Chapter 1
System Design and Data Fusion in Body Sensor Networks

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ABSTRACT

Body Sensor Networks (BSNs) are formed by the equipped or transplanted sensors in the human body, which can sense the physiology and environment parameters. As a novel e-health technology, BSNs promote the deployment of innovative healthcare monitoring applications. In the past few years, most of the related research works have focused on sensor design, signal processing, and communication protocol. This chapter addresses the problem of system design and data fusion technology over a bandwidth and energy constrained body sensor network. Compared with the traditional sensor network, miniaturization and low-power are more important to meet the requirements to facilitate wearing and long-running operation. As there are strong correlations between sensory data collected from different sensors, data fusion is employed to reduce the redundant data and the load in body sensor networks. To accomplish the complex task, more than one kind of node must be equipped or transplanted to monitor multi-targets, which makes the fusion process become sophisticated. In this chapter, a new BSNs system is designed to complete online diagnosis function. Based on the principle of data fusion in BSNs, we measure and investigate its performance in the efficiency of saving energy. Furthermore, the authors discuss the detection and rectification of errors in sensory data. Then a data evaluation method based on Bayesian estimation is proposed. Finally, the authors verify the performance of the designed system and the validity of the proposed data evaluation method. The chapter is concluded by identifying some open research issues on this topic.

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INTRODUCTION

In these years, many technologies have experienced great development, including biomedicine, wireless sensor network, multi-media process, intelligent information process, and so on. As a dominant application framework for the evolving body sensor network technology, human health monitoring is increasingly emerging by using both in-body and out-of-body sensors. Body Sensor Networks (BSNs) are formed by the equipped or transplanted sensors in the human body. These sensors need to collect the important physiology signals (temperature, blood sugar, blood pressure), human activity or action signals, and the environment; then process this information and transmit it to the base station. Being a new solution for universal medical care, disease monitoring, and prevention, the purpose of BSNs is to provide a public computational platform integrated with hardware, software, and wireless communication technology. It becomes ubiquitous and the marketing opportunities for advanced consumer electronics and services will be expanded extensively (Tan & Wang, 2008; Pantelopoulos & Bourbakis, 2010). More and more interests in the design and development of BSN systems for applications of improving people's daily life are growing, which also leads to the introduction of other technologies into BSNs, such as RFID technology, Zigbee, Bluetooth, video surveillance system, WPAN, WLAN, Internet, and cellular network.

According to the inquiry results of World Health Organization (WHO), aging population is becoming a significant problem, which causes millions of people to suffer from obesity or chronic diseases. This trend results in the decline of service quality and the healthcare system overloaded (Venkatasubramanian, Gupta, 2010). BSNs can be used to solve this problem by being applied to medical care, health regeneration, aiding the aged and disabled. Additionally, BSNs can be extended to entertainment like cartoon industry, dance design and training; physical culture like the simulation and analysis of fencing education; other industry like automobile engine, state monitoring and failure detection of machine equipment; even the military area like monitoring and health of soldiers; or in the public area of society like large scale incident and psychological relief. In summary, the following typical applications will benefit from the advanced integration of BSNs and emerging wireless technologies:

- Remote health/fitness monitoring: Health and motion information are monitored in real-time, and delivered to nearby diagnosis or storage devices, through which data can be forwarded to health service center and diagnosed by doctors for further processing.
- Military and sports training: For example, motion sensors can be worn at both hands and elbows, for accurate feature extraction of soldiers and sports players' movements.
- Interactive gaming: BSNs enable game players to perform actual body movements, such as boxing and shooting, that can be feedback to the corresponding gaming console, thereby enhancing their entertainment experiences.
- Personal information sharing: Private or business information can be stored in body sensors for many applications in daily life such as shopping and information exchange.
- Secure authentication: This application involves resorting to both physiological and behavioral biometrics schemes, such as facial patterns, fingerprints, and iris recognition. The potential problems, e.g., proneness to forgery and duplicability, have motivated the investigations into new physical/behavioral characteristics of the human body, e.g., Electroencephalography (EEG) and gait, and multimodal biometric systems.