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Design and Implementation of a Low Power Wireless Telemetry System for Multisignal Monitoring

Prachi Bramhe[1] , Prof. V. G. Girhepunje[2]
M.Tech Student, Priyadarshini College of Engineering, RTMNU
prachibramhe111@gmail.com
vyenktesh1973@gmail.com

Abstract—
An embedded system is a microcontroller-based system that is incorporated into a device to monitor and control the functions of the components of the device. At present, MSP430 microcontroller spreads through different kinds of product market such as industrial control, telemedicine, electronic product consumption, communication system. More and more embedded system developers and system-on-chip design reply on microprocessor-based design methodology to reduce time-to market. MSP430 microcontroller systems is chosen in this project as the system using MSP430 was proved to be good at dealing with multiple task processing, Real time (RT) and reliability of motion control. ECG signal is first digitized by a small portable device consisting of sampler, noise cancellation circuit and ADC. The digitized data corresponding to ECG signal will be transmitted from RF Network End Devices Board to the receiver access point unit. The RF2500 refer to a low-power 2.4-GHZ wireless transceiver radio which has a CC2500 chipset. Hence an ultralow power telemedicine system is proposed which may turn out to be an advance patient diagnostic approach.
Keywords- Electrocardiogram (ECG) Diagnosis, wireless monitoring, MSP 430, Radio Frequency Identification, Analog front end, Biosignal, Filtering, Signal conditioning.

I. INTRODUCTION

Embedded systems have become an integral part of home appliances, automobile, smart building, telecommunication equipment and medical device. When the embedded system designed based on a single chip microcontroller, they become more attractive due to the built-in feature such as the programmable memories, analog-to-digital converter and programmable input/output timers. These built-in components can be used to host the embedded software algorithm that operates a device based on required function [1].

A user estimates the embedded system taking into account its functionality, consumption of energy and reliability in relation to its price, for the user, the reliability of the embedded system usually is unambiguous with its failure-free work [8].

Health Monitoring devices are very popular today, are used by professionals in hospital, but also by the end users at their homes to monitor their health condition. The most common medical devices are: blood pressure meter, thermometer, blood sugar meter pulse oximeter, ECG, etc[1].

Investment in technologies that enable remote monitoring would lead to long gains in terms of hospital finances and patient care. The system described in this project is one of these examples of data acquisition system. In order to reduce the complexity and improve the applicability of multisignal monitoring system, the research efforts are focused on the development of device and instruments which are smaller, simple to use and reliable [4].

MSP430 microcontroller is chosen. The system was proved to be good at dealing with multiple task processing, Real time (RT) and reliability of motion control.

II. LITERATURE SURVEY

The low power acquisition module is shown in fig. 3 contains sensor for monitoring different signals related to health condition connected to a low power microcontroller and transceiver unit. The Toumaz Sensium was selected to provide the processing and wireless communication capabilities of the acquisition module. It comprises a reconfigurable sensor interface, an 8051eWarp microcontroller unit, an11-bit ADC and a RF transceiver [5].

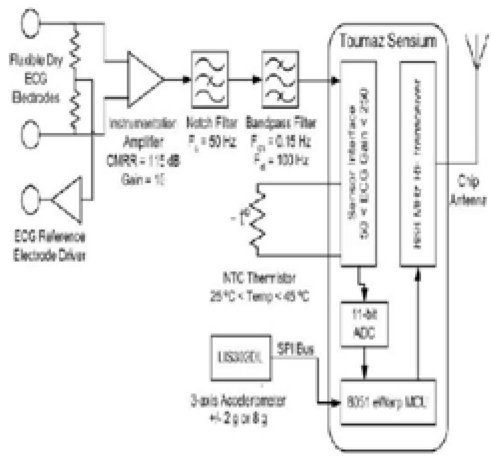

Fig. 1 Low power Wireless Acquisition Module

A Wearable device for recording of biopotentials and body movements contain the block diagram of personal monitor device shown in Fig. 1 the electrode used for biopotential recording are made of an advanced wicking fabrics with conductive sensing fiber integrated. The conductive fabric moves comfortably with the body, picking up electrical signal from the body via the use of high impedance, low power amplifier. The two electrode low-power ECG preamplifier was designed to be textiles electrode. Microcontroller perform channels multiplexing, analog to digital conversion, data packet and transmission stack protocol formation and can also drive RF circuitry. Bluetooth transmitter has been utilized: it operates at a frequency of 2.4 GHZ (ISM band), the antenna is integrated on the circuit board and allow 10 meters operative range [3].

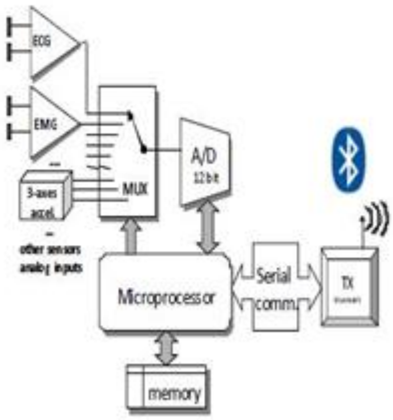

Fig.2 Block Schematic of Personal monitor device

The proposed ECG Tele-Alert system is shown in fig.2. Model consist of an ECG bio amplifier that picks up the bio signal and then converts into electrical signal followed by a low pass filter. Output is digitized by an A/D converter, and programmed in AT89C52 microcontroller followed by GSM MODEM [7].

