



Implementation of Health Care Monitoring System using low power MCU's and ARM CORTEX A8

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Abstract – The present common goal in the medical information technology is the design and implementation of telemedicine solutions, which provides a reliable and quality of services to patients. With the advent of recent development in sensors, low-power integrated circuits (IC's), and wireless communications have brought the design of miniature, low-cost, and intelligent body sensor modules. These modules are capable of measuring, processing, communicating one or more physiological parameters, and can be integrated into a wireless personal area network. In this paper, we proposed a wireless body sensor module, based on low power microcontrollers and RF devices that perform the measurements and transmit the different bio sensors data to a Local Sensor Network server. Local Sensor Network (LSN) server will run a signal monitor application which receives the information from wireless sensor module and draw the signal graph on the display according to received data and further updated to central health care surveillance centre. The LSN server should be able to connect all the nearby sensor modules through wireless media and update its data periodically. Any sudden urge found in the signal will alarm the corresponding doctor. In order to handle such more number of sensor module connections, the Local sensor network server should be implemented with high performance processor. In this paper, the ARM Cortex A8 processor is one of the best choices to meet all the requirements of the LSN server.

I. Introduction

Now a days, the people in the world suffering with a lot of emotional stress[1]. The reasons are many, but these emotional stresses along with changes of life style result in chronic cardiovascular (CV) diseases and became the major adult illnesses. Therefore the evolution of degenerative diseases resulted in the medical cost increased rapidly. Mostly investigation has concentrated on the development of biomedical devices. Furthermore, almost all observation positions of human health [2] (e.g., ECG, EEG, Blood, and Pressure) can be

monitored. With the advent of **Telemedicine Information systems**, we experience a better healthcare monitoring[4] and also save the medicine cost. The **Body Sensor Network (BSN)**[3] technology makes the healthcare systems portable and allows the bio-signals to be monitored from remote location. A **Bio-Information Node (BIN)** can collect the bio-signals (like ECG, EEG, Blood, and Pressure) from the patient and submit the data to the healthcare center through the local sensor network. The Body sensor network (BSN) technology makes the healthcare systems portable, long term and allows the bio-signals to be monitored from remote location. A bio-information node (BIN) can collect the bio-signals (like ECG, EEG, Blood, and Pressure) from the patients and submit the data to the healthcare center through the local sensor network.

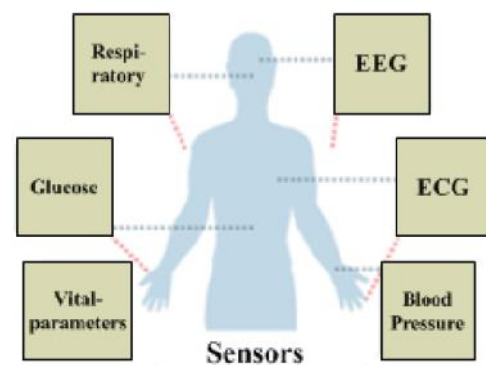


Fig. 1. Different aspects of the human body for monitoring

Body sensor network (BSN)[5] technology has become the key element in the intelligent health care system[6]. Therefore, the requirement to design body sensor node with low power and low cost, which in turn brings portability and availability of the device. In this paper, the body sensor node was implemented with MSP430G2553 microcontroller. The MSP430G2553 microcontroller is based around a 16-bit RISC core integrated with RAM and flash memories, analog and digital peripherals, and a flexible clock subsystem. It supports several low-power operating modes and

consumes as low as 1uA in a standby mode; it also has very fast wake up time of no more than 6us.

