ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

MONITORING AND CONTROLLING HOME ELECTRICITY USING IOT BASED ENERGY METER

Josiah Samuel Raj J [1], Mrs.D.ANITHA,[2]

[1]P.G. Student, Department Of Computer Science And Engineering,

Government College Of Engineering, Tirunelveli

[2]Assistant Professor, Department Of Computer Science And Engineering,
Government College Of Engineering, Tirunelveli

ABSTRACT: Internet of Things (IoT) is a new revolution in the technology that allows the user to connect to the things like electronic devices, appliances and machines with the help of the internet. IoT allows things to communicate with the user by exchanging data and managing the information. IoT is implemented in many scenarios such as Smart Cities, Home Automation, Security and Surveillance, Industries, Energy Sector, Environmental Management, Retail and Logistics, Health and Lifestyle and also in Agriculture. In the recent years, by the growth of IoT and digital technologies, smart grid has been becoming smarter than before and hence it is used for power monitoring and management. By collecting and analyzing the data on power generation, transmission and consumption of the power can improve efficiency of the power system by optimizing the operations, maintenance and planning. Cloud-based monitoring of smart grid can improve energy usage levels by giving feedback to users with real-time pricing information. Likewise, in home automation, the energy meter used in home can also be embedded with IoT hardware and sensors can be used to know of power usage and its cost that can be lively monitored by the user with the help of cloud. The load of current that is consumed by each appliances in the home can also be viewed hence the wastage of power can be reduced. It is easy for the people to manage the power usage of their homes. Smart Energy metering in home is implemented with the same infrastructure like smart grids. It is a simple way for energy consumption and production.

KEYWORDS: Cloud-Based Monitoring, Real-Time Pricing Information, Power Generation, Smart Grid, Power Monitoring And Control.

I. INTRODUCTION

In today days electricity is the every one basic need and consumption of energy is increases day by day .and resources energy decrees day by day. Usage of power is also increasing that's why prevention is better than cure awareness of energy consumption should be brought into every place before resources get extinguished. And in now day's technology is the most important part human's life. By using this technology social interaction of peoples growing. Technology are also use for transportation ,internment and in medical field it's also usage for creation of many devices like mobile phones ,computers laptops have caused many people's are connected to technology to communicate with their friends ,family access and store the information such as document movie music and picture. The internet has become a common interface that many devices use to simplify the daily life of many peoples. Internet helps us to take immediate solution for many problems and also able to connect from any of the remote places which contributes to overall cost reduction and energy consumption.

The designed system will help in reducing the energy wastage by continuously monitoring and controlling the electrical appliances. Smart Home or home automation introduces technology for home atmosphere which is usage to provide ease and protection to its occupants. By using the technology of the Internet of Things, The internet of things (IoT) is the network of physical devices, vehicles, buildings and other items embed with electronic, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. Smart Home automation is the residential extension of building automation and involves the control and automation of lighting, heating, ventilation air conditioning (HVAC),

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

appliances, and security. Modern systems generally consist of switches and sensors connected to a central hub sometimes called a "gateway" from which the system is controlled with a user interface that is interacted either with a wall-mounted terminal, mobile phone software, tablet computer or a web interface. Smart Home automation means to connect all electrical devices in the home to a central control system that control those devices according to user inputs. The connected electrical devices are intelligent in a sense. Internet helps us to bring in with immediate solution for many problems and also able to connect from any of the remote places which contributes to overall cost reduction and energy consumption The Internet might even be utilized in home automation that offers several decisions from economical use of energy to additional console, protection and safety. Even over great distances the user can monitor and manage their home gate, various appliances and turn on/off the T.V without any human intervention. [6] discussed about a system, GSM based AMR has low infrastructure cost and it reduces man power. The system is fully automatic, hence the probability of error is reduced. The data is highly secured and it not only solve the problem of traditional meter reading system but also provides additional features such as power disconnection, reconnection and the concept of power management. The database stores the current month and also all the previous month data for the future use. Hence the system saves a lot amount of time and energy. Due to the power fluctuations, there might be a damage in the home appliances. Hence to avoid such damages and to protect the appliances, the voltage controlling method can be implemented.

