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Wireless Sensor Network based Power Management System in Smart Buildings

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Abstract: *The design and evolution of a smart surveillingand controlling system for household electrical appliances in realtime has been researched in this paper. The system predominantlychecks theelectrical parameters of household appliances such as voltage and current, alsothereafter calculates the power consumed.The modernity of this system is the implementation of the administratingmechanism of appliances in distinct ways. The developedsystem is a low-priced and versatile in running operations and thus can saveelectricity expense of the consumers. The prototype has been broadlytested in real-life situations and experimental results are veryencouraging.*

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

I. INTRODUCTION

IT is foreseen that service and personal care wireless mechatronicsystems will become more and more ubiquitous athome soon and will be very useful in assistivehealthcare particularly for the elderly and disabled people.Wireless mechatronic systems consist of numerous spatially distributedsensors with limited data collection and processing capabilityto monitor the environmental situation.Wireless sensornetworks (WSNs) have become increasingly important becauseof their ability to monitor and manage situational information

for various intelligent services. Due to those advantages,WSNshas been applied in many fields, such as the military, industry,environmental monitoring, and healthcare.TheWSNs are increasingly being used in the home for energycontrolling services. Regular household appliances are monitoredand controlled by WSNs installed in the home [5]. Newtechnologies include cutting-edge advancements in informationtechnology, sensors, metering, transmission, distribution, andelectricity storage technology, as well as providing new informationand flexibility to both consumers and providers of electricity.The ZigBee Alliance, wireless communication platformis presently examining Japan's new smart home wireless systemimplication by having a new initiative with Japan's Governmentthat will evaluate use of the forthcoming ZigBee, Internet Protocol (IP) specification, and the IEEE 802.15.4g standard to helpJapan 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 estimateof the size of the home energy management market.There are several proposals to interconnect various domesticappliances by wireless networks to monitor and control such as provided in. But the prototypes are verified usingtest bed scenarios. Also, smart meter systems like [9]– [11] havebeen designed to specific usages particularly related to geographicalusages and are limited to specific places. Differentinformation and communication technologies integrating withsmart meter devices have been proposed and tested at differentflats in a residential area for optimal power utilization,but individual controlling of the devices are limited to specifichouses.

II. LITERATURE SURVEY

In this section, we briefly discuss the existing works aboutsmart home systems based on the wireless communication technology.Han *et al*. proposed a Home Energy ManagementSystem (HEMS) using the ZigBee technology to reduce thestandby power. The suggested system consists of an automaticstandby power cutoff outlet, a ZigBee hub and a server. Thepower outlet with a ZigBee module cuts off the ac power whenthe energy consumption of the device connected to the poweroutlet is below a fixed value. The central hub collects

informationfrom the power channels and controls these power channelsthrough the ZigBee module. The central hub sends the presentstate information to a server and then a user can monitor orcontrol 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, forsome situation but the system will cut the power off leading todarkness.

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.

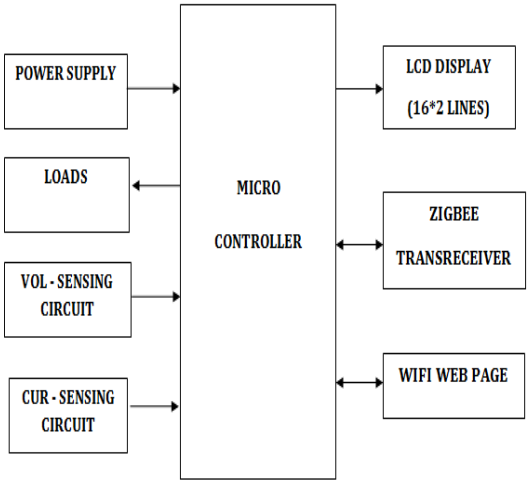

Fig:1:Transmitter Section Block diagram

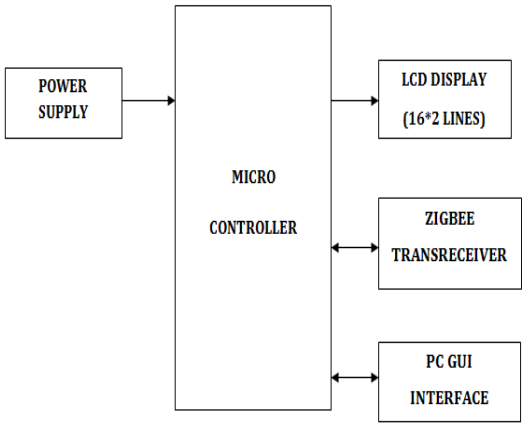

Fig:2: Receiver Section Block diagram

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 caseis 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.

