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Hybrid Networked Energy Consumption DAQ System for Industries Using CAN, ZigBee and Ethernet

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***Abstract*— In recent years, demand of energy has been steadily on the rise. For our future generation we have to save Energy. In order to reduce the energy consumption of the machineries used in an industry, Hybrid networked Energy consumption DAQ system plays an important key role to save Energy. This paper, presents that how to measure and record the energy consumption and temperature acquired by individual machinery used in an industry. Energy monitors networked using Controller Area Network (CAN) monitors the power consumption and temperature and send it through ZigBee to remote Ethernet web server. By accessing the web server via LAN we can see the data of temperature and consumption of individual machines. It also displays the power consumption and temperature at local in a liquid crystal display. So users can monitor the temperature and power consumption from both local and anywhere in an industry. The machine will automatically cut OFF based on high temperature conditions. The machine will automatically run after that machine will reach at low temperature. Once we have learned about the consumption of all the electrical items we will be well equipped with the knowledge to enable us to save energy and reduce our electricity bill.**

***Index terms*— Energy consumption, Microcontroller, Temperature, ZigBee**

I. INTRODUCTION

With the rapid developments in the Wireless communication technology with the use of the Microcontrollers, there are many improvements in automating various industrial aspects for reducing manual efforts. Meanwhile, utilities also hope that the development of new technologies to solve the problems they encountered in the practical work about cumbersome reading and no reliable protection of accuracy and real time; and enable both user friendly and improving public sector efficiency and management level. Existing wire line meter reading system has a large no of risks. Wires are more complex detrimental to adjust and maintenance of the system. The long term indoor and outdoor installation easily leads to aging, resulting in a risk of short circuit and breakage. For these reasons it has become the industry to automatically recording of measuring parameters. In order to solve this problems, we are going to automatically recording the data and also user can monitor the machine conditions at anywhere in the industry.

In this paper, it will describes that the measurement of energy consumption and at what temperature, the machines will run. It can be done for each and every machines equipped in an industry. The data will sent to Ethernet web server through ZigBee. Consumers with this information can check the measured data of individual machines, both remotely using a web server and locally using Liquid crystal display, in order to directly control and handle it. If the machine will run at high temperature conditions, the machine will automatically cut OFF. After few minutes the machine will reach low temperature and start to run. It is designed with long term reliance and convenient installation and maintenance.

The paper is organized as follows: in Section II the related work, are investigated and studied for mitigation of Wireless networks. Section III is devoted to system architecture. In section IV we show the software implementation of system. The demonstration of the system is described in section V followed by some concluding remarks in section VI.

II. RELATED WORK

In this section, we briefly discuss the existing system about Energy consumption DAQ system for Industries based on wireless communication technology. Hung *et al* [1] proposed a Wireless Automatic meter reading system to meet the basic needs of reading with flexibility and expansibility. The proposed system consist of an electric meter measures an electrical parameters and transfers measured data to ZigBee concentrator via RS-485 to RS-232 communication ports and to ZigBee/GPRS

Gateway via wireless network, then to a terminal node via GPRS and back to PC in RS-232 communication format. Gill *et al* [2] proposed ZigBee based home automation system can control and monitor home appliances. The proposed system consists of a home network device and a home gateway supports interoperability between external networks. Suh *et al* [3] proposed an intelligent home control system based on a wireless sensor network with a link quality indicator based routing protocol to enhance network capability. Gallo *et al* [4] proposed a Multifunction DSP based real time power quality analyzer to meet high-performance real time power quality measuring instrument based on Digital signal processor (DSP) is discussed. It also continues with the presentation of power quality analyzer software design in terms of measurement accuracy and speed of execution.

Compared to the existing research, in this paper, our aim is to obtain a low-cost device with high accuracy of temperature and consumption readings and also users can monitor the measurements both locally and remotely using a web browser.

