An Ultra-Low Power ECG Acquisition and Monitoring System for WBAN Applications

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Abstract- This paper proposes a power and area efficient Electrocardiogram (ECG) acquisition and signal processing application sensor node for wireless body area networks (WBAN). This sensor node can accurately record and detect the QRS peaks of ECG waveform with high-frequency noise suppression. The proposed system is implemented in 0.18-µm complementary metal-oxide-semiconductor technology with two chips: analog front end integrated circuit (IC) and digital application specific integrated circuit (ASIC), The Heart signals are sensed by connecting three probes on legs, hands on hum body. These analog signal Amplified and filtered signals using filter circuit are converted to digital signals. This signal is transmitted from micro controller to PC through zigbee wireless protocol interface.. Therefore, this ECG sensor node is convenient for long-term monitoring of cardiovascular condition of patients, and is very suitable for on-body WBAN applications. The transmitted signals is received by PC backend software and monitored in computer frontend software of Lab VIEW.

Index terms-Electrocardiogram (ECG), QRS detection, signal acquisition, wavelet transform.

I.INTRODUCTION

Electrocardiogram (ECG) is the most important indicator among all the vital body parameters, for diagnosing many cardiac diseases. ECG is the electrical representation of the contractile activity of the heart over time, which can be easily recorded using non invasive electrodes on the chest or limbs. ECG indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle, and can measure and diagnose abnormal rhythms of the heart. Therefore, there is an increasing demand for long-term and real-time monitoring and analysis of ECG signal for early diagnosis and improved treatment of cardiac diseases. In this sense, detecting QRS peaks in the ECG is one of the most important tasks that need to be performed. This stage is crucial in basic ECG monitoring systems and is important for all other ECG processing applications.

Thereafter, a threshold is calculated and imposed on the summation of products, instead of on the wavelet coefficients, to identify the important features. Therefore, our design achieves low error rate QRS peak detection. This chip enables the ECG signal processing at the sensor node with low area and power consumption. Combined with the wireless transceiver, the ECG QRS peak information can be extracted accurately and wirelessly transmitted via ZIGBEE to the healthcare server for monitoring and diagnosis. Therefore, the proposed ECG is very suitable for battery-supplied healthcare WBAN applications.

II. LITERATURE SURVEY

ECG is measured since it indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle, and can measure and diagnose abnormal rhythms of the heart.It is measured earlier in short term period. So there is an increasing demand for the long term monitoring. This is done by electrode tissue impedance monitoring of power 30.5microW that is with the high consumption of energy(1). The fully integrated programmable biomedical sensor interface system further reduced the power consumption. They did only ECG acquisition of area 1mm and power 445nW(2).

A single-chip IC for wireless continuous-time health monitoring in 0.18 CMOS is done. They did only noise suppression and wireless transmission. QRS complex shape morphologies and artifacts causes the performance of QRS complex detection algorithms to decrease when the QRS morphology changes(3).

To overcome this problem wireless technique was proposed. In this system Bluetooth technique was used to transmit the data. The two devices are paired at a time and the data are transmitted in a short package through spread spectrum techniques in 2.4GHz band. As it's a short range communication it can be used in a remote location to transfer data for distance location. If the parity of the devices fails, the transfer of data was terminated.

The Zigbee method was later introduced for the wide range communication. Zigbee connects to the other network and transfers the data to the modules. Zigbee works through Internet and achieve end-to-end data transmission. This is considered as an effective method for long term transmission of signal.

TABLE I
COMPARISON WITH EXISTING ECG PATFORMS

	work-2	work-4	work-1	work-3	This Work
Main Functions	ECG acquisition	ECG acquisition	ECG acquisition	ECG acquisition	ECG acquisition
			Band power extraction	Noise suppression;	Noise suppression
			Electrode-tissue impedance monitoring	Wireless transmission	QRS detection
			Activity detection		Can be extended to EEG/EMG/Neural signal acquisition
CMOS Process	0.35µm	0.18µm	0.5µm	0.18µm	0.18µm
Vdd	1 V	1.8 V	2 V	0.7 V	1 V (Analog) /1.1 V (Digital)
Gain	45.6/49/53.5/60dB	-	300/500/900/1300	38-58dB	32.8/38.4/41.4/43.4dB + 8-58 dB
Bandwidth	4.5mHz-292Hz	0.1-150Hz	140/170Hz	0.1-300Hz	0.015Hz-2KHz
Noise	2.04µVrms	-	85 nVrms/$\sqrt{Hz}$	18.7µVrms	46 nV/$\sqrt{Hz}$
ADC (ENOB)	10.2-bit	8.63-bit	10.6-bit	10-bit	>9-bit

III. Methodology:

In this paper we propose a wireless ECG monitoring system which consists of electrodes and in which the monitoring devices with wireless networking technology for better care and anywhere/anytime monitoring.

A. Proposed system:

Figure 1 and 2 explains the architecture of proposed system. The proposed system consists of both analog ECG acquisition front-end and digital signal processing back-end which measures the heart activity then the signal is given to the microcontroller for processing. The whole system works on 12V DC supply. The analog data is converted into digital data by inbuilt ADC present in the microcontroller and then the heart rate is calculated. Finally, the heart rate is transferred through the ZIGBEE modem to the required individual. The digitalized ECG signal is then fed into digital signal processing module to detect the QRS peaks.

