



Energy Monitoring System Using Zigbee and Arduino

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Abstract

The proposed concept provide a low cost Energy Monitoring System (EMS) using ZigBee wireless Communication with Arduino controller. It is used to monitor the electrical real time parameters without any wired network. In this paper we discussed about zigbee versus Arduino interfacing technique, which is used to reduce the more number of coding and get the energy meter reading in less range of delay time. The proposed concept is developed in order to achieve energy saving and provide the awareness to the residential, commercial and industrial consumer about the power utilization day to day with strong communication protocol and arduino controller with simple embedded coding. The objective of the system is, providing fast power communication between distribution and consumer with low cost and easy to interface.

Keywords Zigbee communication, Energy Monitoring System (EMS), Arduino.

1. Introduction

Energy monitoring system is a technique to reduce the power, control the power and to provide the awareness about the power utilization. In the existing system wireless Energy monitoring system is desgined with the same zigbee protocol and the microcontroller base. Hence the cocept need to develop long time programme as well as communication process take much time it means it will take more delay time and more power consumption. Here the proposed system take only short time program with embedded and the program coding directly uploaded with Arduino controller. So that the zigbee versus Arduino interfacing level is very fast and easy when compare with existing system.

Now a days in distribution and consumer side digital meter installed by the electricity board instead of analog meter. In future this digital meter may be changed as smart meter. So the technology is developed and based on this our monitoring level also get smarter. So that if the consumer need to get idea of their power utilization, they required better communication system interfacing with their own existing system like personal computer and mobile phones. If the monitoring system connected with their daily usage devices, easily they can access and get the power ulization details before their mothly assessment. Hence this system based on that purpose only implemented with low cost and simple circuit.

Here the Wireless EMS is developed by zigbee communication protocol for home and office energy savings and high power consumption efficiency [2]-[7]. The proposed concept uses to obtain the real time electrical parameters from digital meter between distribution and consumption. The proposed Energy Monitoring System easily interfaces with our personal computer, laptop and mobile. So that consumer can know about their power consumption. Hence the proposed system implemented to stop

unwanted power consumption and consumer can reduce power utilization by knowing electricity bill before the assessment.

2. Related Work and Motivation

For energy monitoring, now a days many communication technologies are available like Bluetooth, Zigbee, Local are internet and Global mobile communication[1]. But here the Zigbee wireless communication protocol is suitable for getting power transfere between energy meter and user with coverage area 200m and transfereing speed 250Kbps.

Basically home appliance always having three kinds of stages like power modes, normal mode and off mode. In power mode the home appliances ulitizling maximum power but in normal mode, home appliances using almost 10 percent of power consumption [8].

In [9]-[11], monitoring system calculates the power utilization of electric home appliances in normal mode. Also the Zigbee communication protocol is used to send the electrical reading values like current and voltage to the personal computer. Embedded board is used.

In [12], Bluetooth protocol is used for monitoring the home appliances. But the Bluetooth coverage area just 10 meters only. So Bluetooth is only for short distance monitoring like room side. Hence, for long distance monitoring is not easy to achieve via Bluetooth communication.

In [13], discussed about the use of Zigbee protocol with the Advance Metering Infrastructure (AMI). Zigbee protocol is one of the best network to transmit the detailed electrical information with low power consumption and less development cost.

Table 1 Comparisons of bluetooth, wifi, zigbee.

Protocol	Range	Frequency Band	Power Usage
Bluetooth	10 meter	2.4 GHz	High
Wi-fi	100 meter	3.1 to 10.6 GHz	High
Zigbee	10 – 200meter	868/915 Mhz	Low

3. Design of System

3.1. System Overview

The system concept is as shown in Figure 2. As shown in the figure, consumer side receiver protocol and distribution side transmitter protocol are connected [8]. Here the Consumer side we have arranged one Personal Computer (PC) which is interfaced with receiver board [19]-[24] and transmitter side energy meter is the main frame, with this energy meter only the zibee transmitter connected. Between energy meter and personal computer we are transferring energy information like voltage, current and power to the PC through the zigbee wireless communication network. This information will be saved as a report in notepad format for further access.