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III. SYSTEM ARCHITECTURE

A. Overview of the Proposed System

The overall system consists of Data collecting unit and Ethernet web server section. These two sections are linked via low power ZigBee communication protocol. Data Acquisition units consists of two or more acquisition units and each collects energy consumption and temperature measurement of equipments connected with it and relays this information to the CAN-ZigBee gateway Controller Area Network Protocol. In this unit, there will be relay which is used to automatically cut OFF the input power supply at high temperature conditions and will run after the machines reach low temperature. Gateway unit sends this information to the Ethernet web server which saves all this information coming from DAQ and transfers this to the local clients when they requests.

B. Data Collecting Unit

The block diagram of Data collecting unit of DAQ system is shown in Fig (1). In this unit it comprises of PIC Microcontroller which act as the brain of the system. The machines used in an industry are connected to the energy meter count sensor and temperature sensor. Microcontroller acquires the sensor outputs and processes to the LCD. The measured values are displayed through Liquid Crystal Display (LCD) in a plant. These values are sent to Ethernet Web Server section through ZigBee.

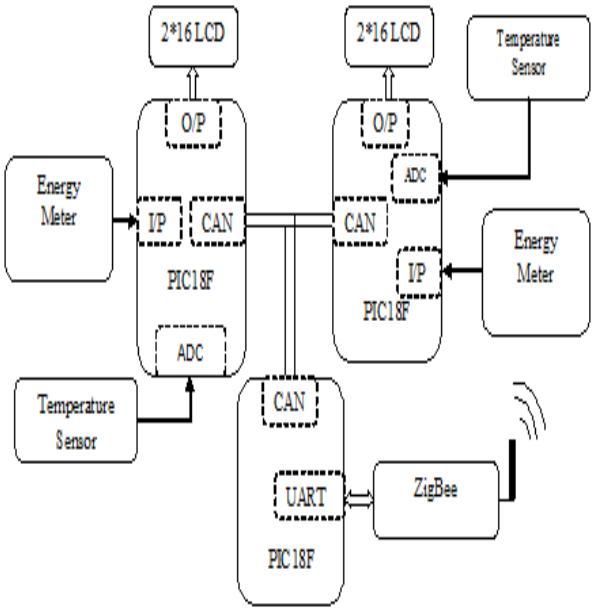

Fig (1) Data collecting unit of the System

C. Ethernet Web Server Section

This section consists of Ethernet Controller connected to PC. It receives the data from the data collecting unit through ZigBee which can be displayed in a web page of PC. By accessing the web server via LAN we can see the measured parameters of each and every machine. Fig 2 shows the Block diagram of an Ethernet web server section of DAQ system for industries.

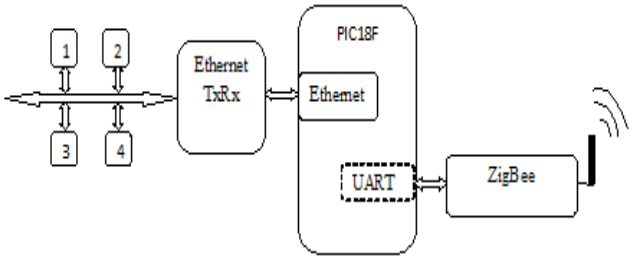

Fig (2) Ethernet web server Section

D. Microcontroller

Microcontroller is a single chip microcomputer. The central processing unit, input/output system, memory and timer are contained in a highly integrated single chip. Microcontrollers are commonly used in specific purpose computers for real-time applications. Like computer systems, Microcontrollers are instruction executors. A Microcontroller is designed for a very specific task to control a particular system. For Microcontrollers, programs are stored in memory on chip and are executed by a central processing unit. A highly integrated chip includes, on one chip, all or most of the parts needed for a controller. The Microcontroller could be called a "one-chip solution". Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Microcontroller drastically reduces parts count and design cost. The microcontroller can be programmed to achieve any task of a design. Here the microcontroller is used for activating and controlling various elements of the automatic distribution system.

E. UART

UART consists of three main blocks.

- a serial transmit block
- a serial receive block and
- a CPU Interface (I/F) block.

The serial transmit block has two buffers (FIFO) into which data is written by the CPU I/F block. After the data is written into the buffers it is transmitted serially onto TXD. As long as the FIFO is not full the serial transmit block sets the signal TX_RDY high.