The IEEE 802.15.4 specification for low-rate wireless personal area networks has been a hailed choice for industrial, commercial, and home automation sensor network because of its

high density of nodes and simple protocol[7]. The ZigBee standard has been adopted for low-power consumption and low-cost effectiveness with standard-based wireless solution; the standard is operated at three industrial, science, and medical (ISM) bands, namely, the 868 MHz and 915MHz

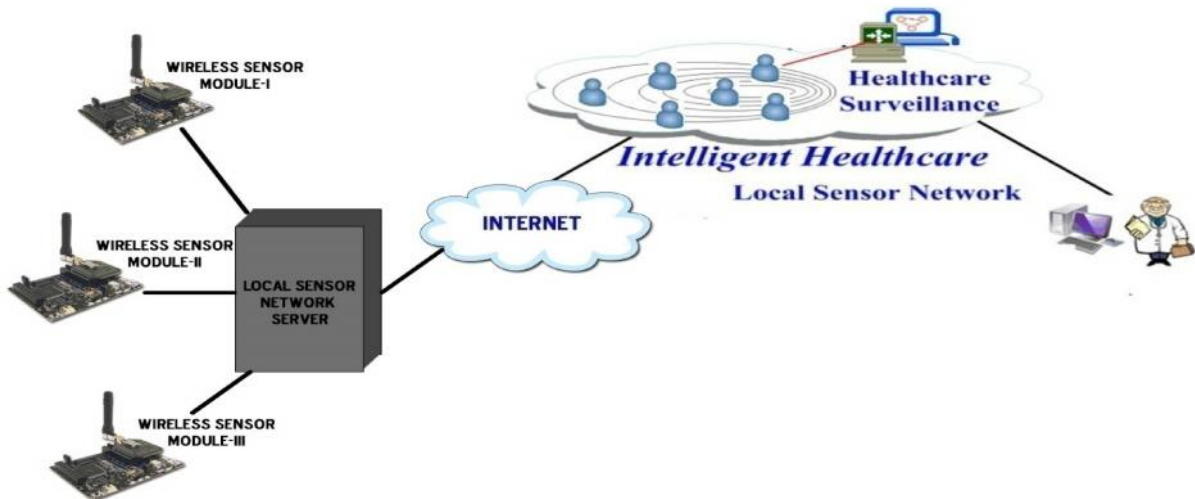


Fig.1. 1. Intelligent health care system

bands for Europe and the U.S., respectively, and the 2.4 GHz band for worldwide interchangeable. In the current paper, the wireless[8] solution is implemented by using the ready made zigbee module CC2500.

In the proposed system we present a wireless sensor module (or BIN) which is able to interface different sensors to it. The MSP430G2553 microcontroller acts as a central core for the wireless sensor module. The core internally contains the inbuilt analog to digital converter, using these converters the analog signal from different sensors will be sampled with proper nyquist rate, So that aliasing affect can be reduced in the signal. Further these sampled digital signal is passed through a digital filter (moving average, IIR or FIR) to filter out unwanted content in the digital signal. After applying the digital filter, the samples of the signal will passed through local sensor network[9] server via zigbee using serial communication with a standard baud rate 9600bps. The received digital sampled signal of a wireless sensor module is plotted on a GUI tool on the PC using MATLAB simulator tool. And further these samples are transferred to local sensor network server. The local sensor network

server should be capable to receive sensor information from different patients. Therefore it should handle and process large amount of data. And further it is used to connect large networks. To handle such complex data handling from different sensor and network connections the local sensor network server should be able to implement with high speed processor. Therefore, the local sensor network server was implemented with the use of high performance ARM + cortex A8 processor. On the beagle bone development board along this ARM processor, all other supporting interfacing mechanisms are readily made available. The Android operating system was ported on the beagle bone board, where as android application is designed to display the sensor information coming from the wireless sensor modules.

In this paper, the android application is able to display heart beat and temperature readings coming from the wireless sensor modules. Our paper is organized as follows. Section II provides a brief discussion on the implementation of intelligent personal care system. Section III the simulation results and the implemented prototypes are shown in this Section. Section IV presents our conclusions.

