

An Internet Connected System Of Power Monitoring and Control for Better Energy Efficiency

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ABSTRACT:Energy conservation is an important aspect in today's scenario. Many systems have been developed in order to capitalize the energy consumption and conserve the energy. Plug loads represent 30% of total electricity use in residential buildings. Significant energy savings would result from an accurate understanding of which miscellaneous electric devices are using energy, at what time, and in what quantity. A better solution is integration of these capabilities at the power supply level. The concept of Internet of Things (IoT) can turn the automated home into a smart home. In this paper, we propose a method achieving this integration which allows efficient power monitoring and control in which native device control feature remains same.

KEYWORDS :Home Energy Management system, Energy reporting, Internet of things (IoT), Android Phone.

I. INTRODUCTION

Energy is an expensive resource. Energy management is the best solution for the energy conservation. Now a days the use of plug load electronic devices are increasing day by day in residential and commercial buildings due to the use of advanced smart phone technologies. Energy is used in our homes for various purposes like heating, air conditioning, lighting, refrigeration, clothes washing, clothes drying, water heating and a whole range of other usages. There is difficulty in identifying the energy consumption by these plug load devices. In this age, energy control is now a top priority. Due to more energy use, climate change and the overall economy of a country is directly affected by the growth in energy consumption.

Therefore it is required to use a smart energy system. In smart energy implementation there is major reductions of energy use in the buildings. The smart energy system has internet connection to monitor and control the electrical devices from anywhere in the world. A traditional home becomes a smart home when it contains one or more smart devices. Traditional devices such as a refrigerator, VCR, TV, video camera, video game console, lights, microwave oven etc. found in many homes, can be upgraded with hardware and software and connected to an internet.

In simple sense smart energy implementation means to connect all electrical devices in the home to a central control system that control those devices according to user inputs. Thus they can convert non-smart device into a smart device with the help of internet. A smart home can be easily controlled through internet using a Smartphone or Computer. The concept of Smart Home can be improved by incorporating the concepts like Internet of Things (IoT). The concept of Internet of Things (IoT) can turn the automated home into a smart home. IoT connects everyday objects to the internet, enabling those objects to communicate with each other.

In the smart homes the "management" refers to the monitoring and control of individual or a collection of devices. Monitoring is the checking of one or more status indicators. Control is exercising of actions that could alter the state of the device. In this paper, we propose an internet connected system for better energy efficiency.

Paper is organized as follows Section II describes related work and literature survey. The System concept and Overview of the system is given in Section III. In Section IV Detailed Component Design is given. Section V presents experimental results showing results. Finally, Section VI presents conclusion.

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II. RELATED WORK

We can easily control and monitor electric devices and appliances from our smart phone or Internet. The lighting in your home can be set to save your money when you leave the room. The Internet provides even more incredible access to information and services [1]. In homes most electrical appliances consume stand by power which are plugged in the sockets or even switched off i.e. not in use. This loss is very small but can be significant for all the appliances in a home [2]. There are different technologies that provide smart home communication are X10, Insteon, Zigbee and Z-Wave (3). Fig. 1 shows the overview of existing home networking technologies. Technically, two types of networking techniques are widely used in the field of home appliance control i.e. "Wired" or "Wireless" technologies.

Generally in public and private sector companies, offices and also in homes most of the people are not interested to switch OFF electronic appliances like fan, light etc, if they are not present. Also consumer uses more electronic and home appliances therefore the energy consumption becoming large thus the power consumption in home area tends to grow [4]. The popularity of home automation has been increasing greatly in recent years due to use of smart phone. This provides higher affordability and simplicity.

The concept of the "Internet of Things" has tied in closely with the popularization of home automation. A home automation system integrates electrical devices in a house with each other [5]. An embedded board physically connected to all home automation devices and through integration with a personal computer (PC) based on web server provides remote access to the system. [6]. The ANSI/CEA Standard: Modular Communications Interface for Energy Management [8] this standard provides a modular communications interface (MCI) to residential devices for applications such as energy management.

