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Design and Implementation of Real Time Wireless Biomedical System Based on ZigBee-GSM interactive module:

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Abstract

We present a framework for a wireless health monitoring system using ZigBee technology. It has the capability to monitor vital signals from multiple biosensors. Biomedical signals are collected and processed using 2-tiered subsystems. The first stage is the mobile device carried on the body that runs a number of biosensors (internal subsystem). At the second stage, further processing is performed by a local base station (external subsystem) using the raw data transmitted on-request by the mobile device. The raw data is also stored at this base station. The processed data as well as the analysis results are then monitored and diagnosed through a human-machine interface. The main advantages of the proposed framework are (1) the ability to detect signals wirelessly within a body sensor network, (2) low-power and reliable data transmission through ZigBee network nodes, (3) secure transmission of medical data over a body sensor network, (4) efficient channel allocation for medical data transmission over wireless networks, and (5) optimized analysis of data using an adaptive hardware architecture that maximizes the utility of processing and computational capacity at each platform.

Keywords- Vital signals; ZigBee; Autonomous healthcare; Adaptive architecture; Reliable and secure data-transmission.

I. INTRODUCTION

As numerous wireless personal area networking (WPAN) technologies emerge, the interest for applications such as health monitoring, smart homes, and industrial control has grown significantly. ZigBee is the first industrial standard WPAN technology [1] that provides short-range, low-power, and secured communication, and supports mesh networking and multi-hopping. It is a new wireless network protocol stack of IEEE 802.15.4 for use in industrial equipment and home appliances in order to take in multi-type, multi-point sensor information [2]. While many smart home application areas such as lighting, security, and climate control have been suggested using the ZigBee standard, health-care applications have not received much attention despite their importance and high-value added. Here, we present a wireless communication system for real-time health monitoring with secure transmission capability. One of the most promising applications of sensor networks is for human health monitoring. A number of tiny wireless sensors, strategically placed on the human body, create a wireless body area network that can monitor various vital signs, providing real-time feedback to the user and medical personnel. The wireless body area networks promise to revolutionize health monitoring. However, designers of such systems face a number of challenging tasks, as they need to address often quite conflicting requirements for size, operating time, precision and reliability.

Lately traditional system to collect parameters for daily homecare is widely used in biomedicine. The traditional system adopts wired way wiring which makes the system complex, bulky 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 [3] and operate within the human body to compensate for various diseases.

Fig: Biomedical sensors

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.

II. SYSTEM ANALYSIS

Our novel model of wireless biomedical system is designed with the following technical features:

- Large versatility (Micro-controller embedded system).
- Efficient power management (power saving technique).
- Pulsed measurement mode concept.

• Embedded interface with a dot matrix sensors (front-end).
• On request addressable sensor node (polling mode).
• Selectable data refreshment time.
• In-situ wireless data programming and upgrading (boot loader technique).
• Bidirectional data link (half duplex with reverse telemetry).
A detailed description of the whole system will be discussed in the following sections.

A. Selected Technology

We have chosen a Zig Bee RF Module to meet IEEE 802.15.4 standards and the ISM 2.4 GHz frequency band. X Bee RF Module complies with Part 15 of the FCC rules and regulations [12]. It supports the unique needs of low-cost, low power wireless sensor networks. The module requires minimal power and provides reliable delivery of data between devices. It 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.

