

# Chapter 13

## Localizing Persons Using Body Area Sensor Network

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### ABSTRACT

*Context awareness is an important aspect in many ICT applications. For example, in an intelligent home network, location of the user enables session transfer, lighting, and temperature control, et cetera. In fact, in a body area sensor network (BASN), location estimation of a user helps in realizing realtime monitoring of the person (especially those who require help) for better health supervision. In this chapter the authors first introduce many localization methods and algorithms from the literature in BASNs. They also present classification of these methods. Amongst them, location estimation using signal strength is one of the foremost. In indoor environments, the authors found that the signal strength based localization methods are usually not accurate, since signal strength fluctuates. The fluctuation in signal strength is due to deficient antenna coverage and multi-path interference. Thus, localization algorithms usually fail to achieve good accuracy. The authors propose to solve this problem by combining multiple receivers in a body area sensor network to estimate the location with a higher accuracy. This method mitigates the errors caused by antenna orientations and beam forming properties. The chapter evaluates the performance of the solution with experiments. It is tested with both range-based and range-free localization algorithm that we developed. The chapter shows that with spatial diversity, the localization accuracy is improved compared to using single receiver alone. Moreover, the authors observe that range-based algorithm has a better performance.*

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## **BODY AREA SENSOR NETWORK AND LOCALIZATIONS**

With a number of devices equipped with sensors, micro-controllers and radio components, important parameters, such as body temperature, momentum, glucose levels, blood pressure or heart rate of the person can be monitored. In the meanwhile ambient intelligence (Ducatel, 2010; Aarts, 2003) is seen to be penetrating our daily lives. Being a way to realize ambient intelligence, the rapid development of these wireless sensor networks also extend to body area networks. Wireless sensors can be placed on persons, on cloths, etc. to monitor diverse vital health parameters of the persons. These devices form a Body Area Sensor Network (BASN). Such networks provide many novel applications in healthcare, fitness, and entertainment, which enable better quality of life of persons. A large amount of BASN applications are in healthcare domain. A BASN can help patients in hospitals gain more freedom. Wireless sensors can replace wired sensors monitoring patients. Thus they can move freely instead of being bonded to beds. More than in the hospitals, chronically ill patients or those are in recovery may return to their normal life at home with their physical conditions closely monitored by the doctors remotely. Another application of such body area sensor networks is helping senior citizens to manage their life in houses or even in public places without any support. In the above applications, context information has to be generated to provide control systems some form of context awareness. In case of emergency, data collected from sensors have to be collected and then processed in a control center to make a decision for actuation. Among the context information, location is an important one. No matter in hospital, home or in public area, locations of the patient have to be known so that first-aid can be provided timely. Moreover, the location information also provides doctors with the movement patterns of patients so that their living habits can be analyzed and

used for disease prevention and diagnosis. Especially, people with Alzheimer disease should be monitored with wearable sensors and their house is equipped with other sensors for monitoring temperature, humidity, smoke or other hazardous gas and cameras for security surveillance. Some areas are dangerous such as kitchen where there are some sharp tools, gas stoves and electrical appliances. When the patient is moving in the house, and moves into the kitchen his location should be known to the monitoring systems so that a video-camera in the kitchen is activated. An alarm and the video are sent to caretakers so that help can be provided timely in case required.

## **APPLYING WIRELESS SENSOR NETWORKS FOR LOCALIZATIONS**

One of the most well-known localization systems is the Global Positioning System (GPS). However, due to poor penetration of the radio signals this system is not suitable for indoor localization (Savvides, 2001). A revolving technique in indoor environment is to use already deployed wireless sensor devices (in hospitals, buildings and other indoor area), together with wearable BASN to estimate the locations of the persons wearing them. This technique is highly practical and cost effective since all the sensors are already deployed and connected wirelessly for their usual tasks. Hence, localization does not add any additional investment on hardware infrastructure. There are a few requirements for reliable localization system. The localization system must have the features such as: (1) Accuracy: although many applications do not require localization to be accurate to centimeter, in many applications in home, buildings or hospitals, a monitoring system has to know where a user is, e.g. a living room or bed room. (2) Low complexity: in an indoor environment, location information is likely to be provided without dedicated hardware to avoid extra cost. Localization is expected to be an ad-

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