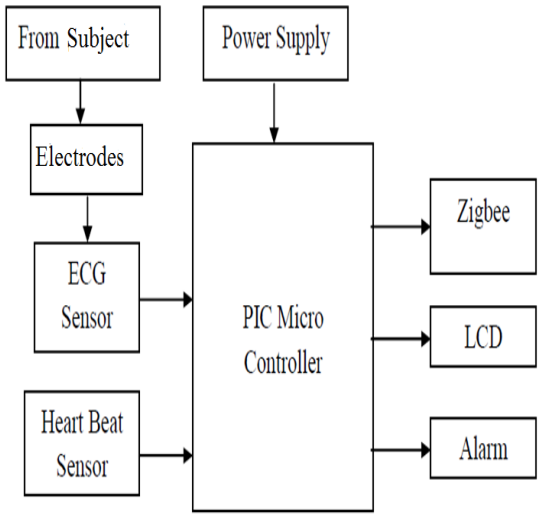

Fig.1 block diagram of proposed system transmitter

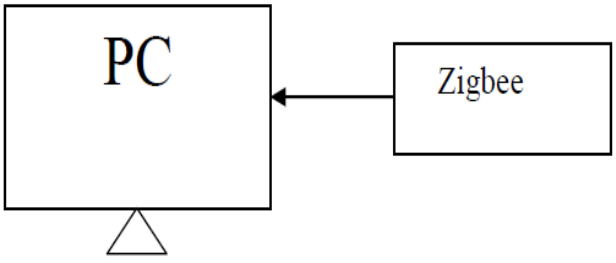

Fig.2 Block diagram of proposed system transmitter

B. ZIGBEE:

ZIGBEE is an high level communication to create personnel area network small, low power digital radios. Though low powered can transmit data over long long distances through intermediate devices to reach more distant ones, creating a mesh with no centralised control or high power transmitter or receiver. The applications include low data rate. Long battery life, secure networking. It is less expensive than WPAN'S such as Bluetooth or WIFI. It is secured by 128 bit symmetric encryption keys. output can be extended upto 10 to 100 metres.

IV. Illustration and result:

To verify our proposed on-chip ECG signal acquisition and processing system, simulation and measurement results are provided in this section. The obtained ECG signal is processed on-chip and transferred wirelessly via zigbee to the system. Here the signal processing such as denoising, QRS detection is done via algorithms provide by the LABVIEW. The signal is plotted in system monitor.

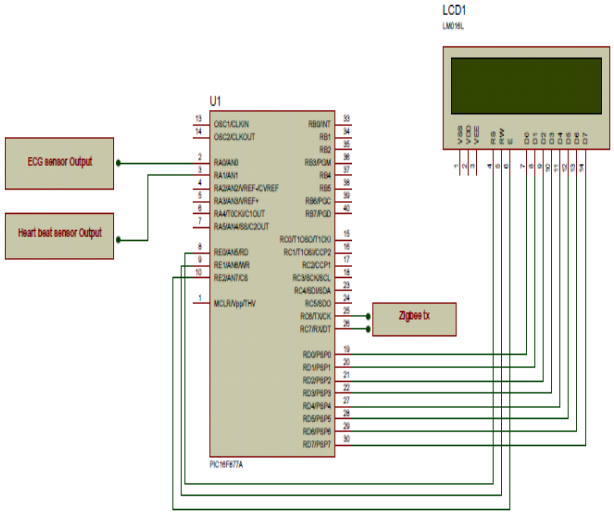

Fig.3 Circuit diagram of system

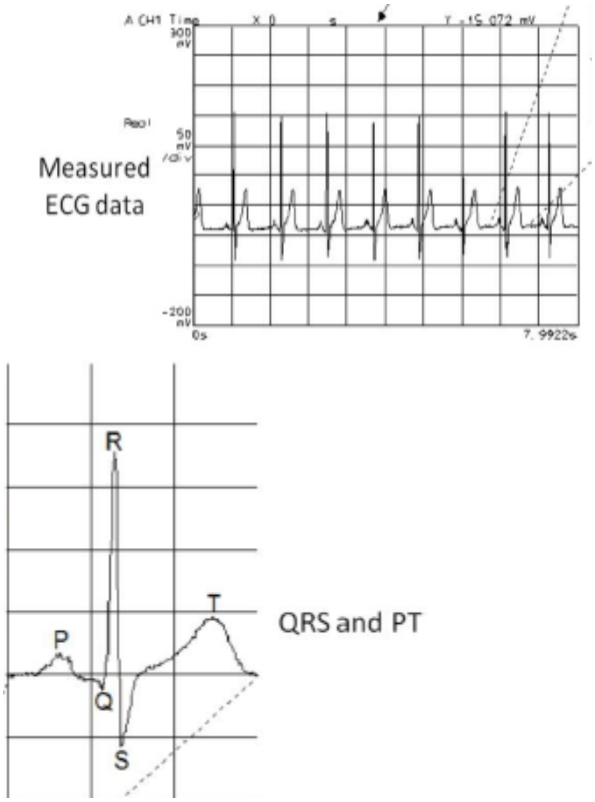

Fig.4 result of proposed system

V. Conclusion:

The present ECG monitoring technology is wired and which is applicable to specific clinical locations. In order to collect the measurements, provide diagnosis, and care, patient have to be physically co-located, in time and place.

The proposed system is both wireless, introducing a new paradigm of care. A real-time on-chip ECG signal processing system is designed. The proposed ECG signal processing system consumes ultra low power and small silicon area, and thus is extremely suitable for long-term cardiovascular monitoring WBAN applications. Benefiting from rapid technology advances in wireless communication, signal processing, biomedical sensing, and integrated

circuits, the WBAN technology is able to develop miniature, lightweight, ultra-low power physiological healthcare surveillance and monitoring devices, for the improvement of human lives

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