Design and Implementation of Low Power Embedded System for Wireless Communication for Autonomous System

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***Abstract*—In the current scenario, embedded system along with wireless technology play an efficient role in the industrial fields for controlling, monitoring and data transmission. This paper investigate a suitable low power wireless technology for data transfer between host and autonomous system for lab testing purpose. ZigBee module is intended to be simpler, less expensive and less power consumption than other wireless network. From host, data can be sent to ZigBee module using serial communication. Transmitted data is received in the ZigBee module which is connected to autonomous system. Current consumption during transmission and reception is also measured.**

***Index Terms*— Autonomous system, embedded system, wireless technology, ZigBee.**

I. INTRODUCTION

In the challenging environment, reliable and effective communication is a high-stake issue. Automation by remote and automatic systems have improved work place, cost-effectiveness, management of technical problems, energy saving, real-time response to events. In response to these challenges wireless communication have been employed for autonomous system for data transmission.

In this paper, wireless communication is demonstrated between host computer and an autonomous system using ZigBee module. Data Acquisition Underwater system is being developed by National Institute of Ocean Technology consisting spherical hull made of glass. As the system is used underwater, it has to be leak proof. During the testing of the system firmware, it is hard to open the spherical hull, so we are stepping into wireless communication.

For wireless communication, ZigBee technology is useful for transferring data between host and autonomous system which uses PIC microcontroller. The microcontroller is connected to ZigBee module using serial port interfacing to which it is connected to host. Another ZigBee module is connected to autonomous system. Host consists of hyper terminal and the data to be transmitted is typed and sent through this software. User can send the command and data from host and transmit using ZigBee wireless technology and receiver (slave) module receives and acknowledge the data back to master. This process continues for every new message which is sent.

II. WIRELESS TECHNOLOGY

The common wireless networking technologies are comprised of Bluetooth technology, ultra-wideband (UWB) technology, Wi-Fi technology and ZigBee technology.

Table 1
Comparison of wireless networking technology

Parameter	Bluetooth	UWB	Wi-Fi	ZigBee
Communication distance (m)	10	<10	50-100	50-500
Frequency range (GHz)	2.4	3.1-10.6	2.4 or 5	2.4
Data rate (Mbps)	1	100-500	11	250×10^{-3}
Network capacity (nodes)	7	10-500	32	65,536
Power consumption (mW)	1-100	30	500-1000	20-20
Complexity	High	Mediu m-high	High	Low

For the investigation and applicable wireless system, the main features are illustrated in Table 1(Kawamura et al., 2013; Bandyopadhyay et al., 2009; Jinyun
et al., 2009; Bluetooth, 2013). As shown in Table 1, Bluetooth has limited applicability because of its very short communication distance and its low network capacity. However, UWB meets a suitable data rate, network capacity and low power consumption node but the communication distance is short.

Wi–Fi is a common wireless technology has adequate communication distance and high communication speed. Some negative aspects of this network are high power consumption, continuous power supply, access point connections for cabling and no multi-hop network topology.

ZigBee is a new wireless technology which includes more benefits compared to other wireless network. It has

suitable communication distances between nodes, low energy consumption and low complexity.

III. DESIGN REQUIREMENT

A. *Explorer 16 Development Board*

The Explorer 16 development board by Microchip Technology provides a low-cost modular development system for PIC24FJ128GA310 16-bit microcontroller. The Explorer board includes 100-pin Processor Installation Module(PIM), +3.3V and +5V (regulated) to the entire board. The Explorer 16 board supports MPLAB ICD 3 for full emulation and debug capabilities.

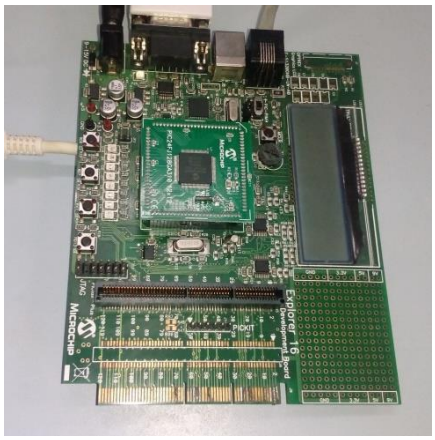

Figure1. Explorer 16 Development Board

B. *ZigBee Technology*

ETRX357-LRS module is a low power ZigBee module. ZigBee is a wireless technology based on IEEE 802.15.4 standard. Also, ZigBee technology has very cost effective nodes, network installation and maintenance compared with other wireless technology. It does not require any access point or central node to transmit data between clusters.

Figure2. ETRX357-LRS ZigBee module

Although ZigBee network has very low data rate (250kbps) for image, voice and video communication, it is capable in providing networking applications for data transmission between nodes with high performance based on wireless hops. Mesh network is formed between nodes in ZigVee devices. Mesh network is a type of chain which connects one device to another.

C. *RS 232 Cable*

For binary serial communication RS-232 acts as telecommunications standard between two Data terminal Equipment (DTE) and Data Communication Equipment (DCE). RS-232 is now used almost exclusively for modems that used to use serial ports.

IV. DESIGN IMPLEMENTATION

This part of work consists of two phases of which the first phase consists of designing the program or code in Embedded C programming language which controls the Explorer 16 board i.e., PIC microcontroller and also allows the microcontroller to controls the ZigBee module connected to it. The second phase consists of deploying the developed program into the microcontroller through MPLAB ICD 3 connected to it and running it.

Once the code has been deployed into the Explorer 16 board, it runs automatically on the board. So before deployment, ZigBee module must be connected to the Explorer 16 board through the serial port.

Figure3. data transfer using ZigBee module

From the host data is transmitted to the ZigBee module. Another ZigBee module is connected to the microcontroller receives the data.

IV. RESULT AND CONCLUSION

The paper was designed for wireless data transfer from host to autonomous system using ZigBee module, host computer have hyper terminal software to transmit the data.

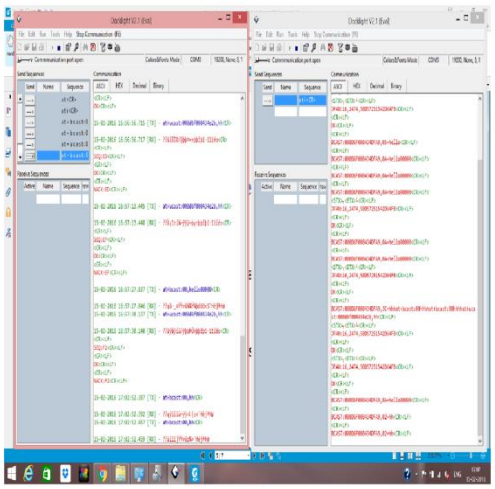

Figure4. transmitting and receiving data through ZigBee module

Transmitted data was received in another module and acknowledge the data. Received data was displayed in the hyper terminal.

Current consumption during transmission and reception was measured. In idle mode current consumption was 28mA. During stabilized connection, current consumption was 46mA. For short distance transmitted received current was 46mA.

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