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Implementation of Human Health Monitoring using Zigbee

[1]Ms. Chetana. P. Dodke , [2]Prof. Trupti. H. Nagrare

[1]Department of Computer Science & Engg. GHRCE,
Nagpur, India.

[2]Department of Information Technology. GHRCE,
Nagpur, India.

Abstract

This paper presents a heterogeneous biomedical implant prototype that has the capability to monitor biomedical signals from multiple biosensors by means of different communication standards. This is why there are great expectations for wireless sensor network technologies which readily allow the sensing of multipoint connections and various types of sensors. It will be necessary to acquire large amount of information to enable smooth control, monitoring and information distribution in ubiquitous implanted biosensors. To validate our prototype, we propose solutions that realize the ideal system using three different types of sensors for autonomous healthcare. In addition, we develop a ZigBee-ready compliant wireless system that offer low power consumption, low cost and advanced network configuration possibilities. Its enhanced user graphical interface gives a possibility to visualize and monitor the progress of multi-sensors' curves concurrency in real-time.

Keywords: Biomedical signals; Zigbee protocols; Wireless bidirectional system; individual healthcare system.

I Introduction

Wireless Biomedical implant is a new research field. It can be used in some special situation such as homecare physiological signs monitoring; for signal collection, processing and transmitting. ZigBee is a new network technology characteristic of low-cost, low power consumption, short-range wireless network communication technology for use in industrial equipment and home appliances in order to take in multi-type, multi-point sensor information [1]. It is a new wireless network protocol stack of IEEE 802.15.4. Lately traditional system to collects parameters for daily homecare is widely used in biomedicine. The traditional system adopts wired way wiring which makes the system complex and expensive, fig.1. Adopting wireless way wiring is convenient and economical. Wireless biomedical sensors are a group of embedded smart sensors that form a network from wireless communication links [2] and operate within the human body to compensate for various diseases. The smart sensors are placed in the body (invivo monitoring). They detect condition and digitize physiological signals change in its environment and communicate with a base station via a wireless interface as it is impractical to distribute wires throughout the body, due to its complexity and limitation of subject's motion [3], fig.1. Applications using or taking interest in wireless biomedical sensors are artificial retina, glucose level monitors, organ monitors, cancer detectors, and general health monitors to name a few. With such a smart system including multiple sensors of different types, we envision a future where biosensors can form a wireless sensor network, as dot matrix sensors, comprising a large number of nodes whose placement in the body can be either pre-determined or random according to the application [4, 5]. Since achieving self-powered of implantable sensors is difficult with current technology, biosensors must operate with very limited power. Prior research shows that the pulsed mode for complete measurement system is the lowest power consumption compared to the continuous measurement mode [6]. Pulsed mode is based on the idea that energy consumption can be reduced by having only a small fraction of nodes perform long range communication with a base station compared to the continuous mode.

II Literature Survey

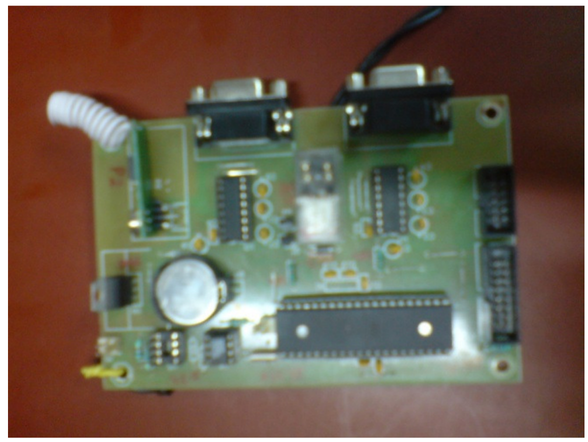
We have chosen a ZigBee RF Module to meet IEEE 802.15.4 standards and the ISM 2.4 GHz frequency band. XBee RF Module complies with Part 15 of the

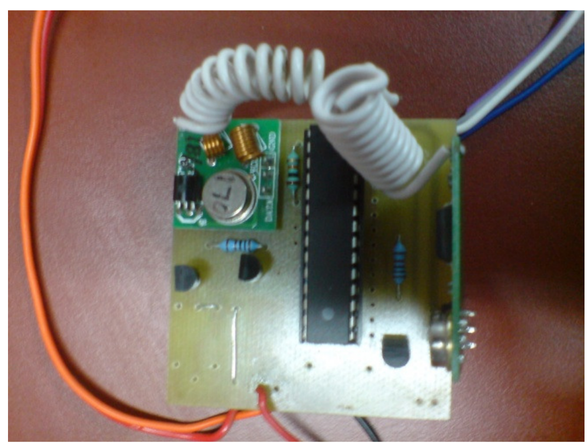
FCC rules and regulations [11]. It supports the unique needs of low-cost, lowpower wireless sensor networks. The module requires minimal power and provides reliable delivery of data between devicesIt is a short range technology that allows secure and robust communications. The use of radio device, capable to transfer data over a range of up to 100 meters outdoor-line of sight and up to 30 meters indoor-urban, is well recommended. As user interface, a windows API (Application Programming Interface) application is to be developed with high level design software for graphical user interface development. The conception, design and implementation of the entire acquiring prototype were carried out using PROTON® Basic Compiler Development Suite (Crownhill Associates), PROTEUS® Professional (Multipower Technology), and EAGLE® Layout Editor (CadSof Computer). The graphical user interface was created under LABVIEW® (National Instruments).

