IoT based Smart Power Grid Monitoring and Control using Arduino

Ch. Uday Sankar[1], Y. Vinay Kumar[2], P. Ashok Kumar[3], L. Chandu[4], Ch. Siva Naga Vardhan[5]
Mrs. S. Bhavani[6] , Dr. N. Samba Siva Rao[7]

[1] *Ch. Uday Sankar, Student, EEE, NRI Institute of Technology, Andhra Pradesh, India*
[2] *Y. Vinay Kumar, Student, EEE, NRI Institute of Technology, Andhra Pradesh, India*
[3] *P. Ashok Kumar, Student, EEE, NRI Institute of Technology, Andhra Pradesh, India*
[4] *L. Chandu, Student, EEE, NRI Institute of Technology, Andhra Pradesh, India*
[5] *Ch. Siva Naga Vardhan, Student, EEE, NRI Institute of Technology, Andhra Pradesh, India*
[6] *S. Bhavani, Associate Professor, EEE, NRI Institute of Technology, Andra Pradesh, India*
[7] *Dr.N. Samba Siva Rao, Professor & HOD, EEE, NRI Institute of Technology, Andra Pradesh, India*

ABSTRACT

This project describes the digitization of load energy usage readings over the internet. The proposed system design eliminates the involvement of human in electricity maintenance. The user can monitor energy consumption in watts from a webpage by providing a channel id for the load. The Webpage utilizes the THINGSPEAK analytics to analyze the energy usage to give more detailed description and visualization of the energy usage statistics. Wi-Fi unit performs IOT operation by sending energy data of the load to the webpage which can be accessed through the channel id of the device. In the proposed system, consumer can do power management by knowing energy usage time to time. This proposed system utilizes an Arduino microcontroller. The unit which is generated can be displayed on the webpage through the Wi-Fi module. Smart grid is one of the features of smart city model. It is energy consumption monitoring and management system. Smart grids are based on communication between the provider and consumer. One of the main issues with today's outdated grid deal with efficiency. The grid becomes overloaded during peak times or seasons. It is also possible to hack the system, and basically, take free electricity. By using smart grid consumer and owner get daily electricity consumption reading and owner can cut electricity supply remotely through internet if bill is not paid. One more thing, the data collected from the smart meters should not be accessed by any unauthorized entities. In case meter tempering is happened then owner and consumer getmessage and then owner take the action accordingly. Fitting the circuit on customer's energy meter, from that energy consumption data can be acquired. After acquiring of data, that data can be updated on cloud service, so that consumer and provider can access that data through internet.

Keyword :- *Arduino Uno Board, ESP 8266 Wi-Fi Module, 16*2 LCD Display, Current Sensor.*

1. INTRODUCTION

Energy generation companies provide electricity to all households via intermediate controlled power transmission hubs known as the Electricity Grid. Sometimes difficulties arisedue to a failure of the electricity grid, resulting in the blackout of an entire area supplied by that grid The project aims to solve this problem by utilising IOT as a means of communication, as well as addressing a variety of other issues that a smart system can address in order to avoid unnecessary losses in energy procedures. IOT smart energy grid is based on AT mega family controller which manages the system's various activities .The Wi-Fi technology is used to communicate with the system over the internet. In this project, a bulb is used to demonstrate as A valid consumer and a bulb to show an invalid consumer. The primary benefit of this project is the reconnection of active grid transmission lines. If an energy grid fails and there is another energy grid, the system switches the transmission lines to this grid, allowing for an interrupted electricity supply to the region whose energy grid failed. And this information about which grids are active is updated on the IOT Gecko webpage, where authorities can login and receive updates. Apart from monitoring the grid,this project has the advance capabilities of monitoring energy consumption and even detects theft of electricity. The amount of electricity consumed and the estimated cost of the usage gets updated on the IOT Gecko webpage along with the Energy Grid information. The system simulates theft conditions utilising two switches.

