Chapter 43
WBAN Based Long Term ECG Monitoring

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ABSTRACT

Healthcare solutions using anytime, and anywhere remote healthcare surveillance devices, have become a major challenge. The patients with chronic diseases who need only therapeutic supervision are not advised to occupy a hospital bed. Using Wearable Wireless Body/Personal Area Network (WWBAN), intelligent monitoring of heart can supply information about medical conditions. Electrocardiogram (ECG) is the core reference in the diagnosis and medication process. An approach on healthcare solution WBAN based, for real-time ECG signal monitoring and long-term recording will be presented. Low-power wireless sensor nodes with local processing and encoding capabilities in order to achieve maximum mobility and flexibility are our main goal. ZigBee wireless technology will be used for transmission. Sensor device will be programmed to process locally the ECG signal and to raise an alert. Low-power and miniaturization are essential physical requirements.

INTRODUCTION

Researches in interdisciplinary fields (Darwish & Hassanien, 2011) work on Wearable and Implantable Body Sensor Networks (WIBSNs). Despite the interest in this area, a gap remains between existing sensor networks and the requirements of medical monitoring. In most cases healthcare is focused on curing diseases in institutional units, which is diagnosis-based treatment only.

Wireless Sensor Network (WSN) technologies change our life with different applications fields. WSN consists in a set of small and autonomous devices. Working together, they solve various tasks and integrating with small and cheap microcontrollers that result in so called sensor node devices, which are used as part of the sensor nets. Reducing the costs and increasing the quality of services (QoS), is a tendency in the financial middlemen. Sensor networks provide the technology to bridge the gap between

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patient load and available resources. Wireless Body Area Network (WBAN) is a special purpose WSN incorporating different networks and wireless devices (Yuce, 2010), used especially in medicine where a large number of patients are monitored in real time. In healthcare system, one of current task for WSN is monitoring of physiological signals – e.g. the heart rate, the blood pressure, electrocardiograms (ECG), electromyograms (EMG) (Cram & Steger, 1983), the body temperature and even muscular activity – which is included in a wide range of biomedical applications. The research focus is on the development of wireless sensor devices, which are tiny and can communicate over short distances. At the same time this sensor nodes, which consist of sensing, data processing, and communicating components, take the idea of sensor networks based on collaborative effort of a large number of nodes: That drive healthcare provision out of hospitals to the home environment, with benefits in low power, multi-functional sensor nodes that are small in size and can communicate over short distances. It also reduces overcrowding in hospital, providing more healthcares services and focus to patients who are seriously and urgently in need of emergency hospital services (Pei-Cheng Hii &Wan-Young Chung, 2011). WSN technology is applied in this system to transmit the ECG data wirelessly over a short distance, from the patient's body to a Central Control Unit (CCU) placed in an accessible location.

An electrocardiogram – abbreviated as EKG or ECG – is a test that measures the electrical activity of the heart. A normal heartbeat on ECG will show the timing of the top and lower chambers. An ECG gives two major kinds of information: First, by measuring time intervals on the ECG, a doctor can determine how long the electrical wave takes to pass through the heart. Second, by measuring the amount of electrical activity passing through the heart muscle, a cardiologist may be able to find out if parts of the heart are too large or if they are overworked.

Wireless sensor devices, such as the Berkeley MICA "motes," consist of an embedded microcontroller, a low-power radio, and a modest amount of local storage in a small package, powered by 2 AA batteries. These devices run a specialized operating system, called TinyOS (Jason Hill et al., 2000), that specifically addresses the concurrency and resource management needs of sensor nodes. The radio transceivers used in these devices differ substantially from existing commercial wireless technologies, such as 802.11b and Bluetooth.

The new generation, incorporates a radio conforming to the new IEEE 802.15.4 standard (so called ZigBee), operating at 2.4 GHz with 250 kbps bandwidth. This standard is being pushed by industry as an alternate technology for ultra-low-power, limited range wireless communications and it is well-suited for a number of novel industrial applications.

Ultra Wide Band (UWB) 802.15.4a transceiver technology is an ideal fit for the requirements of the next generation WSNs. IEEE has recognized the need to standardize UWB technology for use in WBANs. The IEEE 802.15.4a standard sets the UWB physical layer for WSNs. Definition for First Report and Order FCC 02-48, and commercialization of UWB devices, was approved in February 14, 2002. A study group of IEEE has been launched in November 2007 for WBAN standardization. One big advantage of UWB wireless technology is that it can be used for simultaneous monitoring of many continuous physiological signals. UWB wireless technology does not present an Electromagnetic Interference (EMI) risks to other narrow band systems and medical equipments; transmitter power is low and the frequencies used are not crowded (Yuce M.R., 2010). Employing prototype fully IEEE 802.15.4a compliant and the world's first UWB wireless packet, was transmitted and successfully received in real time in March 2009 (DecaWave.com).