The communication protocol between the external unit (Testbed's subsystem prototype) and the internal unit (Implant's subsystem prototype). Both microcontrollers' programs have been structured into two parts as given Main program: It configures the MCU settings and stands-by waiting for interrupt event Interrupt subroutine: It is a program that runs only when an interrupt event is arrived. Hence, it is not usually activated and is brought into action only by a predetermined interrupt event. The Testbed's MCU is the main component of the whole acquiring chain. Indeed, it has two interrupt vectors One interrupt enabled when receiving an instruction from the base station through its incorporated USB interface and, Another one enabled when receiving sensed data wirelessly from the implant's MCU through its implemented USART. Once data flow is received from the implant's MCU, the Testbed's MCU has other tasks to execute such as: data storage, computing and transmitting to the base station before standing-by once again waiting for another acquisition request.

III System Analysis

The implant's evaluation prototype was implemented in 9.5cm x 13.5cm, Fig.7. It consists of the programmable analog front end (right side), the PIC18F4550 microcontroller (center) and the ZigBee wireless module (left side). The conditioning block includes: (1) the pressure (strain gauge), humidity and temperature sensors with respectively 0.85 mV/PSI, 40mV/%RH and 10mV/°C as analog output, (2) the analog multiplexer (CD4051 1/8 analogue multiplexer) and (3) the rail-to-rail unipolar low power amplifier (MCP6002). The serial to USB interface and bidirectional wireless communication of the Testbed's evaluation prototype was implemented in 9.5cm x 13.5cm, Fig.8. It consists of: (1) the USB-to-serial UART interface (an USB2.0 full speed compatible FT232RL chip from FTDI Ltd has been chosen because it provides an easy and cost-effective approach to transferring data between peripheral devices and a PC at up to 1 Megabaud [14], (2) the PIC18F4550 microcontroller (center) and (3) the ZigBee wireless module (left side)





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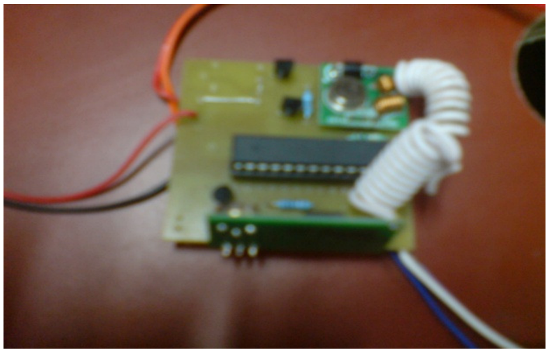
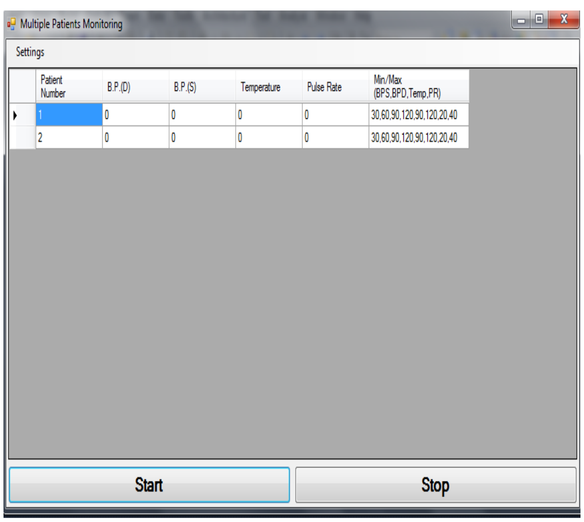


IV Experimental results and discussion

Wireless telemetry, USB powering and data transfer, data acquisition and real-time monitoring have been carried out successfully. Fig.9 shows the user interface (man-machine interface) developed under LabVIEW, a visual programming language from National Instruments, allowing easy settings of the Virtual serial port, address sensor and sampling time. The acquired signals are respectively: ambient humidity (Plot 0), ambient pressure (Plot 1) and human body temperature (Plot2). The signals are recorded during 100 ms and visualized through graphs in real-time.



In order to evaluate the efficiency of the designed acquiring chain, three different sensors are used to measure temperature, humidity and pressure related to the human body and the ambient air. The calibration of the three sensors is done to get accurate measurements. The pressure sensor is calibrated to get ambient atmospheric pressure which is 1 bar, 14.5037744 PSI (Pounds per Square Inch) or 105 Pascal. As shown in the acquiringgraph (fig.), the pressure is too near the real value with an accuracy of 1 PSI. The temperature sensor is adjusted to get ambient temperature and human body heat with accuracy of 0.5°C related to the sensitivity of the chosen sensor. The humidity sensor is tuned to get ambient humidity with accuracy of 2 %RH as sensitivity of the chosen humidity sensor.

The transmission distance range is measured 111 meters and 33 meters for indoor and outdoor data link, respectively. It's clear that the distance range is basically limited by the sensitivity of the ZigBee receiver (-92dBm) and the buildings density (urban compactness). Table I depicts the current drawn by each hardware component under active and stand-by mode. The programmable analog front end is powered on request which gives power savings when the part is not in use. It is obvious that the most consuming part is the transceiver. Therefore, an optimization of its structure will be intended. The system must adopt the solution methodology of getting the work done as quickly as possible and standing-by.

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