The user domain of the smart grid naturally blends with hybrid system. But the typical proposed approaches the development of a firmware for a smart control, which can control the on & off of the load by using IOT platform. In this project we are using the controlling and monitoring in IOT server at anywhere in the world by using Internet. The portion of the smart grid on customer premises-embedded controller in an IOT platform. In this project the smart energy meter are connected to the opto-coupler. In opto-isolator, also called an opto-coupler is a component that transfers electrical signals to the control signals.

In IOT (Internet of Things) is a secure access point we are using in mobile phone or PC. In IOT platform is access on customer and EB admin by using IOT server is not a same password or different password and different user ID in database. In third parties are not accesses but a fully secured. So then only the advanced techniques are used in this project. In order to improve market acceptance and ease of deployment. Now a days the embedded world an advanced & intelligent system by using real time applications. So, thus the system is very cost effective and also it can perform precise operation for saving the power.

II. LITERATURE SURVEY

Palensky P. et al. [4] proposed the demand side management: Demand response, intelligent energy systems, and smart loads. Energy management means to optimize one of the most complex and important technical creations that we know: the energy system. While there is plenty of experience in optimizing energy generation and distribution, it is the demand side that receives increasing attention by research and industry. Demand Side Management (DSM) is a portfolio of measures to improve the energy system at the side of consumption. It ranges from improving energy efficiency by using better materials, over smart energy tariffs with incentives for certain consumption patterns, up to sophisticated real-time control of distributed energy resources. The watts required for each equipment is distributed after verifying their optimal value. The cost value is not known concurrently.

Jenkins N. et al. [5] proposed about the reporting available demand response. Demand response is increasingly important in many power systems but Transmission System Operators (TSO) require confirmation that the response is available if it is to be used effectively. Demand response may be used to minimize the amount of spinning reserve obtained from partially loaded generators. The ability of the proposed smart metering communication system in the U.K. to report the available demand response from domestic appliances was examined. This communication system expects to send all data traffic at an average rate of about 190 Mbytes per minute through a central Data Communication Company (DCC) to any actor operating in the power system. It is unlikely that this communication system will, in addition, support reporting demand response in near real-time. Using load profiles of fridges, cooking appliances and washers and dryers, the load profiles of 40,000 houses were constructed. These load profiles were used to calculate the average number of load changes in a typical house, a 11/0.4 kV transformer and a high voltage substation. Using these average numbers of load changes and the number of transformers and substations in the U.K. power system, the number of messages sent by all smart meters in the U.K. was calculated. It is shown that the wide area network proposed for the U.K. need to send an additional 162 Mbytes per minute to report demand response in near real-time.

The distribution of power in evenly maintained to the large area without any loss of power. The transmission lines carried from the distributor to the home is passed with the information message reported about the transmission to the both end users.

Cooper G. et al. [3] proposed DEHEMS: Creating a digital environment for large-scale energy management at homes. The metering units located at the consumer-end of the Smart Grid, domestic energy monitoring and management systems aim to provide direct energy feedback whilst (or shortly after) consumption occurs, so as to persuade users to achieve energy saving and efficiency. However, existing solutions are challenged by the lack of large-scale practice and study on user behaviours and preferences. In this paper, we present a domestic energy management system (DEHEMS), which deploys electricity and gas monitoring in European-wide homes. The system has been developed in three cycles in order for households to participate and contribute. Results based on both qualitative and quantitative data analysis show that less energy has been consumed using the system. Additionally, positive behavioural changes have been achieved among households. The analysis obtained from the system is used for the research and study purposes. It can minimize the error in the future inventions. It does not monitor the power at the real time usage in the home.

