Chapter 2
Activity Recognition Using Ubiquitous Sensors: An Overview

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ABSTRACT

With the unprecedented sensing capabilities and the emergence of Internet of things, studies on activity recognition have been hot issues for different application areas, such as pervasive healthcare, industry and commerce, and recommendation systems. Much effort has been devoted to activity recognition using different sensors. Based on the differences of ubiquitous sensors, the authors classify the existing work into approximating sensing, wearable sensing, and video/audio sensing. Generally, methodologies for activity recognition are divided into logical reasoning and probabilistic reasoning. They illustrate the generalized framework and outline the advantages and disadvantages for each algorithm. Despite the research on activity recognition, activity recognition still faces many challenges in many aspects including nonintrusive data collection, scalable algorithms, energy consumption, and semantic extraction from social interaction. Towards those challenging research issues, the authors present their contributions to the field of activity recognition.

1. CONTEXT AWARENESS AND ACTIVITY RECOGNITION

The vision proposed by Mark Wiser is unfolding with the significant breakthroughs in sensing and communication. Especially, with the explosion of sensor-equipped mobile phones, broader utilization of the Global Positioning System (GPS), the emergence of lots of ubiquitous sensors offers an opportunity to seamlessly monitor contexts based on lots of digital traces that people leave while interacting with web applications, static infrastructure, and mobile and wearable devices (Zhang, Guo & Yu, 2011; Guo et al., 2012). Meanwhile,

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the popularity of Location Based Services (LBS) facilitates the collection of large-scale digital interaction records, which provides the opportunity for the nonintrusive and transparent data collection. The unprecedented accumulation of sensing data makes it possible for the construction of context-aware applications. Context awareness refers to the idea that computers can both sense, and react based on their environment.

Human activity, one kind of the most important contexts, not only describes the current states of objects, but also indicates user intents. Activity could be applied into the field of healthcare to provide proactive services according to ongoing activities, to trigger reminders and recommendations; activity control has been employed in the industry and commerce, like industry manufacturing and commercial games. Meanwhile, the social attribute of activity has been explored. The social attribute may facilitate the communication efficiency and information sharing. The multi-facet nature of human activity makes the activity recognition a hot issue in the field of pervasive computing.

Even though there is lots of work about the activity recognition (Chen & Hoey, 2012), many applications pose new challenges for existing researches. In this chapter, we summarize the existing work in this field from many aspects including sensing devices, recognition algorithms, and applications; on the other hand, we analyze challenges faced with the introduction of ubiquitous sensors. Meanwhile, our undergoing work is presented to demonstrate the feasibility of the proposed solution.

The rest of this chapter is organized as follows. We will summarize the work of activity recognition based on the differences of ubiquitous sensors in Section 2. Section 3 presents methodologies involved in the activity recognition, including logical reasoning, fuzzy reasoning, probabilistic reasoning and transfer learning. We not only present the generalized framework for activity recognition, but outline the advantages and disadvantages for each algorithm. In Section 4, the application areas of activity recognition are elaborated, including healthcare for the elderly or the disabilities, industry and commerce etc. Even though there are lots of progresses in the field of activity recognition, some challenging research issues are presented in Section 5 followed by our efforts for the activity recognition in Section 6. At last, we conclude this chapter and point out the future work in Section 7.

2. CLASSIFICATION OF ACTIVITY RECOGNITION BASED ON UBIQUITOUS SENSORS

There is lots of work in the field of activity recognition. They may differ from each other in terms of activity types, sensor types, or algorithms. To benefit the summarization of existing work, in this section, we first provide the method about how to classify the work in the field of activity recognition. Then we focus on the classification of activity recognition based on sensor types.

2.1. Classification of Activity Recognition

The researches on the activity recognition could be classified according to different metrics, such as size of users, sensors types, and relationships among target activities. Based on the size of user, the research on activity recognition could be classified into single-user and multi-user. For the single user activity recognition, it focuses on the statuses for the single object. On the contrary, the multi-user activity recognition simultaneously detects multi-activities for more than one object. Compared with the single user activity recognition, the multi-user activity recognition is more interesting and challenging. The smart meeting room (Koike, Nagashima, Nakanishi & Sato, 2004; Yu, Yu, Aoyama, Ozeki & Nakamura, 2010; Ahmed, Sharmin & Ahmed, 2005; Sumi &