INDIVIDUAL LOAD MONITORING AND ANALYSIS USING IoT

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ABSTRACT

Energy management and Energy Auditing are the foremost vital areas in technology. Generation of power needs immense investment and causes hazard to the atmosphere by depleting natural resources. Whereas managing the facility merely needs some basic information and data concerned regarding the energy consumption of apparatus that was utilized by us in day to day activities. The main aim of the project is to produce a detail energy monitoring report of individual devices used in domestic appliances like fan, light, motor etc. through an associate application. Our project uses current sensor and voltage sensor to watch the consumption of individual appliances and these information is provided to the Arduino unit. The detailed information of energy consumption will get updated in the android application through a Wi-Fi module and also the energy consumed by individual devices is updated for every ten second and can be monitored for hours, days, weeks and months. The application used in our project is available in playstore. By implementing this idea in the normal life user will have information concerning detailed energy consumption of individual devices and manage the energy consumption.

Keywords: *Energy management, Energy auditing, current sensor, voltage sensor, Arduino and Wi-Fi module.*

1. INTRODUCTION

Energy is the most vital part in today's world. Without energy the day to day activities are affected. And conjointly with this quick growing world the necessity of energy is also increasing for every second. At this current state generation of energy isn't a giant task. However the power generation requires tons of natural resources which cause hazard to the environment. Generating energy also requires huge amount of money. Thus to avoid all these issues we can simply manage energy. Energy management refers to the method of observing energy consumption in home. By means of energy management we are able to scale back carbon emissions to avoid the hazard in environment. By characterizing the proper energy management technique we can able to save energy.

In the existing methodology NILM technique is employed which has several disadvantages. Non-Intrusive Load monitoring technique is fully based on the working of transients. Each device will have a unique transient during turning on and off. The expert will fed the transients previously and monitor the energy consumption based on the transient. This can be done only for large power consuming equipment and it also requires experts help to fix and install the device.

To boost and overcome the disadvantages in energy management we use the emerging technologies to attain larger efficiencies in term of energy saving. Here we have a tendency to used IoT within the energy management

The Internet of Things (IoT) is a system of interconnected computed devices, mechanical and digital machines, objects that are supplied with distinctive identifiers and therefore it has the ability to transfer knowledge over human-to-human or human-to-computer. It is the network of physical devices, vehicles, home appliances and alternative things embedded with physics, software, sensors, actuators, hardware components, devices and network property that permits all of these objects to exchange knowledge. Every issue is unambiguously spe cifiable through its embedded ADPS however it is in a position to inter-operate with the present network.

In our project we have used current sensor and voltage sensor to observe the facility. An Arduino is employed to observe the period of energy consumption. All the information is collected within the Arduino and processed through the code. Finally the information is distributed through a Wi-Fi module. The application is employed using IoT. Every individual user can have a personal ID to observe the energy consumed in their

house. This may be accessed by the user at anytime. With this application we are able to conjointly refer graphical illustration of the energy consumption individual devices. The projected methodology may be accustomed to manage energy for residential masses.

2. LITERATURE SURVEY

Mikko Tuomisto from VTT Technical Research Centre of Finland, Espoo, Finland presents a technical system, which uses the non-intrusive appliance load monitoring (NIALM) method. The solution enables the end user to observe the electricity consumption of the individual appliances. By dividing electricity consumption to individual appliances, it improves the users' understanding of the overall energy use of the building. This way the owner of the building is able to intervene better with the energy consumption of the building. Observation of the electricity appliances is performed in a web application in a user interface calendar view.

Mario E. Berges, Ethan Goldman, H. Scott Matthews, and Lucio Soibelmanld uses Nonintrusive load monitoring (NILM) technique for deducing the power consumption and operational schedule of individual loads in a building from measurements of the overall voltage and current feeding it, using information and communication technologies. In that article, they reviewed the potential of this technology to enhance residential electricity audits. First, they reviewed the currently commercially available whole-house and plug-level technology for residential electricity monitoring in the context of supporting audits. And then contrasted this with NILM and showed the advantages and disadvantages of the approach by discussing results from a prototype system installed in an apartment.