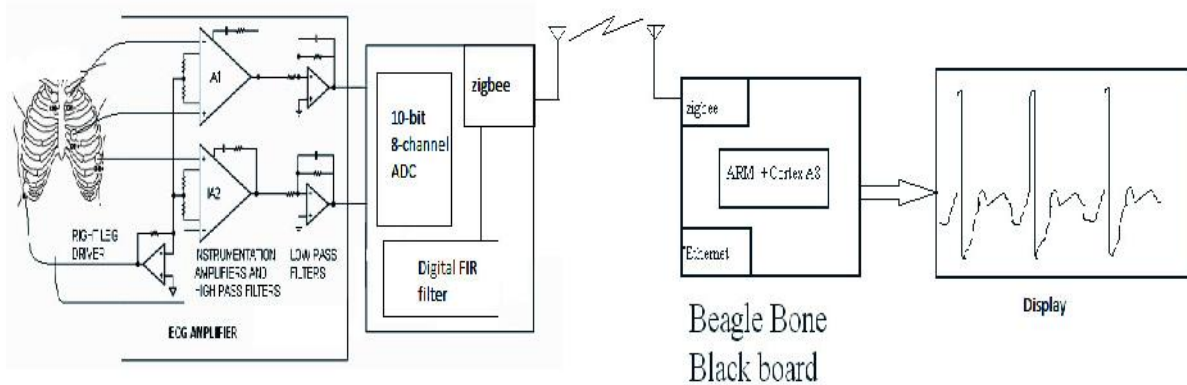


Fig 1.2. block diagram of wireless bio-signal acquisition system

II. Implementation of intelligent personal health care system

The entire system is divided into two parts: 1) wireless sensor module as transmitter. 2) ARM + Cortex A8 processor as local sensor network server. The block diagram of the system is shown in fig 1.2 The wireless sensor module is capable of acquiring the bio-signal, sampled, filtered and transmitted via wireless media. And the local sensor network server receives [1] the data from wireless transmitters and plotted on to the display device.

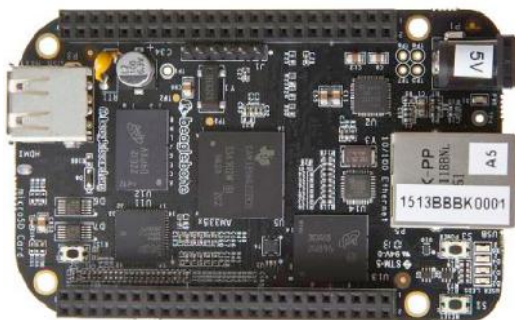


Fig.2.1. beagle bone black

2.1 Local sensor network server: Local sensor network server hardware was implemented with an embedded ARM platform, using ARM+Cortex A8 (AM335x 1GHz) from Texas instruments as the center core which is built upon the Linux operating system and its maximum frequency may be up to 1GHz. This ARM+Cortex A8 comes with integrated components as a development board as shown in fig 2.1. The hardware resources are as

follows: 512MB DDR3 RAM, 4GB 8-bit eMMC on-board flash storage, 3D graphics accelerator, NEON floating-point accelerator, 2xPRU 32-bit microcontrollers, USB, Ethernet, HDMI ports also come with ad-on. In addition, ARM supports many kinds of Network protocols, such as TCP, UDP and other protocols for firmware upgrade. The software compatibility of this board is as follows: It can support Android, Debian, Ubuntu, etc.,

2.2 ECG acquisition node: ECG [10,11] signal acquired from the electrodes and it is amplified using amplifier, which gain of 1000, low input bias current, very low offset and filter with cut off frequency 150Hz. This block has ECG amplifier AC front end circuit. Some of the noise can be cancelled with a high-input-impedance instrumentation amplifier[12] (INA), like the INA333, which removes the AC line noise[13] common to both inputs and amplifies the remaining unequal signals present on the inputs. The wireless sensor module consists of a 16 bit MSP430G2553 micro controller and a zigbee module[14] along with this instrumentation amplifier. The internal inbuilt eight channels 10-bit ADC is used to sample the ECG sensor analog signal filtered and transmits to local sensor network server.

2.3 Temperature Sensor: The MSP430G2553 contains inbuilt temperature sensor, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The body temperature information is also transferred to local sensor network server using the in-built sensor and zigbee module. Again this information is also transferred in message format along with patient ID.

2.4 Zigbee Sensor: CC2500 wireless module implemented with IEEE 802.15.4 and comes with TTL output, which is directly,

interfaced to the beagle bone board and MSP430G2553 devices. This device by default comes with 9600 baud rate and works on 2.4GHz ISM band[15]. It can cover up to 20 meters and runs with 5v power supply.

