Electricity Control & Management using IoT

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Abstract— The electricity usage is increasing day by day. The user comes to know about the electricity consumption of their house after a month. After receiving the electricity bill the user starts worrying. One of the initial step for an effective energy cost control program is the assessment of energy consumption and the pattern of an energy usage. This system modifies the user about their home electricity usage by sending alerts, suggestions, statistics, graphs, etc., which will tend to energy saving. This system uses the concept of IOT that is connecting the system over the internet and transferring the data collected by them to the storage server. Unlike energy meter which are installed at location which cannot be accessed easily, this monitoring system can be installed within the house that is near by the switch board. By this way the people can get an idea of how much they are consuming in the real time. By uploading data into the server, detailed consumption of energy will be available for every month, every day and every hour.

Key words: Smart Phone, Arduino, Wi-Fi, Home Automation

I. INTRODUCTION

Now-a-days electricity is at most important part of our life. It has become our one of the basic needs. Every electronic device needs electricity to operate. According to this survey in 2008, India's residential electricity usage is 20.7 percent of total electricity consumption. India is the 4th largest consumer of energy with consumption of over 600 million tons of oil equivalent. According to the census up to 44 percent of household in rural India lack access to electricity. Electricity consumption in residential sector. The residential building sector is one of the largest consumers of electricity in India. Continuous urbanization and the growth of population result in increasing power consumption in buildings. Energy is used in residential buildings for various purposes: Lighting, Air conditioning, Fans, Refrigerator, Television and other installed equipments. The other installed equipments includes oven, toaster, laptops, set-top box, home audio, computer monitors etc.

Home automation is the use of information technology and control system to reduce the human labor. The rapid growth of technology influence us to use smart phones to remotely control the home appliances. The automation system not only helps to decrease the human labor but it also saves time and energy. In wireless based home automation system different types of technology such as Zigbee, GSM, GPRS, Bluetooth and Wi-Fi are used, each technology has their own pros and cons. A Wi-Fi based wireless automation system can be implemented with a low cost and it is easy to install in an existing home and offices as well as in public spaces at Wi-Fi hotspots setup either free of charges or commercially. Thus efficient energy management is crucial today and innovate and optimize way for an efficient management of energy is proposed here.

The main goal of the proposed system is to develop a system such that it will be able to keep a track of each and every appliances in the home and the user will be able to acquire all appliances every consumption parameters. Along with this, the energy consumption parameters of each individual appliances will be send to arduino were an intelligent algorithm will be running to manage all the appliances, as per user requirement. The user can monitor the energy parameter of each individual load using an android smart phone which will also work as a data setter to set various user programmable parameters like high or low cut-off voltage, etc.,

By automatically turning off loads when not in use, in the way the electricity consumption and cost can be reduced. The system can provide energy savings in homes and offices. Apart from this the loads in the house can also be controlled remotely via smart phones in case of overloads.

To reduce general electricity usage, there is a growing interest in analyzing power consumption in households. By analyzing the electricity usage of each individual appliance separately, more accurate conclusions can be drawn on their efficiency and need for replacement. Furthermore this can also determine whether an appliance is drawing unusually high amounts of power when turned off and whether it should rather be unplugged. In this way electricity consumption and cost can be reduced.

II. LITERATURE SURVEY

Putta Sindhuja et al.,(2015) presented the paper on "smart power monitoring and control system through Ethernet of things using cloud data usage". The technique adopted in this paper is by using Ethernet in order to connect to the cloud. It keeps the history of the appliances power usage. It adopted http method. And the advantages of this technique is that the power consumption is reduced by 15% by switching the electrical appliances when not in used.

Jasmeet Chhabra et al.,(2016)presented by the paper on "IOT based smart home design using power and security management". This technique uses Galileo 2nd generation development as a IOT device. It adopted Ethernet protocol to send data to server. It uses http networking protocol and also it uses android app to control electronic devices/home appliances.

T.Saravanan et al.,(2017) presented a paper on "Internet based smart home design for power and security management". I t uses Ethernet protocol to send and receive data. It uses various sensors for automatic power reduction techniques using IOT.

Pallavi Ravindea Joshil et al., presented a paper on "IOT based smart power management system using WSN. It uses current and voltage sensor to measure power consumed by individual appliances. And it uses ZigBee to collect data locally and it uses Ethernet protocol to send and receive the data to server.

Jonas Katz et al.,(2018) presented a paper on "Household electricity consumers incentives to choose dynamic pricing under different taxation schemes. It uses a demand response techniques based on cost. At the peak hours the demand response will be high and the cost per unit will be high. The disadvantages of this technique is that it have increased cost per unit at peak hours.

