminal that can handle a voltage of 0-25v. The Ground pin is the negative terminal of the voltage sensors. “S” denotes the analog pin which is connected to the pin of the microcontroller. The voltage sensor is consists of two resistors. The two resistors have a resistance of 30KΩ and 7.5KΩ.

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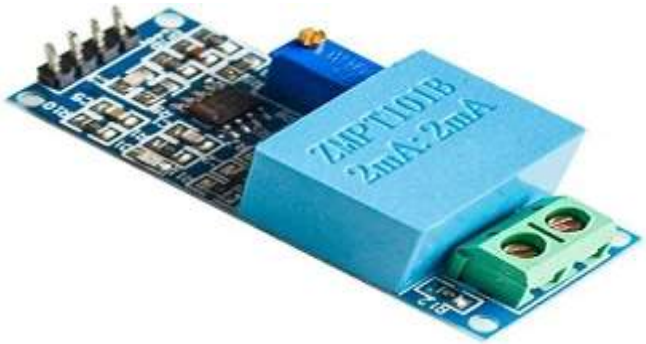
The Arduino accepts a voltage up to 5v. The main advantage of using the voltage sensors is small in weight, eco-friendly. The voltage sensors are used in multiple applications like detection of power failure, sensing the load, controlling the temperature, fault detection and controlling the power demand. The figure 4.3 represents the voltage sensor.

Figure 4.3 Voltage sensor



4.4 BLYNK FRAMEWORK

Blynk is an IoT platform mainly used for iOS or Android. Blynk is used to control Arduino, Raspberry Pi via the internet. The main advantage of this framework is that it creates a graphical interface or human-machine interface. The interface is finally compiled and provides the appropriate address available on the widgets. The second main advantage is that it can control the hardware devices remotely, it can display the sensor data, it can store the data, and finally can visualize the data. There are three major components used in the Blynk framework they are Blynk app, Blynk server, and Blynk libraries. The Blynk app allows us to create interfaces to various widgets. The Blynk server is mainly responsible for providing communication between smartphones and hardware. The Blynk libraries enable communication between different hardware platforms with servers. The libraries process all the incoming and outgoing commands. When the button is pressed in the Blynk application the data will move to the cloud and then finds the hardware in which it is installed. The main advantage of the framework is it provides minimal latency which can be used in limited geographical areas. The application has total control of data where the backup of data can be kept in the private server which in turn provides security of the data.

The steps that need to be followed: Download and install the **Blynk Application** from **Google Play Store** Once the installation is completed, open the application. Then using the sign-up option enters the Email id and Password. From the dashboard create a new project and select ESP32 & Wi-Fi Connection. Then drag & drop or add 4 widgets and assign the variable as per code and then email the authentication code. You will get the authentication code in the mail. Copy this authentication code. This will be used in your code. The figure 4.4 represents the Blynk application.

Figure 4.4 Blynk Application

4.5 REQUIRED LIBRARIES

EmonLib Library - The EmonLib Library is mainly used for Electricity Energy Meter**.** EmonLib continuously monitors the usage of electrical energy. The continuous monitor of electricity repeats every 5 or 10s**.** The output obtained will be a sequence of voltage and current measurements. The true average is calculated based on the voltage obtained and the current from different input channels. Finally the measurements are sketched and are available and should be read and the data needs to be processed.

Blynk Library - Blynk is the most popular Internet of Things mainly used for the iOS or Android. The Blynk app is used to control Arduino via the internet. The Blynk app provides a platform for connecting the hardware devices to the cloud, application designing to control them, and deploying and managing the products at different scale. The Blynk Library can connect over 400 different hardware models. The models include **A**rduino, ESP8266 & ESP32 to the Blynk Cloud**.**

V. RESULT AND DISCUSSION

The following figure 5.1 represents the circuit diagram of the automatic metering system. The current and the voltage sensors are combined together in order to obtain the required parameters to calculate the amount of electricity consumed. The current sensor is interfaced with the voltage sensor. The data obtained from the sensors are collected and sent to the Blynk application.

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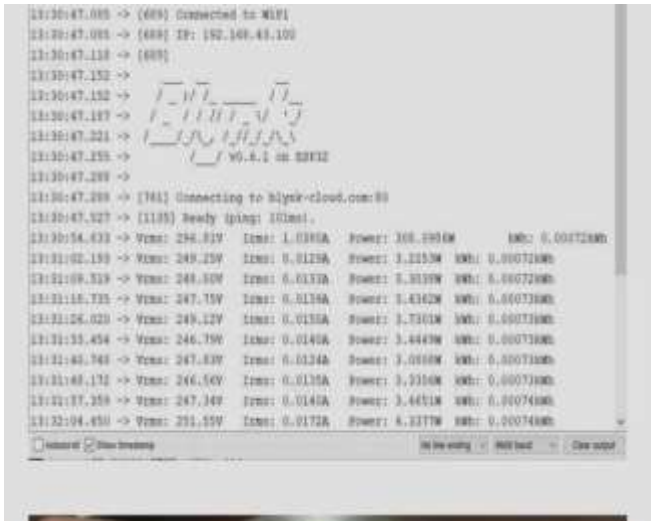
Figure 5.1 Circuit diagram of Automatic metering system

The following figure 5.2 represents the creation for an account in the Blynk application. Once the installation is combined open the application on the android mobile. Then using the signup option enters the email id and the password.

Figure 5.2 Creation of account in the Blynk application

The following figure 5.3 represents the total unit of power consumed in Blynk application. The current sensor is interfaced with the voltage sensor. The data obtained from the sensors are collected and sent to the Blynk application. The Blynk application dashboard views the voltage, current, and total unit of power consumed in kWh.

Figure 5.3 Total unit of power consumption using the Blynk Application



VI. CONCLUSION

The smart energy meter is designed in such a way that it reduced the human labor load. The smart energy meter provides a more structural and organized method for energy consumption and billing. The system provides more security to the user from unwanted threats. The system provides more awareness to the user by providing the daily limit information which in turn helps the user to reduce the consumption of electricity. The automatic method proposed will help the electricity board to disconnect the connection if the users have not paid the bill in time. The system proposed helps in controlling energy consumption and avoiding the wastage of energy.

VII. FUTURE WORK

The smart energy meter works can be extended by conducting experiments on artificial neural networks. The methods like moving average with the different inputs can be used to predict different datasets. The advantage of using artificial neural networks is these models will be capable of comparing the relationship between the dependent and independent variables. The comparison between the variables can improve the future forecast which in turn will help to reduce the error in the previous forecast.

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