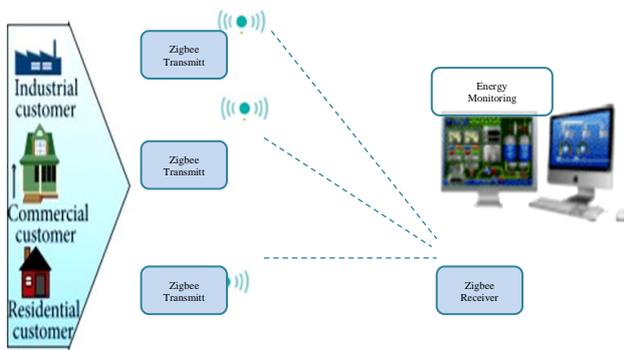


Figure 1 Configuration of Wireless Energy Monitoring System

3.2. Energy Monitoring and Sending Device

The block diagram of energy monitoring and energy sending device is shown in fig 3. This device consists of four main components, such as digital energy meter, power metering IC, Arduino board, zigbee transreciever 2.4G [14].

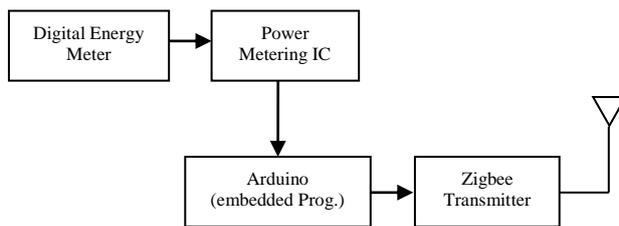


Figure 2 Block Diagram of Energy Monitoring and Sending Device

3.3. Energy Monitoing system (EMS)

The proposed EMS consists of zigbee transceiver and Personal Computer. This device has functions to display the power consumption information in personal computer, laptop and mobile phone. This informations are received through zigbee wireless communication [15]-[18].

The zigbee transceiver supports ZigBee 2006-stack and compatible to IEEE 802.15.4 protocol. Also the ZigBee prototype is 10m to 2Km.Compatibility with the arrange like Wi-Fi, Ethernet and GPRS is great and giving versatile systems administration arrangement makes it reasonable to use for checking and controlling application [25]. Finally the computer

(control server) displays monitoring parameters, such as power consumption value, voltage, current and frequency.

The zigbee prototype connected with Arduino uno, the Arduino uses to communicate energy meter values to zigbee protocol by developing the coding in embedded programming [26]. It has highlight of 32 KB of programmable glimmer memory, 1KB EEPROM, 2KB SRAM, 8 channel 10 bit A/D converters and JTAG interface to give on-chip troubleshooting. Gadget works at 4.5 to 5.5 volts with throughput of 16 MIPS at 16 MHz Also it can accomplish the lower control utilization, high handling speed and throughput of 1 MIPS for each MHz by executing guideline in single clock beat.

3.4. Embedded Coding Used

The program is incorporated with "Arduino IDE".

```
#include <EEPROM.h>
#define CURRENT_SENSOR A0 // Define Analog input pin that sensor is attached
float amplitude_current; // Float amplitude current
float effective_value; // Float effective current
long voltage;
float unit=0;
float uniteeprom;
float unitlevel;
float value;
void setup()
{
    Serial.begin(9600);
}
void loop()
{
    int sensor_max=analog
Read(CURRENT_SENSOR);
    if(sensor_max>0)
    {
        //float value = EEPROM.read(uniteeprom);
        float Volt = (sensor_max / 1023.0) * 5000;
        float Amps = ((Volt - 250) / 185);
        Amps= Amps/10;
        Amps= Amps+0.3;
        Serial.print("Current(mA)");Serial.print(Amps);
        Serial.println("");
        voltage = random(215, 230);
        Serial.print("Voltage(V)");Serial.print(voltage);
        Serial.println("");
        float power = random(78, 90);
        power=power/100;
        Serial.print("Power factor(PF)");Serial.print(power);
        Serial.println("");
        float frequency = random(48.2, 50);
        Serial.print("Frequency(V)");
        Serial.print(frequency);
        Serial.println("");
        unit = Amps*0.0001;
        unitlevel=value+unit;
        value=unitlevel;
        Serial.print("Unit");
        Serial.print(unitlevel);
        Serial.println("");
        //EEPROM.write(uniteeprom,unitlevel);
        Serial.println("");
    }
    else
    {
        Serial.print("Current(mA) 0");
        Serial.println("");
        Serial.print("Voltage(V)0");
        Serial.println("");
        Serial.print("Power factor(PF) 0");
        Serial.println("");
    }
}
```

```

Serial.println("");
  Serial.print("Frequency(V)0");
Serial.println("");
  Serial.print("Unit");Serial.print(unitlevel);
Serial.println(""); Serial.println("");
}
}