Sauter T. et al. [2] proposed "End-to-end communication architecture for smart grids." Smart grids heavily depend on communication in order to coordinate the generation, distribution, and consumption of energy-even more so if distributed power plants based on renewable energies are taken into account. Given the variety of communication partners, a heterogeneous network infrastructure consisting of IP-based and suitable field-level networks is the most appropriate solution. This paper investigates such a two-tier infrastructure and possible field-level networks with particular attention to metering and supervisory control and data acquisition applications. For the problem of network integration, a combination of gateway and tunneling solutions is proposed which allows a semitransparent end-to-end connection between application servers and field nodes. The feasibility of the approach and implementation details are discussed at the example of power line communication and IP-based networks investigated in the European research project on real-time energy management via power lines and internet. Nevertheless, it is shown that the communication architecture is versatile enough to serve as a generic solution for smart grids. Every terminal in the large grids can be controlled for a little extent or only for some specific tasks alone. Not all the functions of the grids involved with the networks are displayed to the people in the organization.

Benzi F. et al. [11] proposed "Electricity smart meters interfacing the households." The recent worldwide measures for energy savings call for a larger awareness of the household energy consumption, given the relevant contribution of domestic load to the national energy balance. On the other hand, electricity smart meters together with gas, heat, and water meters can be interconnected in a large network offering a potential value to implement energy savings and other energy-related services, as long as an efficient interface with the final user is implemented. Unfortunately, so far, the interface of such devices is mostly designed and addressed at the utilities supervising the system, giving them relevant advantages, while the communication with the household is often underestimated. This paper addresses this topic by proposing the definition of a local interface for smart meters, by looking at the actual European Union and international regulations, at the technological solutions available on the market, and at those implemented in different countries, and, finally, by proposing specific architectures for a proper consumer-oriented implementation of a smart meter network.

III. PROPOSED SYSTEM

In this proposed method is approaches the development of a firmware for a smart meter monitoring system by using IOT platform. A proposed method provides the communication between the Electricity Board section and the consumer section using Internet of things (IOT).The power fluctuations are monitored using the current sensors are fed to the microcontroller which indicates it to the Electricity Board. Since IOT is cost effective compared to SMS, monitoring of energy meters at lower cost is made possible. The system is more reliable and accurate reading values are collected from energy meters. Live readings of the energy meter can be viewed through web. Also, the readings can be viewed online. The human intensive work is avoided and all the values are maintained in the central server. The communication medium is secure and tampering of energy meters can be identified easily.

IV. SYSTEM ARCHITECTURE AND MODULE DESCRIPTION

A. SYSTEM ARCHITECTURE

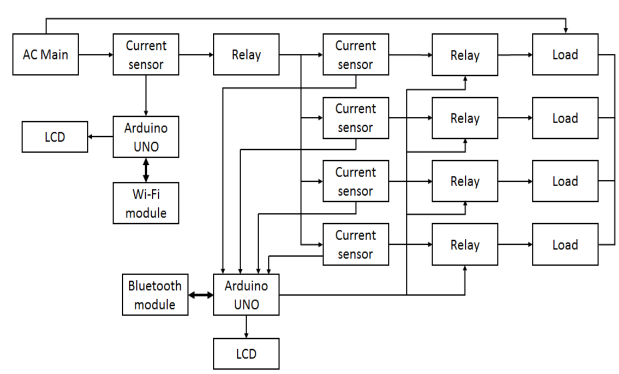


Fig.1.Block diagram

Block diagram description

In this project, monitoring the energy meter by using IoT. AC main supply used to supply all units. Current sensor is used to measure the current from the power line. In this system used two controller for monitoring the current from main supply and monitoring the current from individual loads. Atmega 328 controller used as main controller. In this project used five current sensor. Four current sensors used to measure the current from all loads in home. One current sensor is used to measure the

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE
International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

current from AC main source. Controller receive the data and to update the information in webpage through Wi-Fi module. This information is monitored through server unit. The client receives the data from all load units through Bluetooth module which is also display the information in LCD.

