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WSN BASED POWER MANAGEMENT IN INTELLIGENT BUILDINGS

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ABSTRACT

The main focus of this paper is to sense and control the electrical appliances or devices through wireless sensor network using ZigBee communication module. The implementation of the project is easy, flexible and also cost effective to customers. The electrical parameters of the appliances or devices are measured and the measured values are then sent to controller and transmitted to the PC through the ZigBee medium. Depending upon the values got from the controller the driver activates or deactivates the transfer. The PC uses LabVIEW Software for displaying the graphical variations of electrical appliances and the power consumed by the device.

Keywords: *WSN, ZigBee, LabVIEW, MPLAB I.*

I. INTRODUCTION

The demand for wireless technology in automation systems has widely been increased due to its inheritable advantages like reduce installation cost, minimum space consumption, easy extension, aesthetic benefits, and its increased connectivity options. The need for wireless sensor network has highly increased nowadays because of their monitoring ability and their flexibility towards communication with other intelligent services. WSNs are used in home as energy controlling devices. Household appliances are monitored and controlled by installing WSNs in the home. ZigBee is used as the communication module for transmitting the monitored readings between the WSNs, because of its low cost and low power characteristics. Due to number of standard profiles available ZigBee provides wide scope to develop globalize & customize solutions over other wireless technologies.

Due to the wide variety of advantages, WSNs finds applications over various fields, such as environmental monitoring, personal care and elderly monitoring, military, industry. To meet these requirements a standard-based wireless technology which have the good performance graph for reliability, security, low power and low cost will always be preferred. For viewing the graphical variations through PC we have used LabVIEW software which uses Graphical programming language, which is more flexible. It is designed to facilitate data collection and analysis, numerous display options Contains set of VIs & functions for acquiring, analyzing, displaying and storing data as well as tools to troubleshoot our code. Used in simulation, data acquisition, instrument control, measurement analysis, and data presentation.

The aim of this paper is to sense and control the household appliances or devices through wireless sensor network using ZigBee communication module. The paper mainly focuses on reducing the energy consumption in household appliances. Here the proposed system can handle errors such as no sensor data reception and it notifies in case

of high range values of analog to digital conversion. Household appliances connected to WSN can be controlled manually or automatically. The voltage, current and power consumed by the appliance or device is displayed through LCD and the variations of electrical parameters also can be examined through LabVIEW software.

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II. BLOCK DIAGRAM

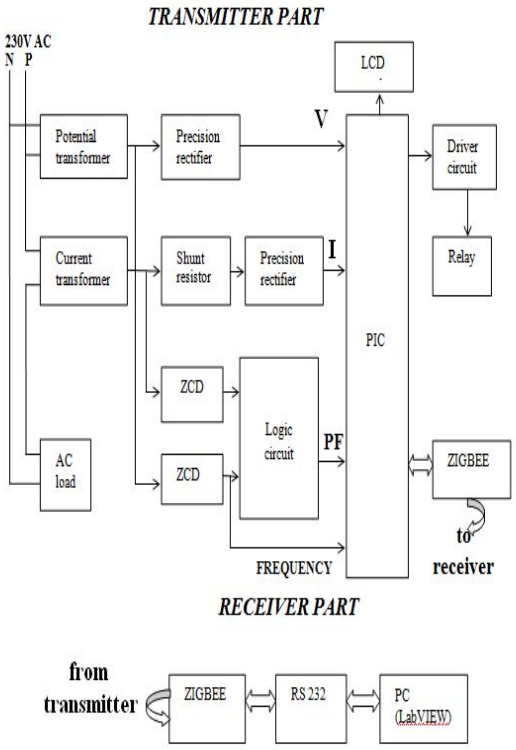

Fig.1 bock diagram of the system

III. HARDWARE DESCRIPTION

In Fig.1, The A.C voltage consumed by the appliance is sent to the transformers. The potential transformer lowers the voltage and sends the signal to the precision rectifier. The current transformer with shunt resister converts the current to voltage and sends the signal to the precision rectifier. The precision rectifier rectifies and filters the received A.C waveform from both transformers to pure D.C waveform within range of (0-5V) D.C. D.C signals are then converted into values that can be used for computation of the controller and also transmitted to the PC through the ZigBee medium. The instruction from the PC is transferred to the pc and the pc interprets the signal and activates the I/O pins. Depending upon the values got from the controller the driver activates or deactivates the transfer. The PC uses LabVIEW software to show the graphical variations of power consumed. The whole function of the WSN is monitored and controlled using embedded and wireless systems.