```

4. Implementation and Test Result

The implemented board of EMS transmitter end is shown in figure 4 and the receiver end is shown in figure 5. The EMS is developed with Arduino controller, energy meter, power metering IC. Here the transmitter side energy meter and receiver side personal computer connected. Between energy meter and personal computer the we can have maximum distance 200 meters.



For function verification of the system, in the personal computer or laptop we have connected zigbee receiver board. So that the once the data collecting from the Arduino controller LED will indicate the signal. Based on the transmission speed the LED getting flickering and the every data will be save in the notepad screen. This measurement will get rotation basis like closed loop. Once the first measurement over again it goes to collect the data from Arduino, for this process only we have designed the circuit with data amplifier/ the data amplifier will separate the parameters neatly and then send to the system with out any interruption with the data communication speed 250kbps. Finally measured parameter displayed in the computer as shown in the Figure6

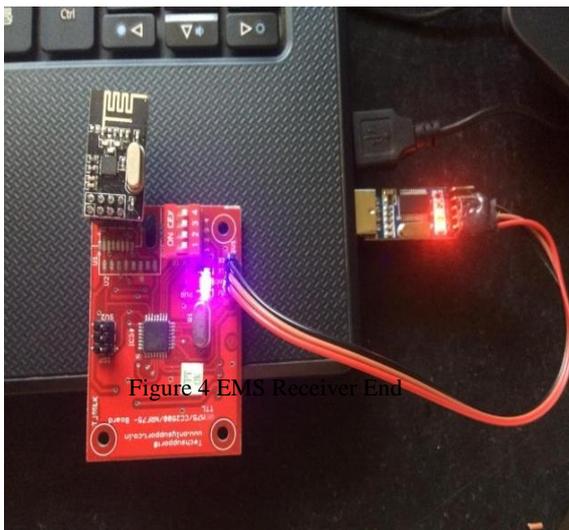


Figure 4 EMS Receiver End

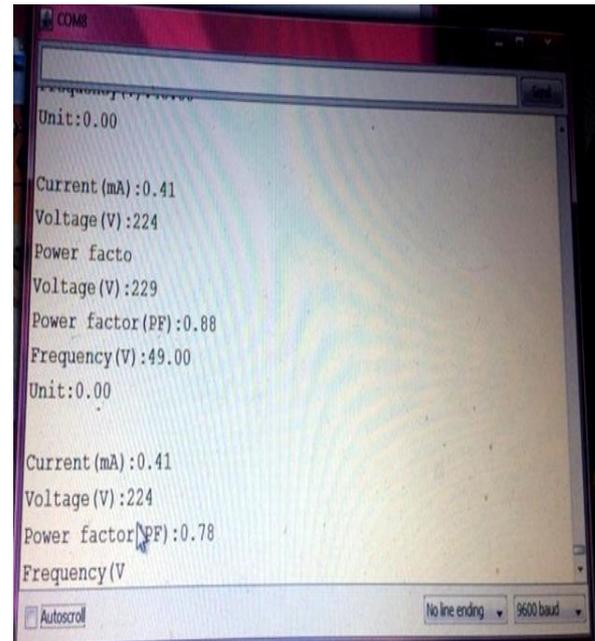


Figure 5 Real Time Output – Displayed in Computer Screen

5. Conclusion

In this paper, wireless energy monitoring system is designed and implemented with low cost and less number of coding using zigbee protocol interfaced with arduino controller. The electrical parameter observed with better communication speed between distribution end and consumer end is obtained in the personal computer like a report in every 2 seconds once. It gives the solution to every consumer to calculate their power utilization and make them to get ready their electricity bill before the monthly assessment. In future, further implementation of this wireless energy monitoring system we planned to develop with IoT techniques to achieve fast power communication. Hence the system will be helpful to implement the energy control system and energy management system.

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