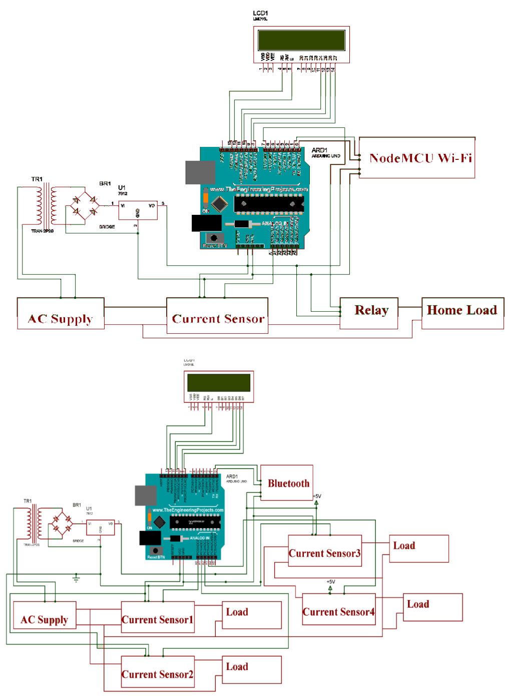


Fig.2. Circuit diagram

Circuit diagram description

AC mains supply gives supply to all components. It is used to convert AC voltage into DC voltage. Transformer used to convert 230V into 12V AC.12V AC is given to diode. Diode range is 1N4007, which is used to convert AC voltage into DC voltage. LM 7805 regulator is used to maintain voltage as constant.

In this project monitoring the energy meter through IoT platform. In this system consists of two units. One unit is used to measure the current from all loads in a home. Four loads are connected to four current sensors. These sensors are used to measure the current from all loads. This system used Atmega328 controller.

It has 28 pins, the inputs can be controlled by transmitting and receiving the inputs to the external device. Four current sensors are connected to controller port A0 to A3. Controller receiver the data from sensor and to update the value in mobile through Bluetooth. It is connected to controller port 0 & 1.

Another unit is used to measure the overall current from EB source and update the information in webpage. One current sensor is connected to AC main source. It is used to measure the current from the main source and is given to controller port A0.

Controller receiver the current value and update the value in webpage trough IoT via Wi-Fi module. It is connected to controller port 0 & 1. LCD is connected to controller port 8, 9, 10, 11, 12 & 13. It is used to display the short messages.

B. HARDWARE REQUIREMENTS

ARDUINO UNO

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control objects in the physical world.

The project is based on microcontroller board designs, manufactured by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on the Processing project, which includes support for the C and C++ programming languages.

The first Arduino was introduced in 2005, aiming to provide an inexpensive and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The hardware design specifications are openly available, allowing the Arduino boards to be manufactured by anyone. Adafruit Industries estimated in mid-2011 that over 300,000 official Arduino had been commercially produced, and in 2013 that 700,000 official boards were in users' hands.

There are many Arduino-compatible and Arduino-derived boards. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use completely different processors, with varying levels of compatibility.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

Hardware

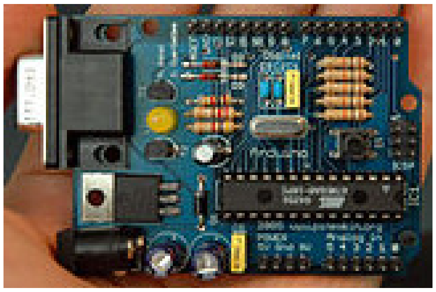


Fig.3. Arduino Uno

An early Arduino board with anRS-232 serial interface (upper left) and an Atmel ATmega8 microcontroller chip (black, lower right); the 14 digital I/O pins are located at the top and the six analog input pins at the lower right.