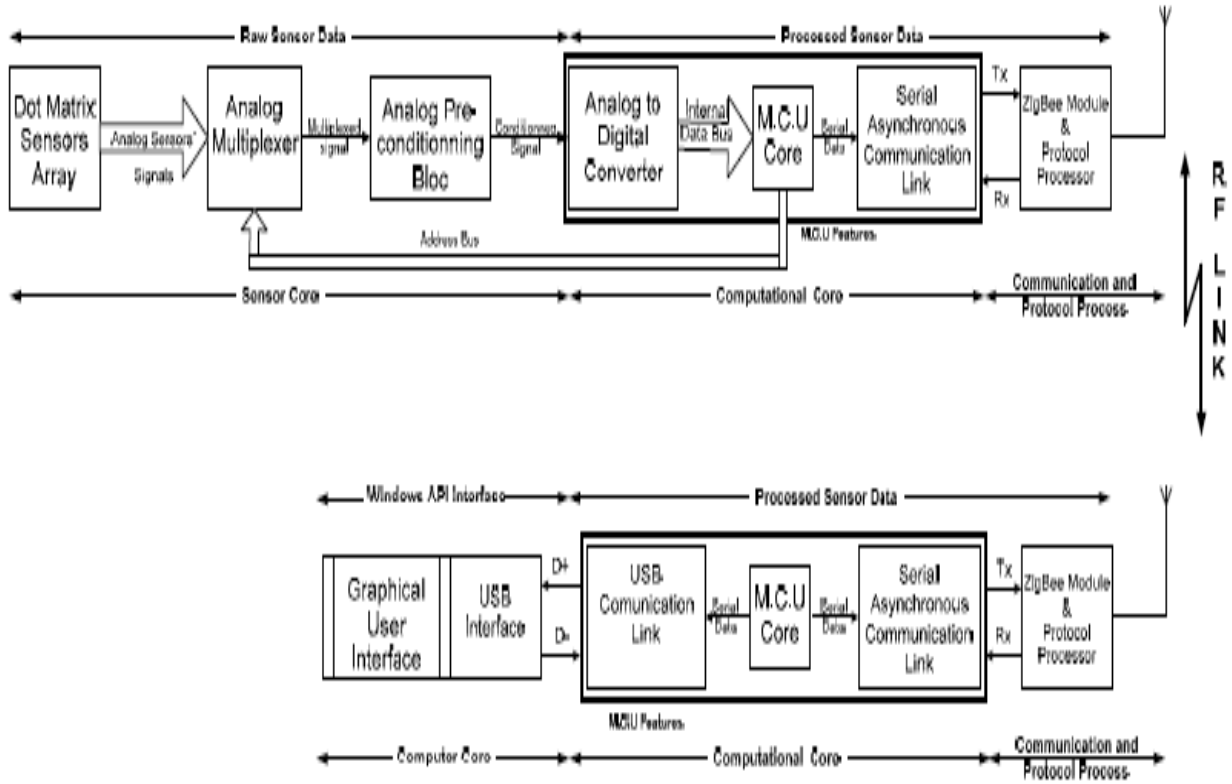

Fig: Block diagram of transmitter and receiver using ZigBee module with RF link

Also GSM control subsystem enables the user to monitor patient remotely whereas the security alert subsystem provides the remote security monitoring. The system is capable enough to instruct user via SMS from a specific cell number to change the condition of the home appliance according to the user's needs and requirements. The second aspect is that of security alert which is achieved in a way that on the detection of intrusion the system allows automatic generation of SMS thus alerting the user against security risk. The working of GSM in Interactive model can be explained as:-

GSM-RF hardware tests are run in order to check the hardware support. The system will call GSM modem and it will get activated.
· After activation the Modem will check for hardware support. If the hardware is missing or some other hardware problem there will be error, resulting in communication failure and the application will be terminated.
· If hardware responds then the serial port will be opened for communication and GSM hardware will allow transmission of SMS.

· The system will then connect and after connection establishment the system will be able to detect intrusion and will alert user about the breach and similarly the system will update status of appliances by receiving SMS from the pre-defined cell number.

· SMS will be silently ignored if cell number is unauthorized.

If it is authorized then necessary action can be told to concern authorities

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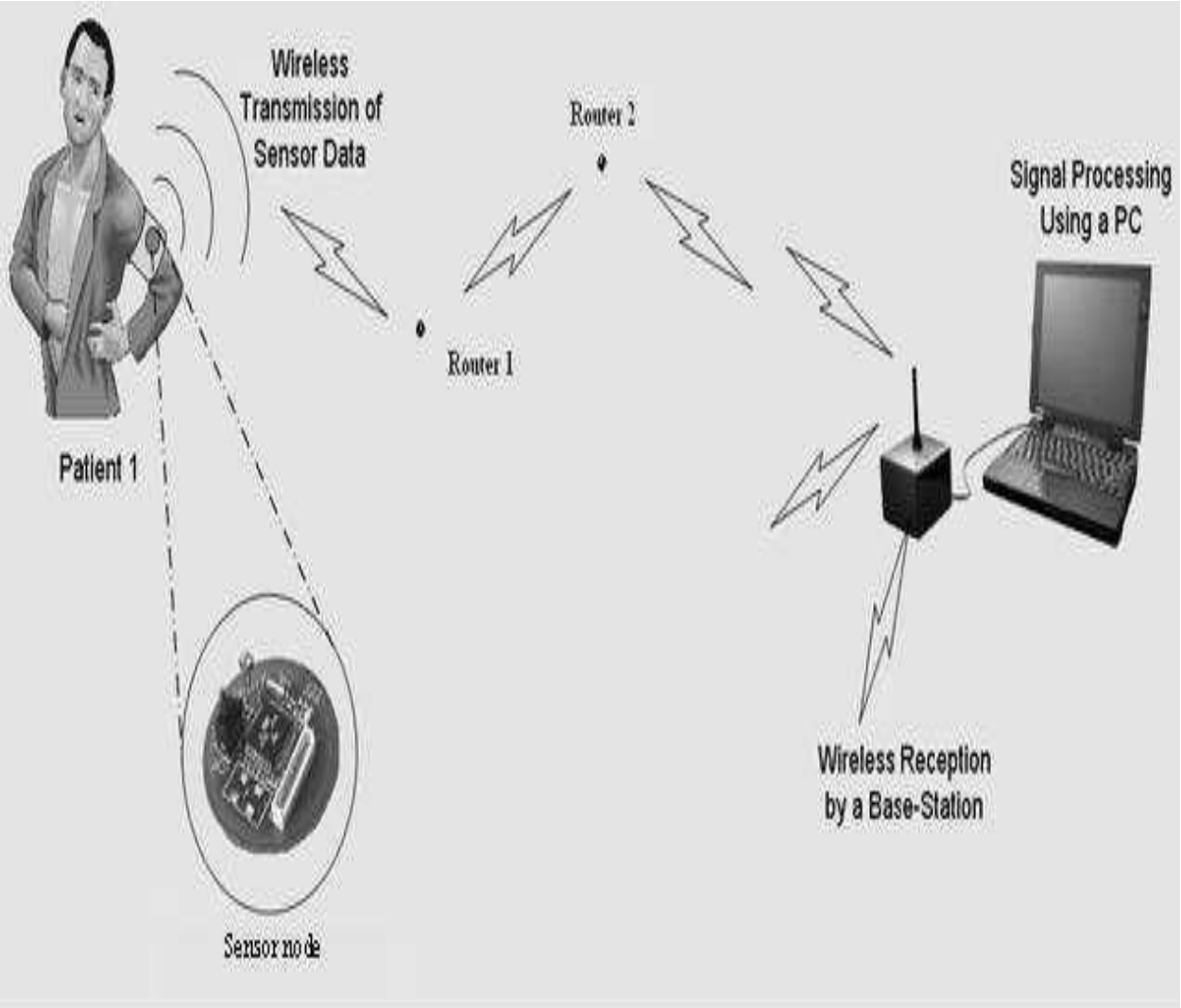