As MCI can enable the product to connect to any type of response system for home or building network. In this concept the network security is provided through the Wi-Fi, ZigBee, Home Plug, Z-Wave, LonWorks as per network. Technically two types of networking techniques are widely used in the field of home appliance control i.e. "Wired" or "Wireless" technologies [9] [10] [12]. Sirsath N. S, Dhole P.S et. al [11] propose the Home Automation system that employs the integration of cloud networking, wireless communication, and power-line communication to provide the user with remote control of various lights and appliances within their home. This system uses a mobile phone application and PC based program to provide interface to the user.

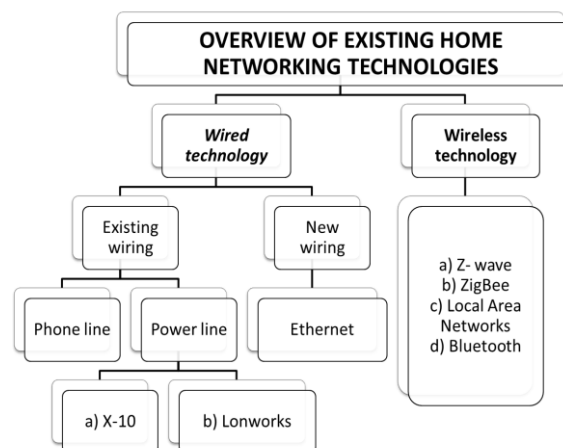


Fig.1 Overview Of Existing Home Networking Technologies

III. OUR APPROACH

A) System concept

Today many hardware-based solutions are available in the market for monitoring and controlling plug load devices. These products can be installed in between the outlet and the device which is to be monitored. In such available

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products there are some advantages and drawbacks. In this paper we propose the concept of the communicating power supply [7]. Communicating power supply can be used for electricity metering, computation, and communication to electronic devices.

The earlier hardware based products having the flexibility with the devices that can be monitored and also controlled. So there is only one monitor can be used with a wide range of devices. But during this approach native controls may be lost. The native controls are basically remotes, switches and devices with which the user is familiar. In this case monitoring and control only works as expected if the monitored device is in the 'on' position.

Here communicating power supply has the benefits of these plug-through devices. Such as all the native controls of the electronic device are continued. The communicating power supply can measure device energy use and reports this information to a central unit along with the device's identity over a network. In fig. 2 the system architecture there are three devices connected to PLC modem which in turn report energy data to a web service. The web server receives the control request and passes control information back to the communicating power supply. The communicating power supply passes the control signal to the device.

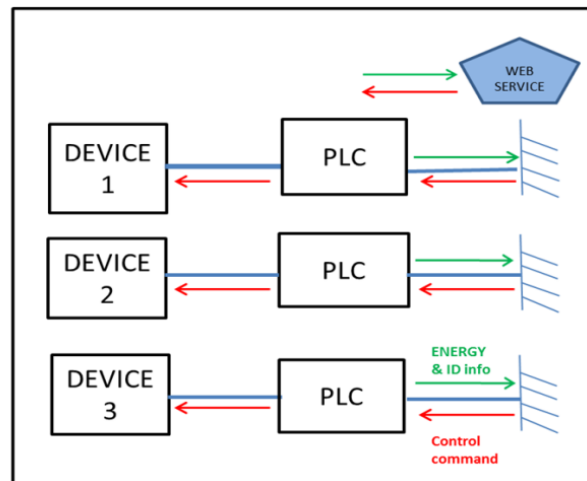


Fig. 2 System Architecture

B) Overview of the system

The software and hardware implementation can make easy communication between the end-use monitor and the central unit. The embedded systems can program to gather data from the energy monitor and communicate this information over the network layer to the data server.

As shown in fig. 3 the user dashboard would be located on a mobile device or PC, which allows control and monitoring via the data server. Thus together communicating power supply and a combination of software and hardware are necessary for implementation of energy reporting system. The communicating power supply which is connected to device communicated with a central hub that can control the local network traffic.

IV. DETAILED COMPONENT DESIGN

As shown in Fig.3, the system contains following components

A. ARM7-LPC2148

The ARM7-LPC2148 Mother Board is a generalpurpose board which can be used for easy development of embedded system based prototypes. This board provides easy extension of ARM7-LPC2148 IC pins so that you don't have to mesh up with all that soldering. This board is developed in such a way that user need not worry about the pins of the controller as ports are grouped in proper way for easiness of the developer.