III. PROBLEM DEFINITION

Most conventional prepaid power meters currently installed in the households only display the total real time usage of its power and the amount of electricity available. There is no way to see what the day's, week's or month's consumption was on these meters and often these power meters are placed in an inconvenient location which makes regular viewing somewhat difficult. These power meters also lack the ability to monitor appliances individually; thus hiding vital information about individual appliances.

IV. METHODOLOGY

The overall processes is the hardware and the software interfaces are connected to each other to monitor the power consumption of the user and further , this will be monitor by the server and will be uploaded to cloud from where the user can log on to the web page in computer and app installed in the mobile. The smart kit will display the voltage, current and unit on 16x2 LCD display

V. SYSTEM IMPLEMENTATION

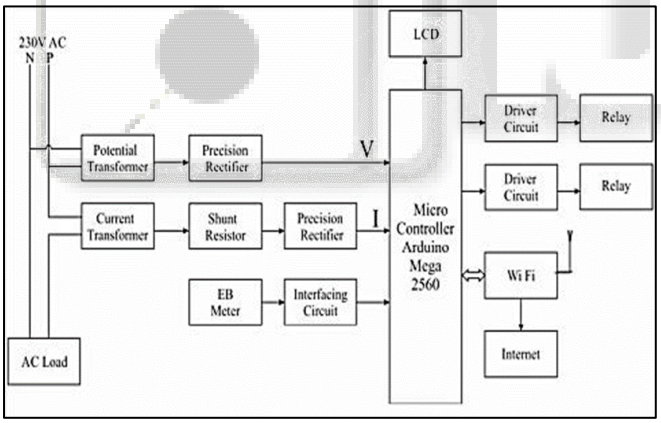

Fig. 1: System Architecture

Electricity control and management system is to develop a system such that it will be capable to keep a track of each and every appliances in the home getting reading such as voltage, current, unit and the user will be able to acquire all the appliance energy consumption parameters. Along with this the energy consumption parameters of each individual appliances will be send to arduino which is connect with the help of wired or wireless connection where an intelligent algorithm will be running to manage all the appliances as per user requirements. The user can monitor the energy parameters of each individual load using an android smart phone which will also work as a data setter to set various user programmable parameters like high/low cut-off voltage, etc. By automatically turning off loads when not in use, the system can provide energy saving in home and offices. To reduce cost the system requires energy metering nodes that can communicate with the arduino wirelessly or in wired way in such a way that only one Wi-Fi access point is needed for a household containing many monitored appliances. Furthermore it is required that the current information regarding the appliances can also be viewed on a local display with a menu interface.

VI. HARDWARE & SOFTWARE DESIGN

A. Arduino mega2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560.It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with

USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila. The ATmega2560 has 256 KB of flash memory for storing code 8 KB of SRAM and 4 KB of EEPROM. The Arduino Mega2560 can be programmed with the Arduino software.

B. Wi-Fi Module

Wi-Fi-enabled device, such as a personal computer, video game console, Smartphone or digital audio player, can connect to the Internet when within range of a wireless network connected to the Internet. The coverage of one or more access points called hotspots comprises an area as small as a few rooms or as large as many square miles. Coverage in the larger area may depend on a group of access points with overlapping coverage. Wi-Fi provides service in private homes and offices as well as in public spaces at Wi-Fi hotspots set up either free-of-charge or commercially. Organizations and businesses, such as airports, hotels, and restaurants, often provide free-use hotspots to attract or assist clients. Enthusiasts or authorities who wish to provide services or even to promote business in selected areas sometimes provide free Wi-Fi access.

C. Relay

A relay is can be defined as an electrically operated switching device. Many relays use an electromagnet to mechanically operate a switch. Relays are mainly used where it is necessary to control a circuit by a digital output signal, or where several circuits must be controlled by one signal. Magnetic latch type relays usually require one a digital high signal to move their contacts in one direction, and another signal to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in situations where power distortions should not be able to alter the contacts. Magnetic latching relays can consist of single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the supply is in the opposite direction. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will go to transition.

D. Input-Output Module

LCD (Liquid Crystal Display) screen is a display device and has numerous applications in many fields. A 20X4 LCD display has been chosen for this project. It is a display module consisting of 20 Columns and 4 Rows. This module is preferred over 7 Segment displays, the main reason being economical; easily to program; has no limitations for displaying special and custom characters. A 20X4 LCD can display up to 20 characters in a line and there are totally 4 such lines. In this LCD each character is displayed in 5x7 matrix format. This LCD has two registers which are, Command and Data Registers. The command register stores the commands which are to be given to the LCD. A command is an instruction given to LCD to do a predetermined task like initializing it, clearing the screen, setting the position of the cursor, control of the display. The data register stores the data which is to be displayed on the screen. The data to be displayed is converted to its corresponding ASCII Value and then sent to the LCD for display.