Fig: Wireless transmission and reception of sensor data

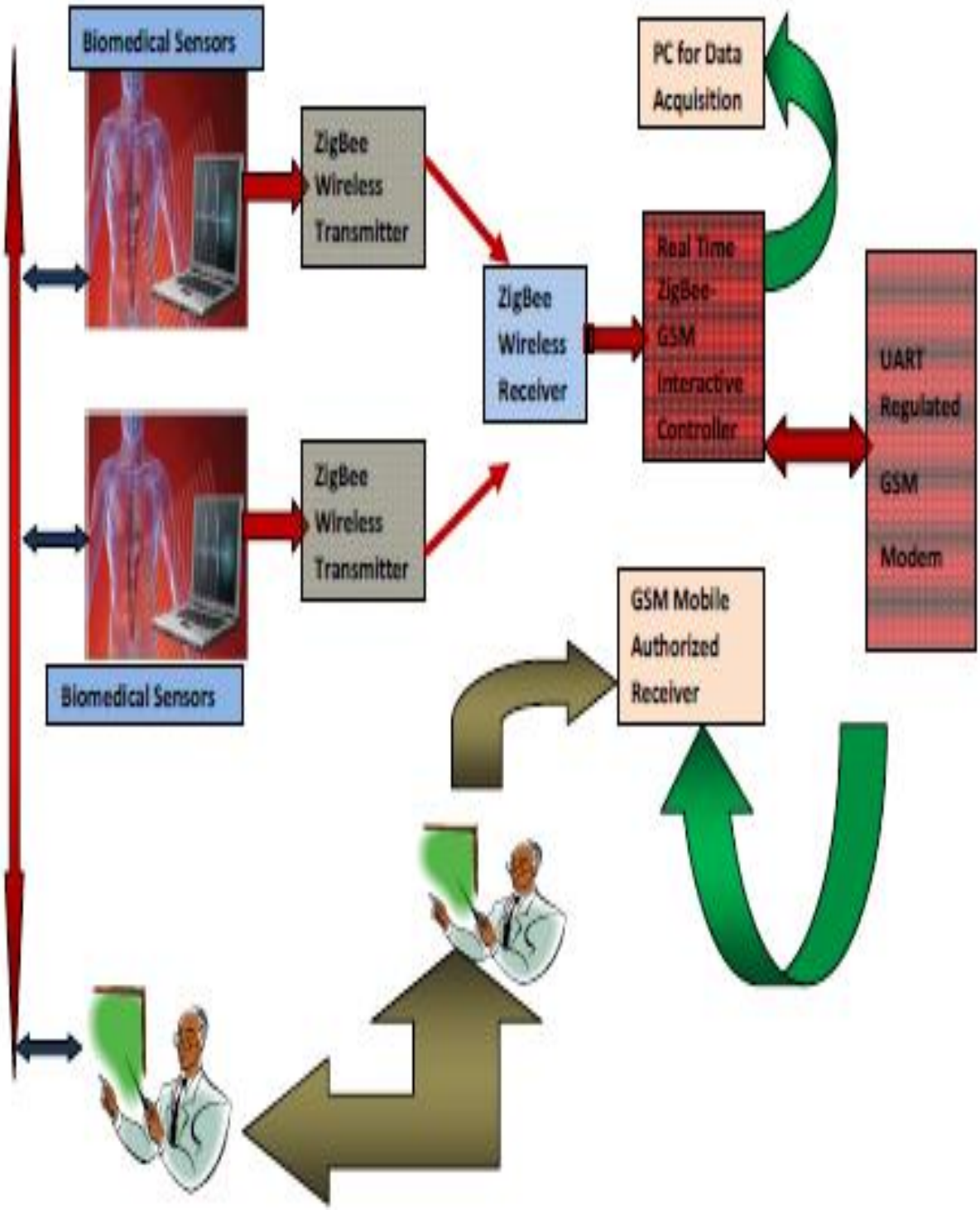
Biomedical Sensors
ZigBee Wireless Transmitter
PC for Data Acquisition
ZigBee Wireless Receiver
Real Time ZigBee-GSM Interactive Controller
UART Regulated GSM Modem
ZigBee Wireless Transmitter
Biomedical Sensors
GSM Mobile Authorized Receiver