III. Implementation results:

In this paper a wireless sensor module was implemented using low power microcontroller MSP430G2553 and wireless zigbee module as shown in the fig.3. An instrumentation amplifier is an analog front end used to amplify the pulse sensor signal which is useful in health monitoring[16].

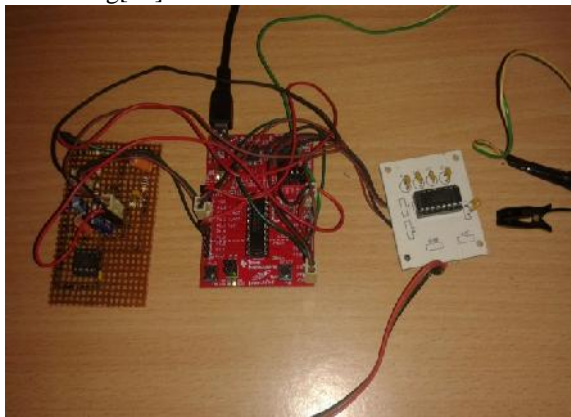


Fig.3.wireless sensor module

The digital sampled signal of a wireless sensor module[17] is plotted on a GUI tool on the PC using MATLAB simulator tool as shown in fig 3.1. This tool will receive the samples of a ECG signal[18,19] through wireless serial port. A signal is formed based on the received samples with a baud rate 9600 bps.

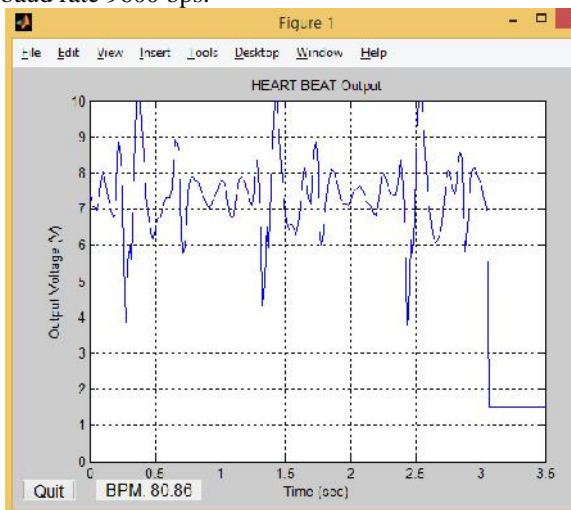


Fig.3.1.GUI tool in MATLAB simulator

Local Sensor Network Server was implemented using beagle bone black development board which consists of ARM + CORTEX A8 processor as

shown in fig 3.2. And it is interfaced with zigbee wireless receiver to receive the serial data from wireless sensor module through wireless medium.



Fig.3.2.LSN server implementation

An android application[20,21,22] as shown in fig.3.3. was designed to monitor the heart beat and temperature. This android application will run under beagle bone board as LSN server. This application periodically updates the heart beat and temperature from different wireless sensor modules[23,24].

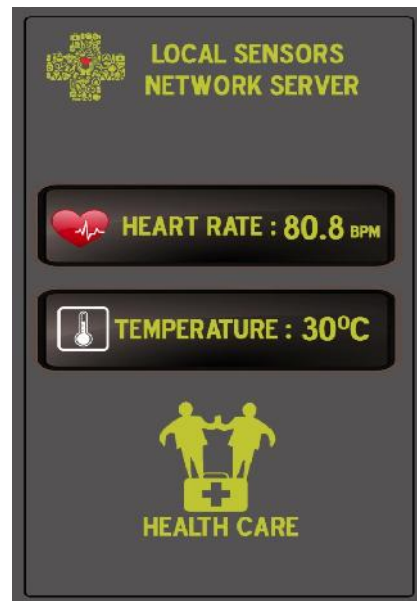


Fig.3.3. Android health monitoring app

IV. Conclusion:

The implementation of health care monitoring system[25] using low power microcontrollers[26] and high performance processors[27] as local sensor network server will promise the quality of services in health care systems along with cost effective services, more active involvement of patients in their own care.

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