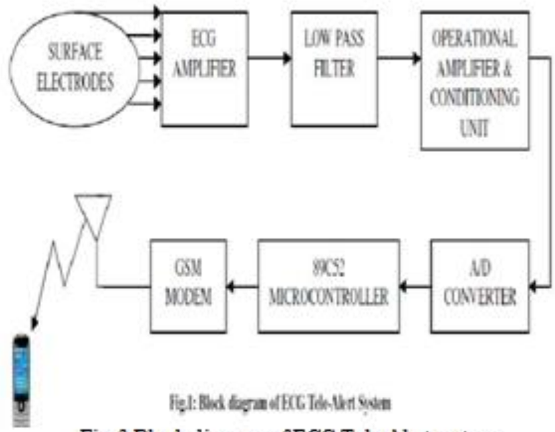

Fig. 3 Block diagram of ECG Tele-Alert system

III. SYSTEM DESCRIPTION

We consider the monitoring system, which has two main units in the system. Transmitting portable unit and receiver-access point unit. Transmitting unit collects physiological signals from ECG and passed through ECG Amplifier, Noise Cancellation Circuit, RF Network End Devices Board and it collect into receiver unit.

Transmitting unit consists of two main parts: 1) ECG amplifier and noise cancellation (ECGA and NC) circuit and 2) an RF network-end device board which is an eZ430-RF2500 board. The eZ430-RF2500 includes a microcontroller and a low power wireless radio transceiver from Texas Instruments.

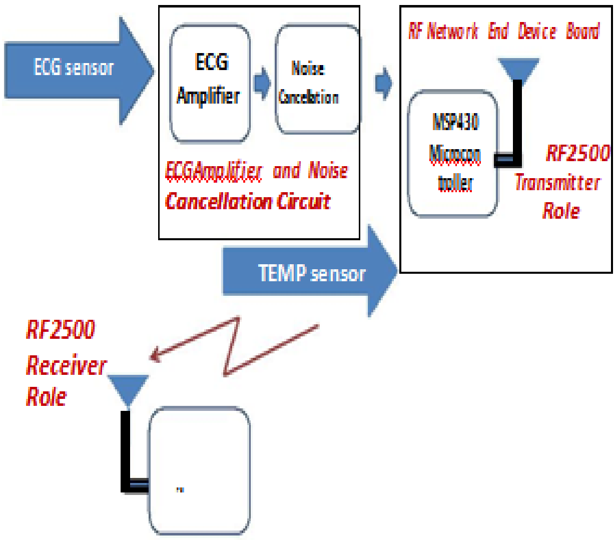

Fig. 4 Transmitting and Receiving unit

1) ECG Amplifier and Noise Cancellation Circuits: The ECG signal captured by the sensors has amplitude of around 1mV peak-to-peak. As a result, there is a need to amplify these signals to at least 1V peak-to-peak to make them useful for sampling. In order to achieve this design of a circuit with an amplification gain of about a thousand is needed. The first block in fig.1.Illustrates the ECG amplifier and noise cancellation circuit (ECGA and NC). The heart of the ECGA and NC circuits is a Texas Instruments INA2322 integrated circuit (IC) and a micro power single-supply complimentary metal-oxide semiconductor (CMOS) instrumentation amplifier with a very favorable CMRR of 60dB in designing a printed-circuit board (PCB) for the ECGA and NC circuit, tiny surface-mount component are use in order to minimize noise and current draw. This board also consists of several operational amplifiers from two CMOS quad opamp packages, together with a multitude of resistor and capacitors. The differential signal from the sensors and amplified by an INA2322 cored circuit while rejecting almost all of the common-mode noise. The INA2322 is also configured with a high-pass feedback filter to dynamically correct any dc shift that may occur over time. Its output is connected to a final operational amplifier which further amplifies the signal and acts as a low-pass filter. The total gain of the signal at this board can be configured to be in the range of 500 to 1000.

2) LM35 Precision Centigrade Temperature Sensors: The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an Advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35s low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while theLM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

3) *RF Network-End Device Board:* After amplifying and filtering ECG signal, they should then be read by a digital system. For this purpose, Texas Instrument commercially available eZ430-RF2500 target board is used as an “RF network end device”. The eZ430 has an internal MSP430 microcontroller chip set. The RF2500 refer to a low-power 2.4-GHZ wireless transceiver radio which has a CC2500 chip set. The MSP430 microcontroller has a 200-Ksample/s, 10-b analog –to-digital converter (ADC), which digitizes the input analog ECG signal. After digitizing and packaging ECG samples, it sends all of the packet via the CC2500 chip set to the receiver end. The MSP430 microcontroller runs the simplicity network protocol, which controls the packet transmission using the CC2500 chip set.

4) RF Network-Access Point Board: The RFNAP board is also an eZ430-Rf2500 target board from Texas Instruments. This board is programmed to receive data from the transmitting unit digitalized output is given to the computer system and it is converted into graphical representation with the help of GUI (graphical user interface).

IV. MSP430 MICROCONTROLLER

The Texas Instrument MSP430^{TM} family of ultra-low-power microcontroller consists of several devices featuring different set of peripherals targeted for various applications. The architecture, combined with five low-power modes is optimized to achieve extended battery life in portable measurement applications. The device features a powerful 16-bit RISC CPU, 16-bit register and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 1µs.

V. CONCLUSION

This kind of project is very effective and very useful to monitor and control all the activity remotely in real time.

This project can be used in a industries where there is lot of axillaries run on heavy power. Equipment like induction motor, transformers, furnaces, exhaust fan, draught motors (inlet/outlet) etc, also very useful to monitor critical patient data over a wireless protocol using xbee modules.

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