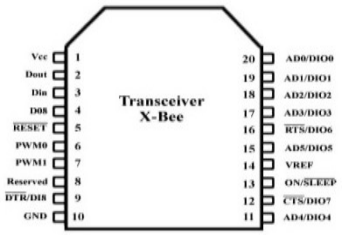

Fig .3: ZIGBEE pin diagram

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).

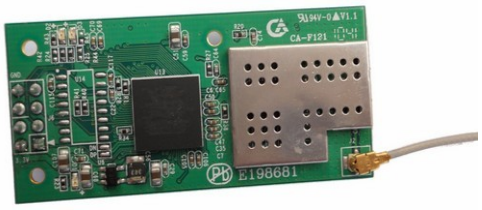

Fig .4: WIFI Module

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:
  - Ad hoc and Infrastructure
- support multiple security authentication mechanisms:
  - WEP64/WEP128/ TKIP/CCMP(AES)
  - WEP/WPA-PSK/WPA2-PSK
- support quick networking
- support wireless roam

VOLTAGE 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 trail at home.

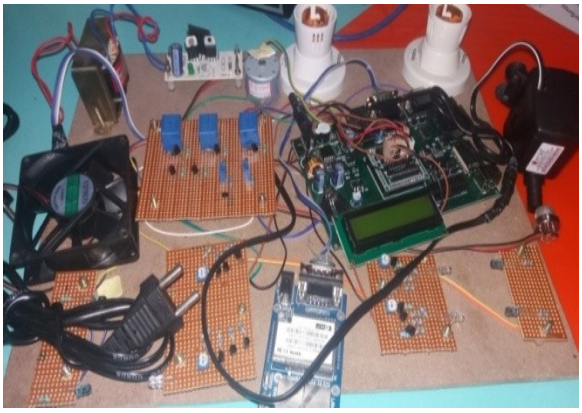

Fig. 5: Transmitter Section Load ‘s Connected Circuit

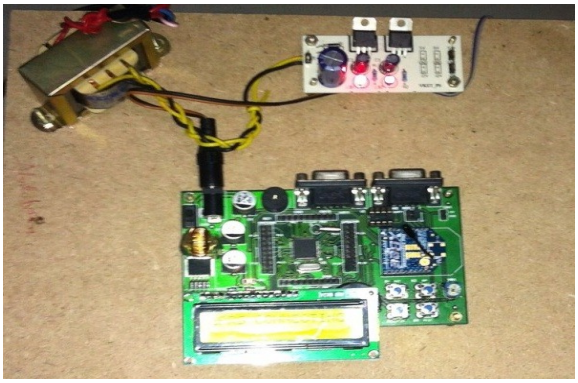

Fig. 6: Receiver Section Circuit

VI. CONCLUSION

A smart power monitoring and control system has been designedand developed toward the implementation of an intelligentbuilding. The developed system effectively monitors andcontrols the electrical appliance usages at an elderly home.Thus, the real-time monitoring of the electrical appliances canbe viewed through a website. The system can be extended formonitoring the whole intelligent building. We aim to determinethe areas of daily peak hours of electricity usage levels and comewith a solution by which we can lower the consumption andenhance better utilization of already limited resources duringpeak hours.The sensor networks are programmed with various user interfacessuitable for users of varying ability and for expert userssuch that the system can be maintained easily and interactedwith very simply. This study also aims to assess consumer’sresponse toward perceptions of smart grid technologies, theiradvantages and disadvantages, possible concerns, and overallperceived utility.The developed system is robust and flexible in operation. Forthe last three months, the system could perform the remotemonitoring and control of appliances effectively. Local and remoteuser interfaces are easy to handle by a novice consumerand are efficient in handling the operations.In future, the system will be integrated with co-systemslike smart home inhabitant behavior recognitions systems todetermine the wellness of the inhabitant in terms of energyconsumption.

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