The serial receive block has four buffers (FIFO). The block check for the parity and the validity of the data frame on the RXD input and then writes correct data into its buffers. It also sets the signal RX_RDY low if its FIFO is empty.

The CPU I/F block is responsible for reading the status register, data register and writing data into interrupt enable register and data register. It receives control signals from the CPU for performing certain tasks.

F. CAN Interface

The controller Area Network (CAN) protocol is used to connect the server to the Machines used in an industry. CAN is a serial protocol that supports distributed real time applications and has adequate security level for the objectives of this work. It has been design to manage efficiently a high number of incoming messages. The communication takes place when the Microcontroller exchanges data with the server through a serial connection. Clients send control signals, called control packets to the server computer. The server receives control packets from the clients, interprets the received packets, updates the database and sends the control packets to the controller.

G. ZigBee Technology

ZigBee technology is a bi-directional wireless communication technology of low power, low cost and low complexity of wireless communication technology. It is used in the application of home automation, Building automation, industrial control and industrial areas of logistics. It is responsible for receiving and transferring data. It is selected around the world as the energy management and efficiency technology of choice in terms of reliably and timing.

H. Ethernet Controller

Ethernet controller is an industry standard Serial Peripheral Interface (SPI). It is designed to serve as an Ethernet network interface for any controller equipped with SPI. It incorporates a number of packet filtering schemes to limit incoming packets. It also provides internal DMA module for fast data throughput and hardware assisted checksum calculation, which is used in various network protocols. Communication with the host controller is implemented via an interrupt pin and the SPI, with clock rates of up to 20 MHz. Two dedicated pins are used for LED link and network activity indication.

IV. SOFTWARE DESIGN IMPLEMENTATION

A. TCP/IP Implementation

Our stack is a collection of different modules. Some modules (such as IP, TCP, UDP and ICMP) must be called when a corresponding packet is received. Any application utilizing our stack must perform certain steps to ensure that modules are called at the appropriate times. This task of managing stack modules remains the same, regardless of main application logic. In order to relieve the main application from the burden of managing the individual modules, our TCP/IP Stack uses a special application layer module known as "StackTask", or the Stack Manager. This module is implemented by the source file "StackTsk.c". StackTask is

implemented as a cooperative task; when given processing time, it polls the MAC layer for valid data packets. When one is received, it decodes it and routes it to the appropriate module for further processing.

B. Web Server

Our module is an IP enabled device. Now if a public IP if provided to it, it can definitely be accessed through the internet. But being an eight bit microcontroller it would not be able to serve thousands of possible requests from the public domain. Also any hacker wanting to crash our system can generate large no of requests that our module cannot handle. In order to address this problem and to manage readings of different parameters of an individual machine, the essence of a Web server is inevitable.

V. EXPERIMENTAL DEMONSTRATION

The system is designed to monitor the energy consumption and temperature reading of each and every machines used in industry. For our demonstration purpose we will use a60W bulb as load to examine our system. The consumption and temperature readings of bulb are measured by Disc type Energy meter and temperature sensor LM 35 respectively connected to PIC 18F Microcontroller. These values are displayed in 2*16 Liquid crystal display using PIC18F Microcontroller. This information can be transmitted to the Ethernet controller ENC28J60 of Ethernet web server section through ZigBee. The energy consumption and temperature readings of every machine can be seen in web page of PC which is connected to Ethernet controller via LAN. Based on temperature conditions, the switch will be opened automatically to cut OFF the input power supply of machines.

VI. CONCLUSION

In this paper, we develop the Hybrid Networked Energy consumption DAQ System for Industries. It is designed on the basis of high performance, extremely low power consumption, high level integration and low price of ZigBee technology. The technology has strong market competitiveness. ZigBee uses wireless communication and computer network technologies to read and process data automatically. It can not only save the human resources, but also improve the accuracy and instantaneity of energy consumption and temperature readings. It enables management sector to timely and accurately messages. Moreover no cabling is required with relatively economical investment. For the Hybrid Networked Energy consumption DAQ system, wireless communication links can be quickly built, engineering period significantly shortened, and it has better scalability compared to a wired system. Based on temperature conditions the machine will automatically shut down and will run.

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