HARDWARE TOOLS

PIC controller 16F877A
ZigBee modules
Power supply unit
Potential Transformer
Current Transformer
Precision Rectifier
Relay with Driver
LCD Display (2X16)

PIC CONTROLLER 16F877A

PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (Complementary Metal Oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data

memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques. Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off are other features of PIC 16F877.

***Pic Start Plus Programmer**:*
The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The PIC start plus development system includes PIC start plus development programmer and MPLAB IDE. The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under MPLAB IDE provides for full interactive control over the programmer.

FEATURES

- Easy Programming and Erasing
- Flash memory
- Commercial and Industrial temperature ranges
- Low-power consumption
- Power saving SLEEP mode
- Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC Oscillator for reliable operation

ZIGBEE MODULES
ZigBee used here is CC2500 which is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. It acts both as transmitter and receiver. The circuit is intended for the 2400- 2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate up to 500 kbaud. CC2500 provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication, and wake-on-radio. The main operating parameters and the 64- byte transmit/receive FIFOs of CC2500 can be controlled via an SPI interface. In a typical system, the CC2500 will be used together with a microcontroller and a few additional passive components. It is always used with microcontroller which supports SPI communication.

Features

- Excellent receiver selectivity and blocking Performance
- It works in voltage range of 1.8 - 3.6V.
- Two AA batteries are enough to power it.
- It has 30m range with onboard antenna.
- Automatic Frequency Compensation(AFC) can be used to align the frequency synthesizer to the received centre frequency
- Integrated analog temperature sensor

POWER SUPPLY UNIT

Block diagram

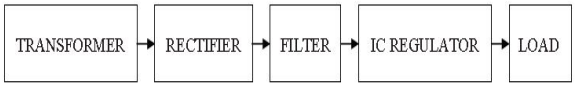

Fig.2 Block diagram of power supply

In fig 2, AC voltage typically 220V rms is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage

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variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies. This voltage regulation gives out constant dc output voltage

.

POTENTIAL CURRENT TRANSFORMER*:*

The potential transformer will step down the power supply voltage (0-230V) to (0-9Vand 15-0-15) level. If the secondary has less turns in the coil then the primary, the secondary coil's voltage will decrease and the current or AMPS will increase or decreased depend upon the wire gauge. This is called a Step-Down transformer**.** Then the secondary of the potential transformer will be connected to the rectifier and then filter and through that voltage measurement can be made. Similarly, the current transformer will step down the supply current that has to be monitored. The step down current is converted by the voltage with the help of shunt resistor. Then the secondary of the current transformer will be connected to the rectifier and then filter and through that current measurements can be done.

RELAY WITH DRIVER

Relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be made on or off so, relays have two switch positions and they are double throw switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical. The coil of a relay passes a relatively large current, typically 30mA for a 6V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil.

IV. SOFTWARE DESCRIPTION

Microchip's seamless migration path with standard pin schemes and code compatibility allows engineers to reuse Verified code and a proven printed circuit board layout. Adding higher memory options, incremental I/O and analog peripherals can be accomplished without losing their software investment, reducing time to market. Embedded Systems typically have no graphical user interface so making Software is a special challenge for programmers nowadays. The PIC microcontroller family offers easy migration within the complete range of products. Migrations between the different PIC microcontrollers enable several advantages such as future cost reductions, feature enhancements and late development changes with minimal impact to the existing hardware, software and in engineering development environment. The voltage, current, power consumed by the device is processed by the microcontroller by using MPLAB IDE and the parameter values are sent to receiver part through ZigBee. ZigBee is connected to the pc. The values of voltage, current and power are graphically viewed through LabVIEW Software. The variations of power consumed by the device can be viewed through LabVIEW.