An Arduino board historically consists of an Atmel 8-, 16- or 32-bit AVR microcontroller (although since 2015 other makers' microcontrollers have been used) with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which lets users connect the CPU board to a variety of interchangea add-on modules known as shields. Some shie communicate with the Arduino board directly o various pins, but many shields are individu addressable via an I²C serial bus—so many shields can stacked and used in parallel. Prior to 2015 Offic Arduino had used the Atmel mega AVR series of chi specifically the ATmega8,ATmega168, ATmega328, ATmega1280 and ATmega2560 and in 2015 units by ot manufacturers were added. A handful of other process have also been used by Arduino compatibles. Most boa include a 5 V linear regulator and a 16 MHz cry oscillator (or ceramic resonator in some varian although some designs such as the Lily Pad run at 8 M and dispense with the onboard voltage regulator due specific form-factor restrictions. An Arduir microcontroller is also pre-programmed with a b loader that simplifies uploading of programs to the chip flash memory, compared with other devices t typically need an external programmer. This makes us an Arduino more straightforward by allowing the use an ordinary computer as the programmer. Currently, c boot boot loader is the default boot loader installed Arduino UNO.

At a conceptual level, when using the Arduino integra development environment, all boards are programn over a serial connection. Its implementation varies w the hardware version. Some serial Arduino boards cont a level shifter circuit to convert between RS-232 lo levels and TTL-level signals. Current Arduino boards programmed via Universal Serial Bus (US implemented using USB-to-serial adapter chips such the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the Arduino Uno, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods, when used with traditional microcontroller tools instead of the Arduino IDE, standard AVR ISP programming is used.

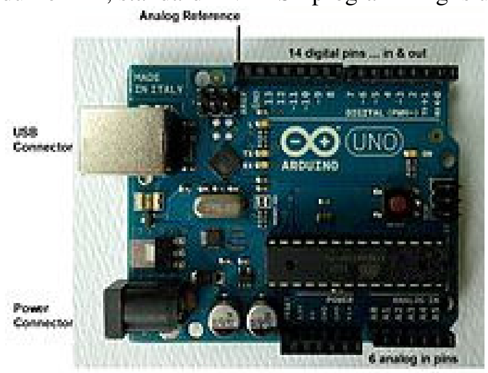
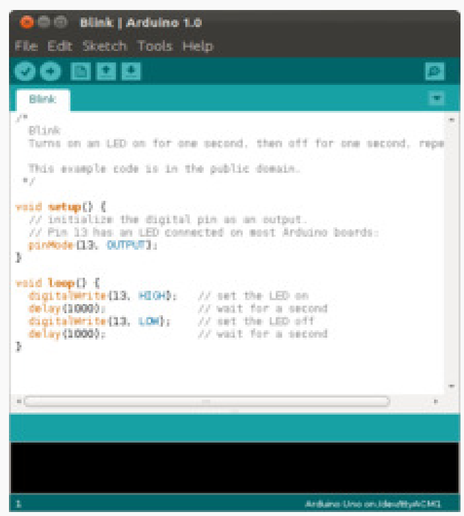


Fig.4. Input and Output configurations of Arduino Uno

Software

Arduino Software IDE



A screenshot of the Arduino IDE showing the "Blink" program, a simple beginner program

Developer(s)	Arduino Software
Stable release	1.6.7 / 17 December 2015; 49 days ago[17]

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

Written in	Java, C and C++
Operating system	Cross-platform
Type	Integrated development environment
License	LGPL or GPL license
Website	arduino.cc

Fig.5. Arduino IDE

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.
The Arduino project provides the Arduino integrated development environment (IDE), which is a platform application written in Java. It originated from the IDE for the Processing programming language project and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism for compiling and loading programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch".
The Arduino IDE supports the C and C++ programming languages using special rules of code organization. The Arduino IDE supplies a software library called "Wiring" from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consists of two functions that are compiled and linked with a program stub main () into an executable cyclic executive program:

Setup (): a function that runs once at the start of a program and that can initialize settings.

Loop (): a function called repeatedly until the board powers off.