E. Current Transformer

A current transformer (CT) is a measurement device designed to provide a current in its secondary coil proportional to the current flowing in its primary.

Current transformers are commonly used in metering and protective relaying in the electrical power industry where they facilitate the safe measurement of large currents, often in the presence of high voltages. The current transformer safely isolates measurement and control circuitry from the high voltages typically present on the circuit being measured. Current transformers used in metering equipment for three-phase 400 ampere electricity supply. Specially constructed wideband CTs are also used, usually with an oscilloscope, to measure high frequency waveforms or pulsed currents within pulsed power systems. One type provides a voltage output that is proportional to the measured current; another, called a Rogowski coil, requires an external integrator in order to provide a proportional output.

F. Potential Transformer

A Potential transformer is used to step down the voltage of the AC sinusoidal signal to a lower level to make is easy to be measure using a small rated voltmeter. Primary side of P.T. is having large no. of turns. Primary is generally connected across any one line and earth. Hence, sometimes it is also called the parallel transformer. Secondary of P.T. consists of lesser number of turns when compared to primary and can be connected directly to a voltmeter for measurement. The voltmeter always has large resistance. Hence the secondary of a P.T. operates almost in open circuited condition. A diode bridge is an arrangement of four diodes forming a bridge circuit that provides the same polarity of output for either polarity of input. Its widely used in the conversion of an alternating current (AC) input into a direct current (DC) output, also called by its name bridge rectifier. A bridge rectifier produces full-wave rectification from an AC input supply. The output from the secondary of the transformer is fed into the diode bridge rectifier configuration which gives a rectified full wave DC voltage. The output at this stage contains a huge amount of ripple. The reading is taken at this stage would vary by a very large rate and hence it will be very tedious to get a stable reading. One way to reduce this ripple is to use a filtering capacitor. The capacitor charges up to positive cycles of the peak value. When the voltage across the capacitor decreases the capacitor begins to discharge. Again the capacitor charges when the voltage across it is greater than the voltage stored. It is then given to a Resistive divider, which gives an output of 5V that can be connected to the arduino analog port.

G. Energy Meter

In electric meter or energy meter is a device that measures the amount of electrical energy consumed by a residence, business, or an electrically powered device. Electric meters are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic readings of electric meters establishes billing cycles and energy used during a cycle. The most common unit of measurement on the electricity meter is the kilowatt hour, which is equal to the amount of energy used by a load of one kilowatt over a period of one hour, or 3,600,000 joules. Some electricity companies use the SI mega joule instead.

H. Arduino IDE

IDE stands for Integrated Development Environment, entire programming for proposed system is done in Arduino IDE tool. Baud rate is set to 9600 bits per second for serial communication between Arduino board and Smartphone. Arduino IDE command "Serial. Available 0" is used to receive data serially from Smartphone and "Serial.printlnO" command is used to transmit data serially from Arduino board to Smartphone. Arduino consists of both a physical programmable circuit board and a piece of software or IDE that runs on your computer, used to write and upload computer code to the physical board.

VII. RESULT

The Current and Potential transformer measure AC Current and Voltage and the analog value are fed to the Arduino. The Analog value is converted into Digital using ADC (Analog to Digital Converter) inside the controller. The Voltage, Current, Power, Energy, Units consumed are calculated and the value is sent to the LCD for displaying. The calculated values are also uploaded to the cloud storage with the help of Wi-Fi module. An interactive webpage is developed to control the appliances remotely through internet and also for accessing the data uploaded. Upon receiving command from the user; the relay driver operates to switch on or off a particular load. The user can monitor the energy parameters of each individual load using an android Smartphone which will also work as a data setter to set various user programmable parameters like maximum or minimum voltage

VIII. CONCLUSION

Increasing the energy consumption awareness in every household is an important step to make the user able to manage their energy consumption. This concept allows user to observe not only the overall household consumption but also each device consumption and identify the device that consume most power at home. This ultimately achieves in

energy consumption of every household resulting in Energy Management using IoT. The system so developed is not fully complete as we have developed a prototype only for controlling two appliances i.e. fan and light. In future, we propose to extend the system for controlling appliances like Refrigerator, Air cooler, Television etc.

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