2. LITERATURE SURVEY

One year after the previous edition of the Cluster book (2012), it is clear that the Internet of Things (IOT) has reached many different players and gained additional recognition. Smart Cities (and regions), Smart Car and Mobility, Smart Home and Assisted Living, Smart Industries, Public safety, Energy environmental protection, Agriculture, and Tourism have received a lot of attention as potential Internet of Things application areas. In line with this trend, the majority of governments in Europe, Asia, and the Americas now see the Internet of Things as a source of innovation and growth. Although larger players in some application areas have yet to recognise the potential, many of them are paying close attention or even hastening the pace by coining new terms for the IoT and adding new components to it.Furthermore, end users in the private and business sectors have developed significant competence in dealing with smart devices and networked applications. As the Internet of Things evolves, its potential is increased by combining it with related technology approaches and concepts such as cloud computing, the Future Internet, Big Data, robotics, and Semantic technologies. The concept is not new in and of itself, but it has only recently become apparent as related concepts have begun to reveal synergies by combining them. However, the Internet of Things is still maturing, in particular due to a number of factors, which limit the full exploitation of the IOT. Among those factors the following appear to be most relevant.

-No clear global approach to the use of unique identifiers and numbering spaces for various types of persistent and volatile objects.
-There will be no accelerated use or development of IOT reference architectures.
-Slower progress in semantic interoperability for exchanging sensor data in heterogeneous environments.
-Difficulties in developing a clear strategy for enabling innovation, trust, and data ownership in the IOT while also respecting security and privacy in a complex environment.
-Difficulties in developing a business that fully utilises the Internet of Things.
-A lack of large-scale testing and learning environments that facilitate experimentation with complex sensor networks while also stimulating innovation through reflection and experience.

[1], describes the development of an energy metre based on non-invasive current sensing. Noninvasive current sensing has the advantage of being able to be installed at any point where power is to be measured. In this case, the energy consumption details are displayed on a smartphone. To send data over the internet, an ENC28J60 Ethernet module was used.
[2] developed a power line communication-based automatic metre reading device (AMR) (PLCC). Data is sent over electrical wiring cables in PLCC. This possibility necessitates appropriate changes to the house's domestic wiring. Furthermore, it employs an invasive technique to detect mains current.The disadvantage of this type of system is that it does not allow the user to measure the power consumed by an individual device.
[3] describes the development of a wireless automatic metre reading system (WAMRS) that uses the widely used GSM/GPRS network. The system includes a microcontroller that sends power consumption values calculated from sensed voltage and current values to a master station on a regular basis over an existing GSM/GPRS network. The main disadvantage of this technology is the factor of distance. Long-distance GPRS or GSM network coverage may be unavailable, while speed of operation may be another disadvantage.

3. SYSTEM OVERVIEW

Fig-1: Smart Grid Representation

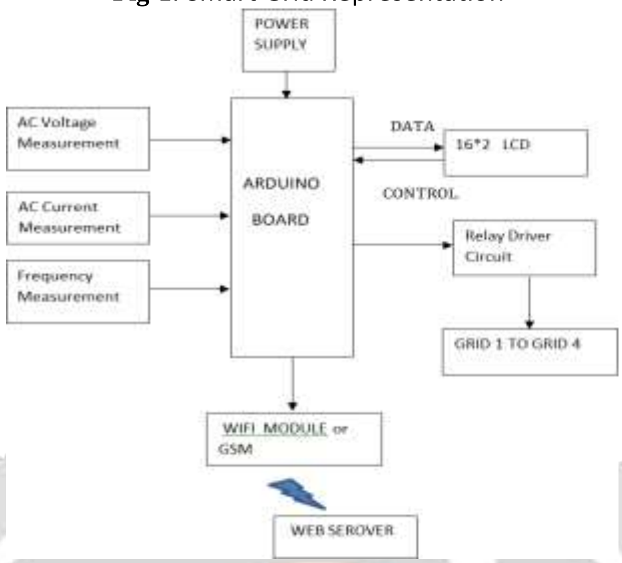

Fig-2:- Block diagram of system

3.1 Arduino UNO R3

In addition to all of the previous board's features, the Uno now employs an ATmega16U2 rather than the 8U2 found on the Uno (or the FTDI found on previous generations). This enables faster transfer rates and increased memory. There are no drivers required for Linux or Mac (an inf file for Windows is required and included in the Arduino IDE), and the Uno can be used as a keyboard, mouse, joystick, and so on. In addition to the AREF, the Uno R3 includes SDA and SCL pins. In addition, two new pins have been added near the RESET pin. One example is the IOREF, which allows the shields to adapt to the voltage supplied by the board. The other is unconnected and will be used in the future. The Uno R3 is compatible with all existing shields, but it can also adapt to new shields that use these additional pins. The ATmega328-based ArduinoUno is a microcontroller board. Arduino is an open-source prototyping platform that is ideal for both hobbyists and professionals due to its simplicity.The Arduino Uno has 14 digital I/O pins (six of which can be used as PWM outputs), 6 analogue inputs, and a 16 MHz processor, crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connectitto a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Arduino Uno differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it features the Atmega8U2 microcontroller chip programmed as a USB-to-serial converter.