Vignesh Mani, Abhilasha, Gunasekhar, Lavanya and Suresh Sankaranarayanan Proposed that with upcoming machine to machine communication where devices can be connected wirelessly leading to IoT, here they had developed an IoT based Smart Energy Management system where appliances like Fan and Bulb to start with are controlled wirelessly based on humidity and light intensity information. These inputs are used towards controlling the appliances intelligently rather than just switching on or off. In addition the system also keeps computing throughput the day power consumption of the appliances which gives the user knowledge on power being consumed over a period of time. These details are updated in Cloud server. These prototype systems developed have achieved energy conservation at every household

Srihari Mandava and Abhishek Gudipalli proposed that Internet of Things (IOT) is a network which houses and connects electronics, sensors, software and network connections for collecting and exchanging data to take control of things on this globe. This IOT connects the physical world with the computer based system and at the end, it results in more efficiency, accuracy and profit for the user. The IOT is not limited to a particular area and in future it plays a greater role in each and every area of research. Home Energy Management System (HEMS) is an area which utilizes renewable energy sources, reducing carbon emissions, coordinating the load at home with the demand and constraints of the user like electricity bill making the information from various sensors through different communication technologies. HEMS are one of the areas where this IOT plays a key role in future for making energy management at home as simple as possible for the user.

3. COMPONENTS

3.1. Current Sensor

The Winson WCS2720 provides economical and precise solution for both DC and AC current sensing in industrial, commercial and communications systems. This can be used for easy installation. Typical applications include motor control, load detection and management, over-current fault detection and any intelligent power management system etc. The WCS2720 consists of a precise, low-temperature drift linear hall sensor IC with temperature compensation circuit and a current path with 0.4 mΩ typical internal conductor resistance. The two node terminals of the conductive path are electrically isolated from the device leads. The terminals of the conductive path are electrically isolated from the sensor leads. This allows the WCS2720 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques and make system more competitive in cost.

Chart-1 Winson WCS2720 current sensor

3.2. Arduino voltage Sensor module

This module is based on resistance point's pressure principle and can make the input of red terminal reduce 5 times the original voltage. The maximum Arduino analog input voltage is 5V, so the input voltage of the module should not be more than 5V*5=25V. Because the Arduino AVR chip have 10 bit AD, so this module simulation resolution is 0.00498V (5V/1023).

The input voltage of this module should me more than 0.00489V * 5 = 0.02455V. The voltage input range should be 0–25V. The voltage detection range should be 0.02455-25V.

Chart-2 Arduino voltage sensor module

3.3. Arduino UNO

Arduino is a single-board microcontroller which form victimization in physical science and in multidisciplinary comes an additional accessible. The hardware consists of associate degree ASCII text file hardware board which is designed around associate degree of 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software system consists of a regular artificial language compiler and a boot loader that executes on the microcontroller. The Arduino Uno is hopped-up via the USB affiliation or with associate degree external power .The supply is chosen mechanically. External power will return either from a635ssociate degree AC to- DC adapter (wall-wart) or battery. The adapter is connected by plugging a two 1mm positive plug into the power jack. Leads from battery is inserted within the Gnd and $_{Vin}$ pin. The board will have six to twenty volts.

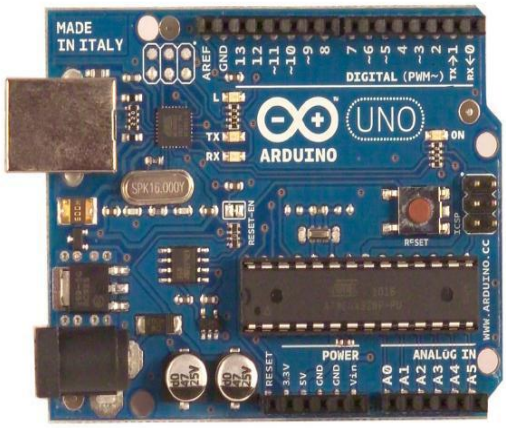

Chart-3 Arduino UNO

3.4. LCD

LCD which is known as Liquid Crystal Display is used to display using liquid crystal. It is used to display output in term of words, number etc. The most basic form of electronic 7 segment display which has its own limitations. The next best available option is Liquid Crystal Display which comes in different size specifications. Out of all available LCD modules in market, the most commonly used one is 16×2 LCD Module which can display 32 ASCII characters in 2 lines (16 characters in 1 line). Other commonly used

LCD displays are 20×4 Character LCD, Nokia 5110 LCD module, 128×64 Graphical LCD Display and 2.4 inch TFT Touch screen LCD display.

