A Small, Wearable, Stretchable Electrocardiogram and Physical Activity Monitoring System

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ABSTRACT

Recently, many research studies and development projects focus on wearable sensor systems for applications such as human activity recognition or monitoring, biomedical clothing, health monitoring and medical care. In general, this kind of wearable system should be small-sized, lightweight, low-power, comfortable and non-invasive for the user. In this study, we present a prototype of electrocardiogram (ECG) and physical activity monitoring system using a low-power consumption 315 MHz RF transceiver module and stretchable wiring used to increase the snugness of the system.

Currently, most of the wearable systems use Bluetooth or ZigBee as the wireless interface. In general, when Bluetooth or ZigBee are active, they consume more than 15 mA current during RF communication. Since the battery is the main power source for these kinds of wearable systems, reducing the power consumption during RF communication can significantly increase the battery lifetime.

Therefore, the authors have realized a low-power consumption, small-sized and lightweight 315 MHz transceiver module powered by a 3.3 V supply voltage. The module consumes 1 mA and 2 mA for the transmission and receiving modes respectively.

The entire system is composed of three blocks - the main block, RF block and the power block. The interconnection of each block is implemented with stretchable wiring to enhance the tensility and flexibility. Therefore, the user's comfort and mobility should be improved.

Without the antenna, the system can be fabricated with an area of 110 x 30 mm^2. The main block is comprised of an ECG amplifier circuit, a 3-axes accelerometer, an altimeter sensor, a humidity sensor, a temperature sensor and an 8051 MCU. The low-power 315 MHz transceiver module is equipped in the RF block. The power block is composed of a typical coin-sized rechargeable lithium-ion battery (3.7V, 75 mAh) and a regulator with charging circuit. The block diagram and image of the proposed system are shown in Figs. 1 and 2, respectively.

The 8051 MCU is used to control the entire operation of the system. The ECG and accelerometer data are sampled at 125 Hz. The altimeter, humidity, temperature and battery voltage data are sampled at 8 Hz. The data are packed into a packet and transferred to the 315 MHz RF module using a Universal Asynchronous Receiver Transmitter (UART). Then, the sensed information and ECG are displayed in graphical form on the PC in real time.

During continuous transmission of the sensed information, the MCU, sensors and ECG circuitry are always active. Under this condition, the entire system only consumes 15.5 mA of current. Thus, for a 75 mAh battery, the proposed system can operate for more than 4 hours. In the future, further reduction of current consumption can be achieved through reduction of the wireless communication period, putting the MCU, RF module and sensors in standby mode, and decreasing the frequency of MCU clock.

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Categories and Subject Descriptors

J.3 [**Computer Applications**]: Life and Medical Sciences - *Health, Medical information systems.*

General Terms

Design, Experimentation.

Keywords

ECG Monitoring, Small-sized, Stretchable, Wearable, Low power consumption, 315 MHz RF transceiver.

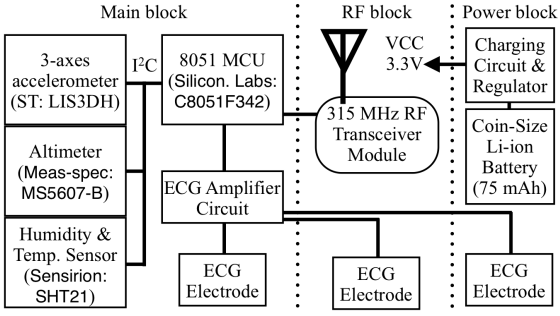

Figure 1. Block diagram of the system.

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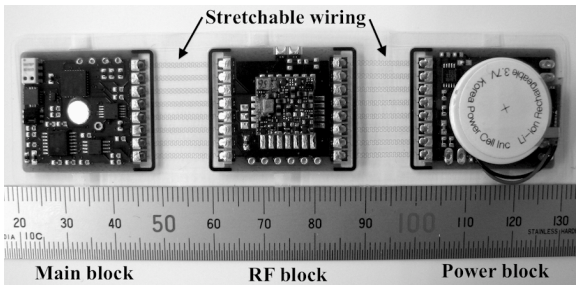

Figure 2. Image of the system.