After compilation and linking with the GNU tool chain, also included with the IDE distribution, the Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

TABLE I
SPECIFICATIONS OF ATMEGA328P

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (Atmega328P) of which 0.5 KB used by boot loader
SRAM	2 KB (Atmega328P)
EEPROM	1 KB (Atmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

ATMEGA 328

Atmega328 is an 8-bit and 28 Pins AVR Microcontroller, manufactured by Microchip, follows RISC Architecture and has a flash type program memory of 32KB.It has an EEPROM memory of 1KB and its SRAM memory is of 2KB.It has 8 Pin for ADC operations, which all combines to form PortA(PA0 – PA7).It also has 3 built-in Timers, two of them are 8 Bit timers while the third one is 16-Bit Timer. UNO is based on atmega328Microcontroller. It's UNO's heart. It operates ranging from 3.3V to 5.5V but normally we use 5V as a standard. Its excellent features include the cost efficiency, low power dissipation, programming lock for security purposes, and real timer counter with separate oscillator. It's normally used in Embedded Systems applications.

Atmega328 pin out

Through pinout diagram we can understand the configurations of the pins of any electronic device, so you are working on any Engineering Project then you must first read the components' pin out.

- Functions associated with the pins must be known in order to use the device appropriately.
- Atmega-328 pins are divided into different ports which are given in detail below.
- VCC is a digital voltage supply.
- AVCC is a supply voltage pin for analog to digital converter.
- GND denotes Ground and it has a 0V.

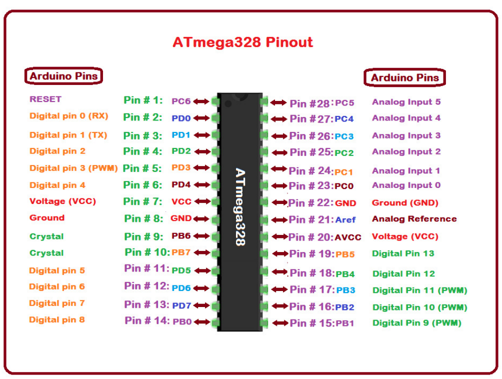
ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

- Port A consists of the pins from PA0 to PA7. These pins serve as analog input to analog to digital converters. If analog to digital converter is not used, port A acts as an eight (8) bit bidirectional input/output port.
- Port B consists of the pins from PB0 to PB7. This port is an 8 bit bidirectional port having an internal pull-up resistor.
- Port C consists of the pins from PC0 to PC7. The output buffers of port C has symmetrical drive characteristics with source capability as well high sink.
- Port D consists of the pins from PD0 to PD7. It is also an 8 bit input/output port having an internal pull-up resistor.

Applications

- A complete package including Atmega 328 and Arduino can be used in several different real life applications.
- It can be used in Embedded Systems Projects.
- It can also be used in robotics.
- Quad-copter and even small aero-plane can also be designed through it.
- Power monitoring and management systems can also be prepared using this device.
-



V. RESULTS AND DISCUSSION

A. SMART ENERGY METER FOR HOME

Main Display

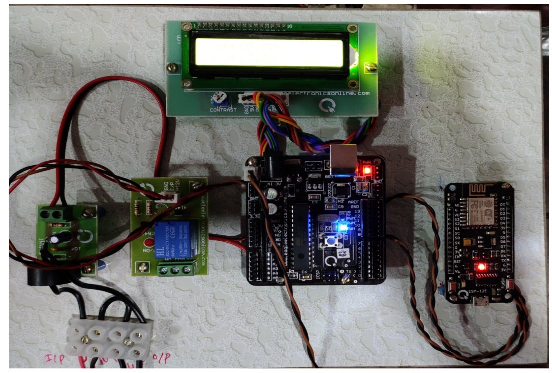


Fig.6. Smart Energy Meter

The input AC from the Electricity board is stepped down with the help of the transformer and passed through the current sensor and regulator and then given to Arduino Uno. The microcontroller Ardiuno Uno which is loaded with instructions is connected to the Wi-Fi Module.

