Wireless Sensor Network based Power Management System in Smart Buildings

N. Neha Beri
Master of Engineering in Embedded System from Osmania University, Hyderabad, Telangana-500007, India.

Abstract: The design and evolution of a smart surveilling and controlling system for household electrical appliances in real-time has been researched in this paper. The system predominantly checks the electrical parameters of household appliances such as voltage and current, also thereafter calculates the power consumed. The modernity of this system is the implementation of the administrating mechanism of appliances in distinct ways. The developed system is a low-priced and versatile in running operations and thus can save electricity expense of the consumers. The prototype has been broadly tested in real-life situations and experimental results are very encouraging.

Keywords: Zigbee, WiFi, Wireless sensor network, ARM7TDMI.

I. INTRODUCTION

It is foreseen that service and personal care wireless mechatronics systems will become more and more ubiquitous at home soon and will be very useful in assistive healthcare particularly for the elderly and disabled people. Wireless mechatronic systems consist of numerous spatially distributed sensors with limited data collection and processing capability to monitor the environmental situation. Wireless sensor networks (WSNs) have become increasingly important because of their ability to monitor and manage situational information for various intelligent services. Due to those advantages, WSNs has been applied in many fields, such as the military, industry, environmental monitoring, and healthcare. The WSNs are increasingly being used in the home for energy controlling services. Regular household appliances are monitored and controlled by WSNs installed in the home [5]. New technologies include cutting-edge advancements in information technology, sensors, metering, transmission, distribution, and electricity storage technology, as well as providing new information and flexibility to both consumers and providers of electricity. The ZigBee Alliance, wireless communication platforms is presently examining Japan’s new smart home wireless system implication by having a new initiative with Japan’s Government that will evaluate use of the forthcoming ZigBee, Internet Protocol (IP) specification, and the IEEE 802.15.4g standard to help Japan to create smart homes that improve energy management and efficiency. It is expected that 65 million households will equip with smartmeters by 2015 in the United States, and it is a realistic estimate of the size of the home energy management market. There are several proposals to interconnect various domestic appliances by wireless networks to monitor and control such as provided in [9]. But the prototypes are verified using test bed scenarios. Also, smart meter systems like [9–11] have been designed to specific usages particularly related to geographical usages and are limited to specific places.

II. LITERATURE SURVEY

In this section, we briefly discuss the existing works about smart home systems based on the wireless communication technology. Han et al. proposed a Home Energy Management System (HEMS) using the ZigBee technology to reduce the standby power. The suggested system consists of an automatic standby power cutoff outlet, a ZigBee hub and a server. The power outlet with a ZigBee module cuts off the ac power when the energy consumption of the device connected to the power outlet is below a fixed value. The central hub collects
information from the power channels and controls these power channels through the ZigBee module. The central hub sends the present state information to a server and then a user can monitor or control the present energy usage using the HEMS user interface. This facility may create some uneasiness for the users. For example, if the users may want low intensity of light, for some situation but the system will cut the power off leading to darkness.

III. SYSTEM OVERVIEW

The electrical parameters of home appliances are measured by interfacing of sensors. The output of the sensed data are transmitted through the Zigbee module and received at the receiver section where in the remote monitoring takes place and the building environment is controlled.

IV. PLATFORM DEVELOPMENT

**Micro controller:**
This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, reset circuitry, pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices as per the program being written.

**ARM7TDMI:**
ARM is the abbreviation of Advanced RISC Machines, it is the name of a class of processors, and is the name of a kind technology too. The RISC instruction set, and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs.

**Liquid-crystal display (LCD):**
It is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock.

**ZIGBEE:**
Zigbee modules feature a UART interface, which allows any microcontroller or microprocessor to immediately use the services of the Zigbee protocol. All a Zigbee hardware designer must do in this case is ensure that the host’s serial port logic levels are compatible with the XBee’s 2.8- to 3.4-V logic levels. The logic level conversion can be performed using either a standard RS-232 IC or logic level translators such as the 74LVTH125 when the host is directly connected to the XBee UART. The X-Bee RF Modules interface to a host device through a logic-level asynchronous Serial port. Through its serial port, the module can communicate with any logic and voltage Compatible UART; or through a level translator to any serial device. Data is presented to the X-Bee module through its DIN pin, and it must be in the asynchronous serial format, which consists of a start bit, 8 data bits, and a stop bit. Because the input data goes directly into the input of a UART within the X-Bee module, no bit inversions are necessary within the asynchronous serial data stream. All the required timing and parity checking is automatically taken care of by the X-Bee’s UART.