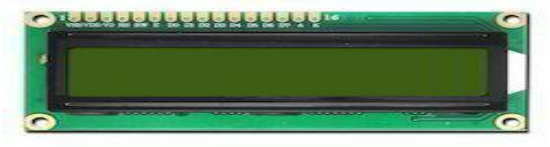

Chart-4 Liquid Crystal Display

3.5. ESP8266 NodeMCU Wi-Fi

The ESP8266 is the name of a small controller designed by Espress if Systems. The ESP8266 itself may be a self-contained wireless local area networking resolution which provides a bridge from existing small controller to wireless local area network and is additionally capable of running self-contained applications. This module comes with an inbuilt USB connection and a fashionable assortment of pin-outs. With a small USB cable, you will be able to connect Node MCU dev kit to your laptop computer and flash it with Arduino. Additionally it can be used in real time bread board. The chip has a WiFi and Serial transceiver. This makes it terribly convenient to use the ESP8266 chip.

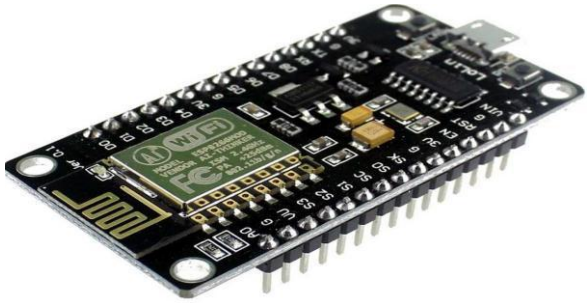

Chart-5 ESP8266 NodeMCU Wi-Fi

3.6. Power supply

Available power source is an Ac voltage arrives at 230V.Since our electronic circuits require only very minimal voltage and current we use step down power transformer. Step down transformer is designed in such a way that the input is 230V and output of 12V. Another thing is that electronic circuits operate in DC whereas available output of transformer is Ac of 12V. So rectifier circuit is used to convert AC to DC.

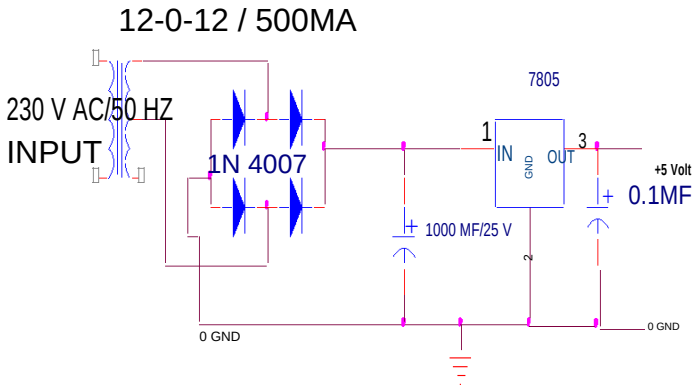

Chart-6 Power supply

3.7. Transformer

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors, the transformer's coils or windings. Transformer can be used for stepping down the supply voltage. Here 230V is converted in to 12V. Filter circuits are used to convert rippling DC to smooth DC. The filter circuit is a capacitor, connected parallel to the output of rectifier circuit. This smooth DC voltage will be in the range of +12 volts. But we require only 5V supply for the operation of micro controllers and its supporting components. Here again regulator ICs such as 7805 is used to regulate the incoming 12VDC to fixed regulated 5V as output. This DC regulated 5V is applied to the circuits. Even though the circuit is functioning with 5V, the relays are driven by 6V or 12V. For this purpose 7806/7812 regulator IC is additionally connected to the rectifier filter circuit. Thus 12V regulated is used for driving 12V relays.