Individual Load Monitoring Meter

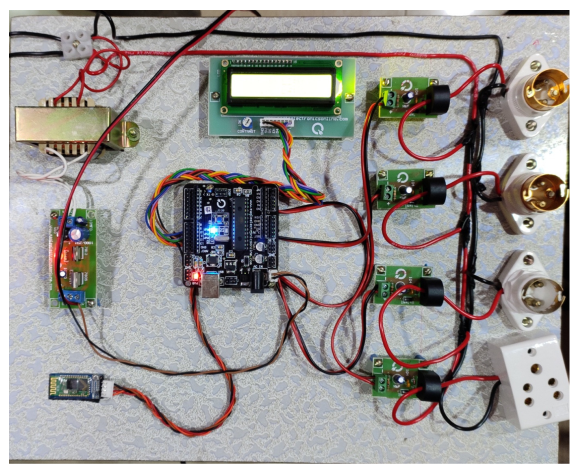


Fig.7. Load Monitoring Meter

This extension of the energy meter can be fixed inside the home circuit box.

The number of loads can be given as the input as appliances watts and their usage.

Before any appliances powered on the meter displays no value. During the power consumption and when load is acquired the meter displays the reading as well update its cost to the cloud.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

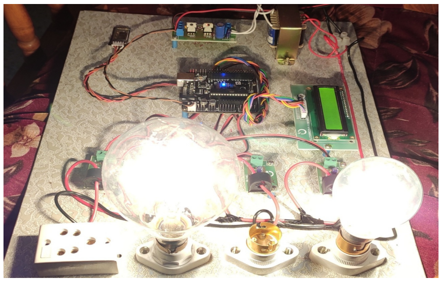


Fig.8. Usage of two input loads

Monitoring the Individual Load by Bluetooth devices

Fig.9. Monitoring through Bluetooth interface during power usage

Bluetooth module transferring data to the smart phone can be viewed by "Bluetooth Electronics" application.

Power consumption and billing cost monitoring through cloud

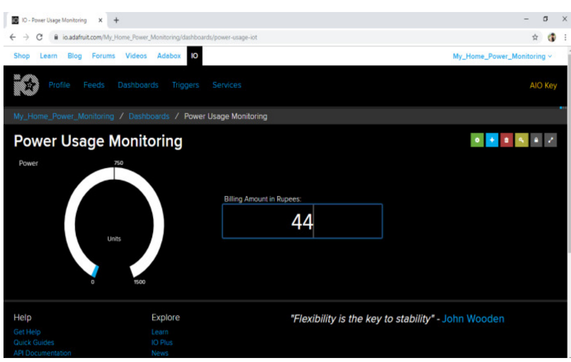


Fig.10. Power consumption charges monitoring through cloud

The real-time usage of the power and its corresponding cost can be monitored by the user in the server at anytime and at anywhere over the internet.

Power control using Mobile devices

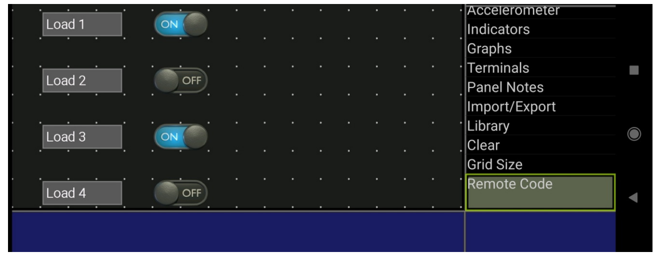


Fig.11. Power control using Mobile devices

The status of two input loads which is currently running can be controlled by the mobile application. It is turned on or off as required. Hence the power wastage is minimized.

VI. CONCLUSION

The Arduino Microcontroller the operations were studied and it is programmed and the system working model was developed in order to accomplish the objective. "The IOT based Smart Energy meter" saves the customer's time by making their work easier. The operation of the calculating the power cost is simple and doesn't involve delays. In this project Atmega 328 controller along with serial communication has been used to interface with the Wi-Fi. The IOT based Energy meter for monitoring current and displayed in LCD. The current value is send through serial communication to the webpage via IoT. In future this project can implement the energy management about unnecessary voltage trips, and for heavy appliances. Addition of more other sensors to make it even more better to use.