Fig.3: Zig Bee – GSM interaction process

B. Development environment

The conception, design and implementation of the entire acquiring prototype were carried out using PROTON® Basic Compiler Development Suite (Crown hill Associates), PROTEUS® Professional (Multi-power Technology), and EAGLE® Layout Editor(Cad Soft Computer). The software developments for microcontroller can be done in suitable IDE for selected microcontrollers.

The suggested architecture has the minimum requisites of an autonomous system: a dot matrix multi-sensors array, an intelligent power saving and supervision, an embedded microcontroller and a serial communications block for the two way transmission of data (half-duplex) through a ZigBee RF transceiver module& via GSM. The latter allows the MCU to receive instructions, memory program upgrade and gather information from requested sensors (polling mode). Microcontroller cab be selected which has an on-chip FLASH Program Memory with In-System Programming (ISP) which makes it flexible and easy to upgrade. It is an 8-bit RISC (Reduced Instruction Set Computer) circuit with 8 A/D converters, 3 timers, serial UART (Universal Asynchronous Receiver Transmitter) and an enhanced USB interface working with a clock frequency up to 20 MHz Its internally implemented RISC architecture gives an instruction runtime of between 80 and 200 ns depending on the chosen oscillator. The dot matrix sensors array contains several sensors, which can sense one or more physical quantities. The addressable sensor interface chip provides the address, the amplification and analog-to-digital conversion of the sensed signal. It contains an analog multiplexer, a programmable analog front-end and a ten bits analog to digital converter, makes the sensor interface chip a versatile component, which can be programmed at any time. It offers also, options for intelligent power management. Indeed, all channels which are not in use can be switched off individually. Thus, the microcontroller has several important tasks:

(1) It controls the sensor interface chip and provides its settings, such as the configuration of the readout electronics like sensor address and analog front-end configuration as well as sensor-specific software routines.

(2) It gathers the data coming from the sensor interface chip and stores it in a memory.

(3) It implements some smart compression algorithms (base-band coder/decoder) to reduce the energy consumption during data transmission.

The bi-directional communication link sends the sensor's data to the transceiver and provides the microcontroller with new programming instructions. Hence, the accuracy, the sensitivity, the acquisition rate and the data processing can be changed during operation, which are necessary to adapt the system to the environment changes and to compensate for drift phenomena.

IV. CONCLUSIONS

In This research we have focused to develop an optimized microcontroller-based architecture for REAL TIME multi-purpose wireless biomedical system based on ZigBee & GSM wireless data transceiver. It has the capability to monitor biomedical signals from multiple biosensors by means of different communication standards. Its capability has been tested through standard sensors such as pressure, temperature and oxygen sensors with enhanced user graphical interface to visualize and monitor the progress of multi-sensors' curves concurrency in real-time. In addition, we have developed a ZigBee-ready compliant wireless system that offer low power consumption, low cost and advanced network configuration possibilities. Its reliability has been measured and proved through experimental results related to the bit error rate measurement. Hence, an affordable transmitting power level has been chosen in order to reduce the power consumption and save the energy. This work can further shows the success of our proof-of-concept study for real-time efficient biomedical evaluation prototype. For this purpose, and in addition to the use of higher transmission frequency for the real implantable system, our future work can be concentrated on a comparative study between UHF, ZigBee and Wi-Fi wireless data link system to evaluate the most adequate wireless link to be compliant with such a biomedical care systems.

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