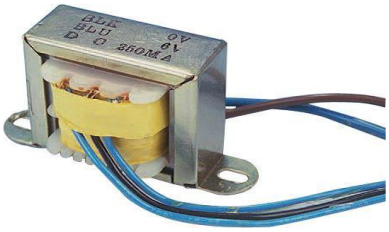

Chart-7 Transformer

4. WORKING

The supply from the switch is taken out through a wire and given to the step down transformer. The step down transformer reduces the voltage from 230V to 12V. A voltage regulator is given to regulate the output voltage. From there the output is provided to the power supply unit. The bridge rectifier converts the AC supply in to DC. A capacitor is given to rectify the harmonics and gives a pure DC source. The obtained DC is given to the Arduino. Meanwhile the voltage sensor is connected in parallel since the voltage is constant. Whereas the current sensor is connected in series. Each load will have an individual current sensor. It will monitor the current consumed by the loads and feed to the Arduino. The Arduino will collect all the data and calculate according to the program fed to it. The LCD will display the current and voltage of each load separately. The Wi-Fi module sends the data to the application. The application can be viewed through the mobile. It updates the data for each 10 second. The energy consumed by the individual load can be seen for every minute, hour, day and week through normal value and also through graphical representation.

5. RESULT

In our project we simply used a light and the output is shown.

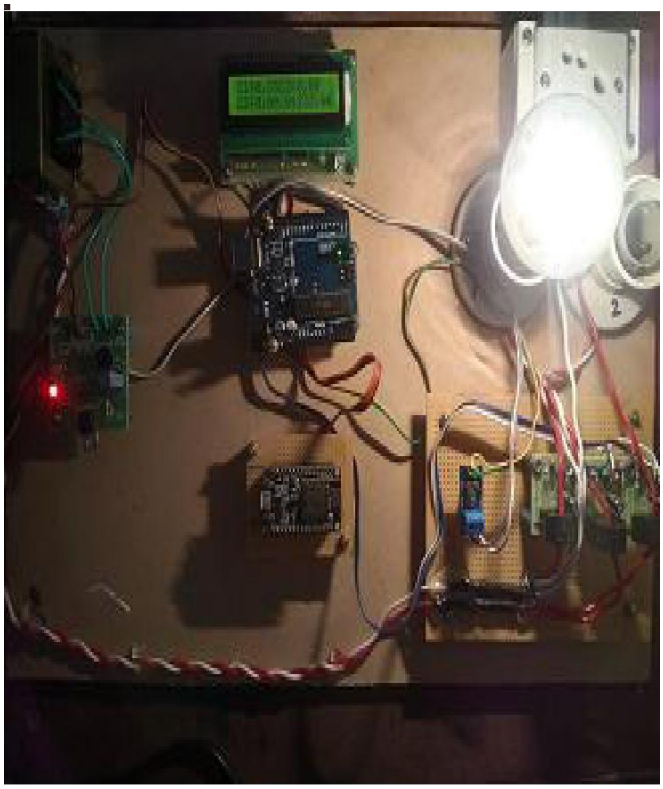

Chart-8 Hardware output

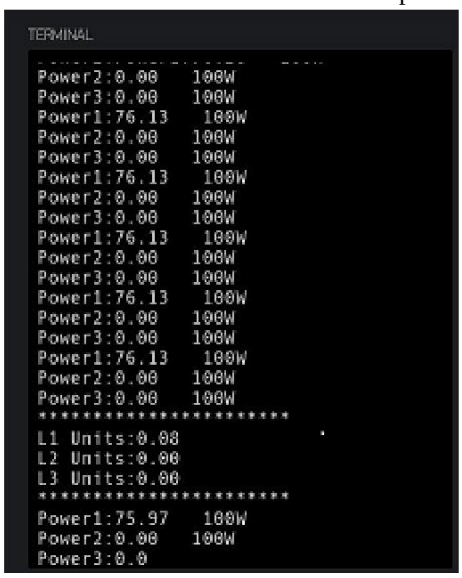

Chart-9 Application output

6. CONCLUSION

The energy consumption of individual loads used in the residential side can be monitored through the application. The user can have a brief knowledge about the energy consumption of each load and use the devices according to the need. This leads to the energy saving.

7. FUTURE WORKS

In future this method can be implemented with better technologies and with more application. It can also be implemented for Commercial and other types of loads. Automation can also be done in this area.

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