



LOW-POWER WIRELESS ECG ACQUISITION AND CLASSIFICATION SYSTEM FOR BODY SENSOR NETWORKS

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Abstract: A low-power biosignal acquisition and classification system for body sensor networks consists of three main parts: 1) a high-pass sigma delta modulator- based biosignal processor (BSP) for signal acquisition and digitization, 2) a low-power, super-regenerative on-off keying transceiver for short-range wireless transmission, and 3) a digital signal processor (DSP) for electrocardiogram (ECG) classification. The BSP and transmitter circuits, which are the body-end circuits, can be operated for over 80 days using air batteries as the power supply. Measurement results on the human body can effectively acquire ECG signals with the help of GSM mobile communication.

Keywords: Body sensor network (BSN), electrocardiogram (ECG), biosignal processor (BSP), Heart disease, GSM module

I. Introduction

Heart disease has been the number one cause of death for a period of over 10 years. Therefore, several medical devices have been developed to monitor the heart disease for healthcare. In recent years, body sensor network (BSN)-based applications or devices have become increasingly popular and widely accepted. People are now willing to use verified devices for biosignal acquisition, such as the electrocardiogram (ECG) or the electroencephalogram, because these devices can help in monitoring patient health in real time. With the development of networks, collected health information can be sent to the cloud server of the nearest clinic or hospital. Doctors can then provide patients with medical advice. In other words, BSN-based devices or applications can help both patients and doctors in daily health monitoring. Several BSN-based systems have been proposed. Baek et al. proposed a smart health monitoring chair that allows the non-invasive measurement of bio signals. This chair is suitable for home care systems without wearing anything if the continuous tracking ECG signal is not required. Vuorela et al. proposed a portable physiological signal recorder that is quite convenient for patients; however, signals are recorded in the recorder's memory and cannot be observed in real time. Yang et al. demonstrated a low-power, bio patch prototype with flexible electrodes. This prototype is considerably suitable for portable health monitoring systems, but it lacks a wireless communication feature. Tsai et al. proposed a complete BSN system for ECG measurement, but its power consumption is relatively high, thus making it inappropriate for long-term use. Yan et al. demonstrated a wearable cardiac monitoring system with 25 electrodes. The system features a complete system-on-chip (SOC) system and the ability to wirelessly transmit ECG signals. However, the location and the transmission distance are limited because of the use of inductive coupling. Therefore, an ideal BSN system must be applicable in the long term and is convenient; it must also provide on-time monitoring and allow wireless communication.

This study proposes a biosignal acquisition and classification system. This system features low-power consumption, wireless transmission, and on-time monitoring. This system can be used in wearable wireless ECG acquisition systems and consists of three main blocks: a biosignal processor (BSP), an on-off keying (OOK) transceiver, and a digital signal processor (DSP). The BSP circuits are composed of a chopper-based continuous-time amplifier (CBCTA) and one high-pass sigma-delta modulator (HPSDM). These two circuits reduce front-end circuit complexity to save power consumption while maintaining a high resolution (>12 bits). Transceivers are always the most power-hungry devices; therefore, the super-regenerative transceiver is employed because of its low power and low circuit complexity. For real-time detection and ECG classification, a DSP circuit with wavelet transform is implemented to achieve these features. Therefore, the proposed system can provide a low-power SOC solution for wireless ECG acquisition and classification systems.

II. ECG Acquisition and Classification System

In the system shown in Fig. 1, the biosignals are sensed by the BSP circuits and converted to digital signals. The data are then sent out by the transmitter. The signals are received and processed by the receiver and DSP, respectively. The body-end circuits and receiving-end circuits are the two main parts of the system. The design objectives of the body-end circuits, which are composed of the BSP and the transmitter, are 1) low power

consumption for long-term usage and 2) acquisition resolution that is high enough for ECG signal classification. Given these two objectives, the body-end circuits should have low circuit complexity and require an appropriate architecture for the transceiver to achieve the demand for low-power consumption. For the receiving-end circuits, the major objectives are 1) recovering the radio frequency (RF) signal and 2) recovering the biosignal classification. However, the receiving-end circuits can be integrated into a monitoring and control service (MCS), which can come in the form of a smart phone or a personal computer. Unlike body-end circuits, recovering-end circuits do not urgently require low-power consumption, as these devices can share the same power source. The following figure 2 describes the major concerns of the proposed system.