Features :-

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- 1) All the external connection can be done directly with screw type connectors (No need for soldering OR jumper wire)
- 2) 3.3V power supply connection with reverse polarity protection
- 3) ARM7-LPC2148 port pins are sequentially rearranged
- 4) Port pins are grouped in 8-Bit style
- 5) Most used ADC pins are grouped together for easy interface

B. Power line Modem [SUNROM]:

Power line modem is useful to send and receive serial data over existing AC mains power lines of the building. It has high immunity to electrical noise persistence in the power line and built in error checking so it never gives out corrupt data. The modem is in form of a ready to use circuit module, which is capable of providing 9600 baud rate low rate bi-directional data communication. Due to its small size it can be integrated into and become part of the user's power line data communication system.

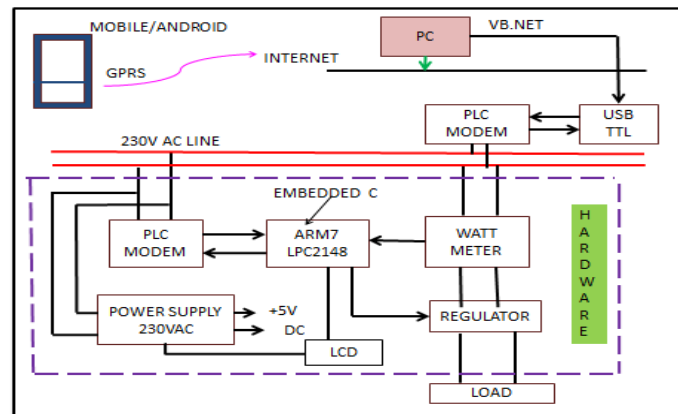


Fig.3 Overview of Functional diagram

C. Watt Meter

The wattmeter is used for measuring the electric power (or the supply rate of electrical energy) in watts of any given circuit. Power consumption of various devices becomes very important. Various commercial meters are available of different price, capabilities, and quality in market. Their function is usually integration of the power consumed by an attached appliance, and calculating its cost. Some such devices are fairly cheap; the FH9999 one was the cheapest one available at the moment, so it was selected for experiments.

D. Power Supply

A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another.

E. Regulator

The LM117 series of adjustable 3-terminal positive or by connecting a fixed resistor between the voltage regulators. In addition to higher performance than fixed series data sheet regulators the LM117 series offers full overload protection available only in IC's.

F. PC

A personal computer is a general-purpose computer operated directly by an end-user for energy management. The personal computer will monitor and control the system.

G. TTL CP2102

Use this device to connect your PC to a serial (TTL level) device. Here 6 pins are used for 3.3V, RST, TXD, RXD, GND & 5V. TTL CP210 is used for communication between PLC modem Rx unit and PC.

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H. Mobile Phone/Android

The android application is very useful in homeautomation system. The android application provides aninterface to the consumer for the purpose of control the home appliances connected to the automation system. Thisapplication provides the consumer the current status of the appliances and also provides the option to control or switch ON/OFF the electrical devices.

I.Client

This is the remote user who wants to automate home appliances by using android mobile device or PC. Android is an operating system designed for mobile devices such as smart phones used by the ARM processors.

V. EXPERIMENTAL RESULTS

The system will allow the user to control and monitor appliances and lights in their home from a Mobile Device and PC from anywhere in the world through an internet connection. It will also allow the user to control their device units within their home from home server using GUI. Fig.4 shows the screenshot of Online Realtime Monitoring SysteminMicrosoft Visual Studio.