The control of the home appliances will be implemented to save the energy by accessing it through the internet. This will allow the regulated power to flow to the home and access can be given to the household members.

REFERENCES

[1] V. Giordano, F. Gangale, and G. Fulli, "Smart grid projects in Europe: Lessons learned and current developments, 2012 update" Eur. Commission, Joint Res. Centre, Inst. Energy Transp., Sci.Policy Rep., 2013.

[2] National Institute of Standards and Technology, *NIST Frame work and Roadmap for Smart Grid Interoperability Standards, Release 1.0*,Office of the National Coordinator for Smart Grid Interoperability-U.S.Department of Commerce, NIST Special Publication 1108, Jan. 2010

[3] R. Ma, H. H. Chen, Y. Huang, and W. Meng, "Smart grid communication: Its challenges and opportunities," *IEEE Trans. Smart Grid*, vol. 4, no. 1, pp. 36–46, Mar. 2013.

[4] P. Palensky and D. Dietrich, "Demand side management: Demand response, intelligent energy systems, and smart loads," *IEEE Trans. Ind.Informat.*, vol. 7, no. 3, pp. 381–388, Aug. 2011.

[5] K. Samarakoon, J. Ekanayake, and N. Jenkins, "Reporting available demand response," *IEEE Trans. Smart Grid*, vol. 4, no. 4,pp. 1842–1851, Dec. 2013.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 6, Issue 10, October 2020

[6] Christo Ananth, G.Poncelina, M.Poolammal, S.Priyanka, M.Rakshana, Praghash.K., "GSM Based AMR", International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST), Volume 1,Issue 4,July 2015, pp:26-28

[7] A. A. Khan and H. T. Mouftah, "Web services for indoor energy management in a smart grid environment," in Proc. 2011 IEEE 22nd Int.Symp. Pers. Indoor Mobile Radio Commun. (PIMRC), pp. 1036–1040.

[8] J. Byun, I. Hong, B. Kang, and S. Park, "A smart energy distribution and management system for renewable energy distribution and context awareservices based on user patterns and load forecasting," IEEE Trans.Consum. Electron., vol. 57, no. 2, pp. 436–444, May 2011.

[9] A. Zaballos, A. Vallejo, and J. Selga, "Heterogeneous communication architecture for the smart grid," IEEE Netw., vol. 25, no. 5, pp. 30–37,Sep. 2011.

[10] T. Sauter and M. Lobashov, "End-to-end communication architecture forsmart grids," IEEE Trans. Ind. Electron., vol. 58, no. 4, pp. 1218–1228,Apr. 2011.

[11] F. Benzi, N. Anglani, E. Bassi, and L. Frosini, "Electricity smart meters interfacing the households," IEEE Trans. Ind. Electron., vol. 58, no. 10,pp. 4487–4494, Oct. 2011.

[12] Enel Press Release. (2011, Nov. 4). Italy's First Smart Grid in Isernia[Online]. Available: http://goo.gl/RsY8F

[13] B. Botte, V. Cannatelli, and S. Rogai, "The telestore project inEnel's metering system," in Proc. 2005 18th Int. Conf. Exhib. Electr.Distrib. (CIRED), pp. 1–4.

[14] Y. Yang, Z. Wei, D. Jia, Y. Cong, and R. Shan, "A cloud architecture based on smart home," in Proc. 2010 2nd Int. Workshop Educ. Technol.Comput. Sci. (ETCS), vol. 2. Wuhan, China, pp. 440–443.

[15] Q. Hu and F. Li, "Hardware design of smart home energy management system with dynamic price response," IEEE Trans. Smart Grid, vol. 4,no. 4, pp. 1878–1887, Dec. 2013.