3.1.1 Features of the Arduino UNO:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

3.2 Liquid Crystal Display

This is the first Parallel Port interfacing example. We'll begin with something simple. Because this example does not make use of the Bi-directional feature found on newer ports, it should work with the majority, if not all, Parallel Ports. It does not, however, demonstrate the use of the Status Port as an input to the Parallel Port for a 16 Character x 2 Line LCD Module. These LCD Modules are very common these days and are very easy to work with because all of the logic required to run them is on board.

Fig-3.2: LCD Display

3.3 ESP8266 3Module

The ESP-01 ESP8266 Serial WIFIWireless Transceiver Module is a self-contained SOC with an integrated TCP/IP protocol stack that can provide access to your WiFi network to any microcontroller. The ESP8266 can host an application or offload all Wi-Fi networking functions to another application processor. Each ESP8266 module comes pre-programmed with AT command set firmware, which means you can simply connect it to your Arduino device and get about as much WiFi-ability as a WiFi Shield (and that's just out of the box)! The ESP8266 module is a low-cost board with a large and rapidly growing community. This module has a powerful enough onboard processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime.

3.4 Signal Cond. Block of voltages and current

When a microcontroller measures voltages and current, a proportionalDC analogue voltage is applied to its ADC. Initially, AC voltages or currents are converted to DC (step down) by CT or PT. The capacity of CT and PT will be determined by the load handling capacity and the available mains supply. 5A/50 ma CT is used in our project work to sense the load current, which is connected in series with the load.The voltage can be measured using 230V to 6V, 9V, or 12V PT. If the input voltage exceeds 300V, a special PT is used to withstand 440V. The current capacity of PT is insignificant. Currently available capacity ofPT up to 300 ma is appropriate. In the case of PT voltages, the ratio of the relationship between primary and secondary is linear. When the CTcurrent ratio is important. The secondary current is proportional tothe primary current The current ratio will be determined by the number of secondary and primary turns .The highest possiblevalue of the Burdon resistor is determined by the secondary current as well as the required voltage across the Burdon resistor.

4. ADVANTAGES AND DISADVANTAGES

4.1 Advantages

- More efficient transmission of electricity.
- Quicker restoration of electricity after powerdisturbances.
- Reduced operations and management costs forutilities, and ultimately lower power costs forconsumers.
- Time saving technology.
- Tamper detection to reduce electricity theft.

4.2 Disadvantages

- Exposure of sensitive customer data.
- Connectivity to untrustworthy partners that cannotbe selected.
- Exposure of critical infrastructure due to connectivity reasons.

5.COCNCLUSION

The Smart Grid is causing a revolution in the energy domain. Smart Grid technology is both owner and user friendly. The user can check their daily consumption from any location by using the internet. The control unit allows the owner to control the customer metre. One of the most promising and prominent internet of things applications is smart grid. Electricity transmission that is more efficient. Faster restoration of power after a power outage. Utility operations and management costs are reduced, resulting in lower power costs for consumers. Technology that saves time. Meter tempering control.

6.REFERENCES

[1] Madhuri G.Hiremath1, Veeresh Pujari2, Dr. BaswarajGadgay. “IOT Based Energy Monitoring & Control Devices”,International Journal for Research in Applied Science &Engineering Technology (IJRASET), Volume 5 Issue VI, June2017.

[2] Rajiv .K. Bhatia and Varsha Bodade,"Smart Grid Securityand Privacy: Challenges, Literature Survey and Issues",International Journal of Advanced Research in ComputerScience and Software Engineering, Volume 4, Issue 1,January 2014.

[3] Mitali Mahadev Raut, 2Ruchira Rajesh Sable, 3ShrutikaRajendra Toraskar. “Internet of Things(IOT) Based SmartGrid”, International Journal of Engineering Trends andTechnology (IJETT) , Volume 34 Number 1- April 2016.

[4] Stamatis Karnouskos,"The cooperative Internet ofThingsenabled Smart Grid", SAP Research,Vincenz-Priessnitz Strasse 1, D-76131, Karlsruhe, Germany,2013.

[5] https://en.wikipedia.org/wiki/Liquid-crystal_display.

[6] https://www.eeweb.com/company blog/allegro_microsystems/hall-effect-linear-current sensor-ic.