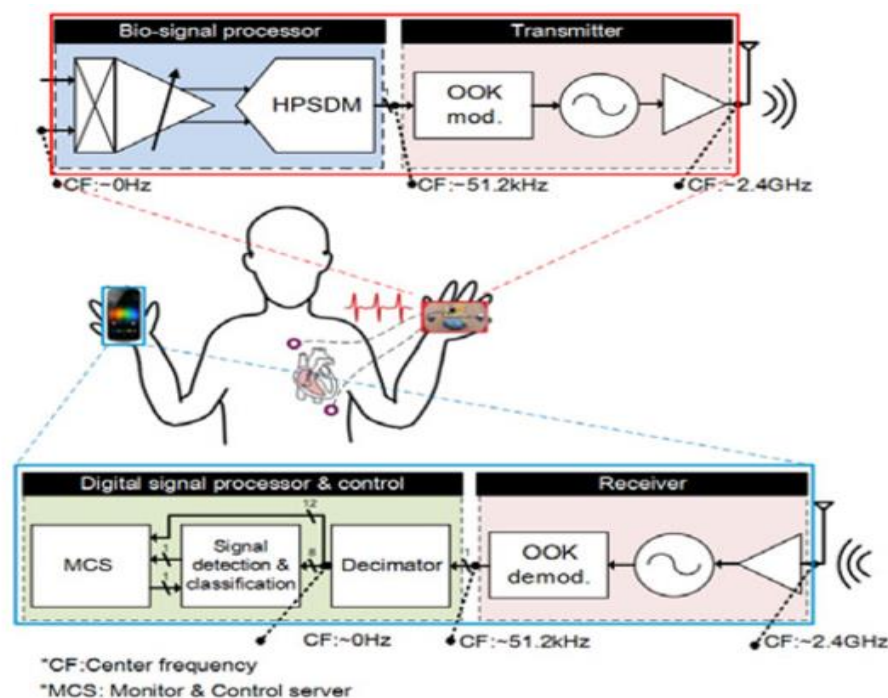


Fig.1. Block diagrams of the proposed low-power wireless biosignal acquisition and classification system.

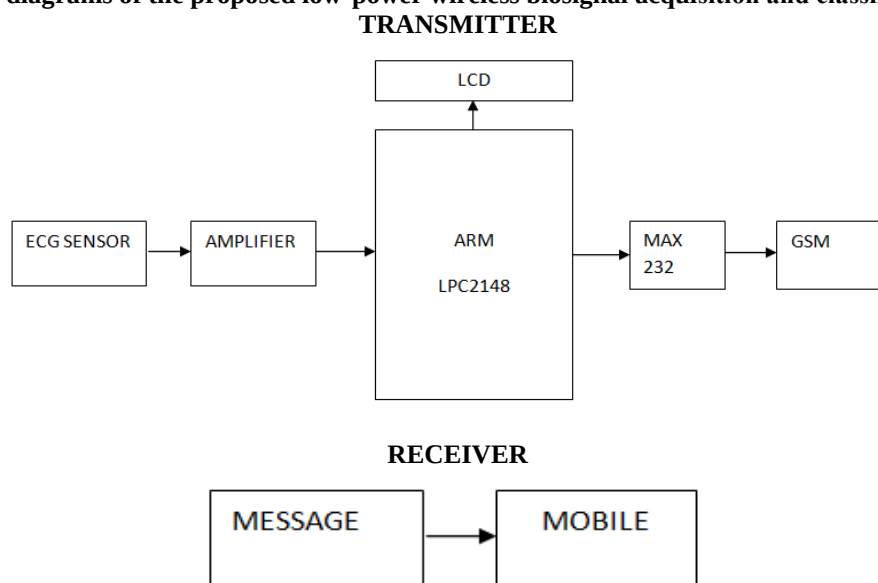


Fig.2. Block diagrams of the low-power wireless biosignal acquisition and classification system using GSM

In existing system we are using the RF transceiver. By using RF transceiver data transmission process limited to very short distance (10 metres) and data losses may be occur. In proposed system we are using the GSM module. By using GSM module data transmission process is not limited. We can able to send the data through message and it reduces the loss of data while transmitting the information or the result.

III. Results

It produces accuracy in terms of beat detection and classification. These results indicate that the system can correctly diagnose heart disease based on the MIT-BIH arrhythmia database. The symptoms, which can be suggested and controlled by cardiologists on the MCS. Therefore, the device can assist the cardiologists in diagnosing their patients, and the customized device can be used by patients as their “virtual cardiologist.” So the cardiologist can view the result without any loss by using GSM communication.

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