SOFTWARE TOOLS

- Programming Language: Embedded C
- Development Tool: MPLAB IDE

PIC microcontrollers achieve low-risk product development by providing seamless program size expansion. Pin compatibility facilitates drop-in replacements of package types as well as variations of reprogrammable and one-time programmable (OTP) program memory without having to completely re-write code. Microchip's MPLAB Integrated Development Environment (IDE), a simple yet powerful development environment, supports low-risk product development by providing a complete management solution
for all development systems in one tool.

To maintain the process, the controller is commanded using embedded C language. The code is written in the editor and is compiled by High-tech Compiler. After compilation the program is build, so that its hex file is generated. The hex file information is easily understandable by the PIC controller.pic gets analog values from transformer gets rectified and converted into digital signals. Those signals are in zeros and ones in which it makes relay on if PIC output is 1 and off if PIC output is 0.

ISSN 2348 – 8034
Impact Factor- 3.155

V. LABVIEW OUTPUT

DESCRIPTION

LabVIEW output screen in fig.4, displays the numerical value and also the graphical variations of voltage, current, power and frequency of the connected appliance. The graph shows the variation of amplitude with time. Through LabVIEW we can set the range of maximum and minimum value of supply that has to be consumed by the appliance. If the supply consumption by the appliance is low, then the graphical waveform peaks obtained will be at lower level. and similarly if the consumption is high then the graph shows higher peak variations with higher value notification then depending upon that relay turns ON or OFF the appliance to avoid further more power consumption. Fig.3 shows the experimental setup.

OUTPUT1:

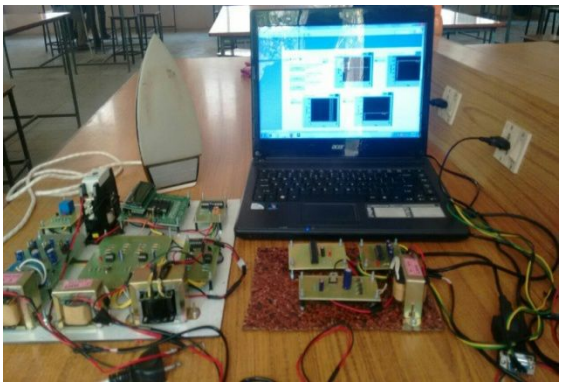

Fig.3 experimental setup

OUTPUT2:

Fig. 4 output taken from appliance (Iron box)

VI. ADVANTAGES

To Monitor and control the devices automatically or manually
ZigBee is used as communication medium to transfer the data which reduces cost.
Implementation is easy and flexible
Energy consumption is achieved and used in home automation.
PIC16F877A microcontroller operates with very less power yet providing superior performance.

VII. RESULT

The following appliances such as room heaters, microwave, oven, toasters, water kettle, fridge, television, audio device, battery chargers, and water pump can be test by enlarging the project, we can even use ten different

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electrical appliances in the experimental setup; By monitoring consumption of power of the appliances, data are collected by a smart coordinator, which saves all data in the system for processing as well as for future use. The parameters will be entered in the data coordinator in software from appliances include voltage, current, and power. These parameters will be stored in a database and analyzed.

Collected data will be displayed on the computer through LabVIEW window so that appropriate action can be taken from the user. The processed voltage, current, and power values are displayed on the LabVIEW software running on a computer. The processed data area accurate and user friendly. The sensing system in the sensor node measures the parameters (voltage and current). The raw data (i.e., converted ADC values) are transmitted to the coordinator. The computer then collects the data from the coordinator and processes them. The computer then applies the necessary formulas to get the actual voltage, current, and power consumption of the electrical appliances. The voltage and current readings are processed using embedded c programming The developed system has software recovery strategies such as exception-handling, auto restart, and alert text mechanism for sensors failure. The exception handling procedure can handle errors such as no sensor data reception and high range values of analog-to-digital-converted values and computational errors resulted during the normalization of voltage and current sense data values.

VIII. CONCLUSION

This work has been designed and developed toward the implementation of an intelligent building. The developed system effectively monitors and controls the electrical appliance in home and reduces the power consumption. Thus, the real-time monitoring of the electrical appliances can be viewed. This system can even 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 can be achieved

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