Fig.3: ZIGBEE pin diagram

WIFI:
Wi-Fi is the name of a popular wireless networking technology that uses radio waves to provide wireless high-speed Internet and network connections. A common misconception is that the term Wi-Fi is short for "wireless fidelity," however this is not the case. Wi-Fi is simply a trademarked phrase that means IEEE 802.11x. Wi-Fi works with no physical wired connection between sender and receiver by using radio frequency (RF) technology, a frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. The cornerstone of any wireless network is an access point (AP). The primary job of an access point is to broadcast a wireless signal that computers can detect and "tune" into. In order to connect to an access point and join a wireless network, computers and devices must be equipped with wireless network adapters Wi-Fi is supported by many applications and devices including video game consoles, home networks, PDAs, mobile phones, major operating systems, and other types of consumer electronics. Any products that are tested and approved as "Wi-Fi Certified" (a registered trademark) by the Wi-Fi Alliance are certified as interoperable with each other, even if they are from different manufacturers. For example, a user with a Wi-Fi Certified product can use any brand of access point with any other brand of client hardware that also is also "Wi-Fi Certified". Products that pass this certification are required to carry an identifying seal on their packaging that states "Wi-Fi Certified" and indicates the radio frequency band used (2.5GHz for 802.11b, 802.11g, or 802.11n, and 5GHz for 802.11a).

Fig.4: WIFI Module

VSD03 is the new third-generation embedded UART-WIFI modules studied by VSD TECH. UART-WIFI is an embedded module based on the UART serial, according with the WIFI wireless WLAN standards, It accords with IEEE802.11 protocol stack and TCP / IP protocol stackand it enables the data conversion between the user serial and the wireless network module. Through the UART-WIFI module, the traditional serial devices can easily access to the wireless network. VSD03 does a comprehensive hardware and software upgrades based on the products. Its main features include:

Interface:
- 2*4 pins of Interface: HDR254M-2X4
- The range of baud rate: 1200~115200bps
• RTS / CTS Hardware flow control
• single 3.3V power supply

Wireless
• support IEEE802.11b / g wireless standards
• support the range of frequency: 2.412~2.484 GHz
• support two types of wireless networks:
  o Ad hoc and Infrastructure
• support multiple security authentication mechanisms:
  o WEP64/WEP128/ TKIP/CCMP(AES)
  o WEP/WPA-PSK/WPA2-PSK
• support quick networking
• support wireless roam

VOLTA GE SENSING CIRCUIT:
Step-down Voltage transformer is used to generate the AC signal. This generated AC signal is then further filtered to bring 3.3V for the Zigbee operation.

CURRENT SENSING CIRCUIT:
A current measurement sensor is used at an amplified voltage rate of 3.3V for the Zigbee operation. Electric Isolation is achieved through the current transformer.

V. EXPERIMENTAL RESULTS
Since the prototype model is at experimental stage, the results are generated for trial at home.

VI. CONCLUSION
A smart power monitoring and control system has been designed and developed toward the implementation of an intelligent building. The developed system effectively monitors and controls the electrical appliance usages at an elderly home. Thus, the real-time monitoring of the electrical appliances can be viewed through a website. The system can be extended for monitoring the whole intelligent building. We aim to determine the areas of daily peak hours of electricity usage levels and come with a solution by which we can lower the consumption and enhance better utilization of already limited resources during peak hours. The sensor networks are programmed with various user interfaces suitable for users of varying ability and for expert users such that the system can be maintained easily and interacted with very simply. This study also aims to assess consumer’s response toward perceptions of smart grid technologies, their advantages and disadvantages, possible concerns, and overall perceived utility. The developed system is robust and flexible in operation. For the last three months, the system could perform the remote monitoring and control of appliances effectively. Local and remote user interfaces are easy to handle by a novice consumer and are efficient in handling the operations. In future, the system will be integrated with co-systems like smart home inhabitant behavior recognitions systems to determine the wellness of the inhabitant in terms of energy consumption.
REFERENCES:


AUTHOR'S PROFILE


Email: nehaberi@outlook.com