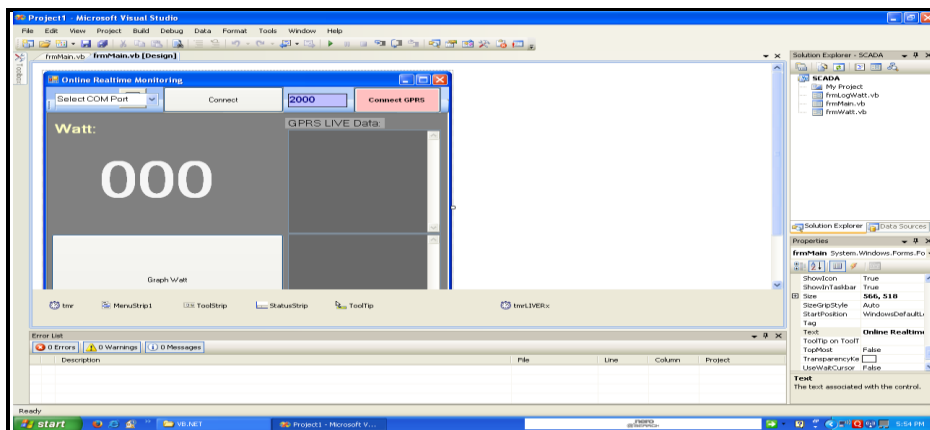
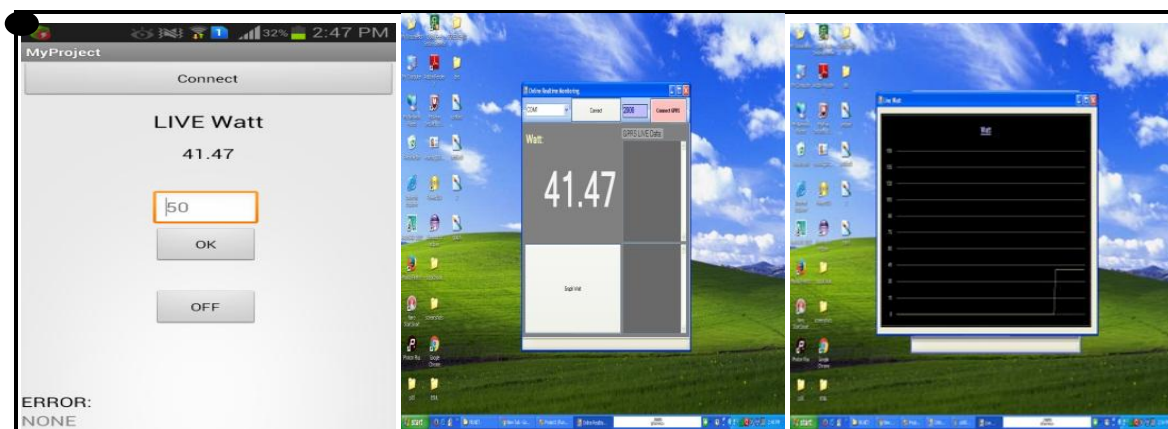


Fig. 4 Screenshot of Online Realtime Monitoring System in Microsoft Visual Studio onPC ,



(a)(b) (c)

Fig. 5 Screenshots of PC and mobile devices.(a) Login window where user can login to use application in Android Mobile Phone, (b) Screenshot of Online Realtime Monitoring in Microsoft Visual Studio, (c) Screenshot of Live Watt in Microsoft Visual Studio.

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The fig. 5 shows that the monitoring and controlling of appliances and lights can be done through android mobile using internet remotely. After pressing connect on login window the entire system can be monitored by the user remotely on android mobile. The user can also control the entire system by entering the user requirement in drop box. User can also ON OFF the entire system remotely. Also graph of live wattage is shown in figure.

The Smart phone app for home control and monitoring system provides the remote connection to the HomeEnergy Management system. The hardware function is for achieving device monitoring and control as per user response. The software is the smart power management system which aims to the objectives of electricity-saving and energy conservation.

VI. CONCLUSION

Our paper summarizes the current research status on communication networks for the electrical energy consumption in residential buildings. Many research efforts are still required for intelligent energy management. The objective of the paper is to realise the Smart Living, more specifically the home lighting control system using communicating power supply.

These devices can be used to provide native controls and identity information. Power line communication is a technique that allows exchange of data with the help of electric power supply network that are presented in every residence, office and in every building. This allows consumers to use their already existing wiring system to connect home appliances to each other and to the Internet. It will allow the user to control various appliances and lights within their home from any location in the world by using internet. The proper implementation of the proposed system may result in low cost, reduced configuration.

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