Chapter 35
Making Location-Aware Computing Working Accurately in Smart Spaces

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ABSTRACT

In smart environment, making a location-aware personal computing working accurately is a way of getting close to the pervasive computing vision. The best candidate to determine a user location in indoor environment is by using IEEE 802.11 (Wi-Fi) signals, since it is more and more widely available and installed on most mobile devices used by users. Unfortunately, the signal strength, signals quality and noise of Wi-Fi, in worst scenario, it fluctuates up to 33% because of the reflection, refraction, temperature, humidity, the dynamic environment, etc. We present our current development on a light-weight algorithm, which is easy, simple but robust in producing the determination of user location using WiFi signals. The algorithm is based on "multiple observers" on ηk-Nearest Neighbour. We extend our approach in the estimation indoor-user location by using combination of different technologies, i.e. WiFi, GPS, GSM and Accelerometer. The algorithm is based on opportunistic localization algorithm and fuse different sensor data in order to be able to use the data which is available at the user position and processable in a mobile device.

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INTRODUCTION

Pervasive computing is centred on the idea of providing computing services to the user anywhere anytime. It has been shown that pervasive computing can have a significant impact on daily lives activities based on location, ranging from the activities at work or at home, to the activities during travel (nomadicity). In this chapter, we present and review *location-aware personal computing* as a way of getting close to the pervasive computing vision with minimal overhead and propose our current development of a light-weight algorithm in producing the determination of user location.

Central to location-aware personal computing is the use of smart PDA and location information. Smart PDA personifies a ubiquitous personal device that can execute client front-ends, and connect wirelessly to backend services. Location information serves as a proxy for the user. Smart PDA and location information can minimize both user involvement and dependency on a ubiquitous computing infrastructure.

This chapter presents the determination of indoor-user location using WiFi signals and the estimation of indoor-user location using combination of different technologies, i.e. WiFi, GPS, Bluetooth, GSM and some others.

This chapter also deals with the limitations of previous work and proposes efficient location management techniques. The proposed models fulfil the design requirements in two ways. First, the models with their associated schemes have lower communication costs (i.e. fewer update messages from objects running in the system are needed for position tracking), which leads to lower energy consumption. Second, from the system point of view, optimal resource utilization is achieved. On the one hand, the models would lead to a lighter work load at the server side. On the other hand, they also improve the efficiency of query processing with more precise query results generated and produce a higher service satisfaction level of the system.

THE STATE OF THE ART OF LOCATION AWARE COMPUTING

Currently, Location-Aware Computing becomes a rapidly growing field in the area of Context-Aware Computing. User and equipment location are the two main focuses of developing location-aware applications. Unfortunately a range of mobile devices (Laptop, PDA, Smart Phone) in the market are still lacking of a satisfactory location technology, which enables them to estimate their own location.

Location-Aware Computing which promises accuracy, economy and ease of deployment, is currently still seen to be under construction. Numerous location models have been proposed in different domains and can be categorised into two classes, i.e. *symbolic or descriptive (hierarchical, topological) location* such as a city or a room, and *coordinate (Cartesian, metric or geometric) location* such as (x,y,z) coordinate (latitude, longitude, altitude) in GPS or active bat.

User location is a main concern of Location-Aware Computing, symbolic location is preferred over coordinate location in the user's daily activities. The use of coordinate location for human-serving can be converted into symbolic location, which is a more natural human location description, which, except in special cases, makes daily communication easier.

Our previous work proposes the ηk-Nearest Neighbour to estimate symbolic user location (Mantoro & Johnson, 2005), instead of the used of neural network approach, which required a heavy computation effort during learning process (Mantoro, 2003) and we also proposed the use of *multivariate regression estimation* in estimating a coordinate of user location in indoor environment (Mantoro et al, 2008) both using IEEE 802.11 (Wi-Fi) signals.

Our Opportunistic Localisation (Weyn, et al 2009) describes the concept of using all available information which can be grasped by the mobile device in order to infer a location instead of using