Levels of Abstraction for Behavior Modeling in the GerHome Project

Laura Pomponio, Centre Scientifique et Technique du Bâtiment & Aix-Marseille University, France
Marc Le Goc, Aix-Marseille University, France
Alain Anfosso, Centre Scientifique et Technique du Bâtiment, France
Eric Pascual, Centre Scientifique et Technique du Bâtiment, France

ABSTRACT

Defining activity models in order to monitor human behavior in smart environments is one of the major issues at the moment of building systems of activity supervision for diagnosis, prediction and control. For the purpose of addressing this problem, this paper proposes a general theoretical approach based on the use of a Knowledge Engineering methodology and a Machine Learning process, which are funded on a general theory of dynamic process modeling, the Timed Observation Theory.

Keywords: Health Care, Knowledge Engineering, Machine Learning, Smart Environments, Timed Data Mining

INTRODUCTION

A smart environment “is able to acquire and apply knowledge about an environment and also to adapt to its inhabitants in order to improve their experience in that environment” (Cook & Das, 2005, p. 3). An example of smart environment is a smart home as Aware Home (Abowd et al., 2008), EasyLiving (Brumitt et al., 2008), MavHome(Cook, 2006; Youngblood & Cook, 2007; Jakkula et al., 2008; Rashidi & Cook, 2008a; Cook et al., 2009), CUS Smart Home (You et al., 2007), iDorm (Hagras et al., 2007), QuoVADis (Medjahed et al., 2009) and CASAS (Rashidi et al., 2010; Rashidi & Cook, 2008b, 2008c, 2009, 2010), where inhabitant behavior is recorded by sensors and monitored by a program in order to detect the activity carried out (such as cooking, eating, watching TV, etc.). In particular, activity monitoring requires models of the resident’s activities to recognize his behavior. Thus, one of the major issues is then the building of activity models.

The work described in this paper proposes a general theoretical framework to define and to identify resident activities. This proposal
is presented and illustrated in the GerHome project of Centre Scientifique et Technique du Bâtiment (CSTB, France), whose aim is to develop technical solutions to the problem of providing greater autonomy and better quality of life to the elderly at home. The objective of this paper is to present a general and formal notion of abstraction level that allows the automatic recognition of any notion of activity.

The next section introduces related works and the motivation of our approach. After that, we present the basis of the Timed Observation Theory that constitutes the theoretical framework proposed for modeling and recognizing activities. Next, the Timed Observation Modeling for Diagnosis methodology (TOM4D) and the Timed Observation Mining for Learning process (TOM4L) are presented in order to describe a knowledge discovery and modeling process from data which is used to build operational abstraction levels. Subsequently, the application of this approach to the resident’s activities in the GerHome project is described; and then, a discussion about the generality of our proposal is presented. Finally, we conclude with a short synthesis of our work and its application on the next generation of medical alert devices.

**RELATED WORKS**

Human activity recognition in perceptual environments involves severe challenges due to the erratic nature of human behavior. To determine what is being done can be complicated if different activities are executed at the same time; e.g., to cook while watching TV. Besides, the same detected action can be associated with several activities depending on the context in which it is carried out then, to discriminate what is the right activity is not trivial; e.g., to open sink water tap can be part of cooking or washing dishes. Moreover, activities can be interleaved: while washing dishes the phone rings, the activity is paused, the phone is answered and then, the activity is taken up again. Thus, to determine what a person is doing at a particular time is not a simple task.

The problem lies in the meaning and the interpretation of the perceptual inputs due to the large gap that exists between the low level signals, as pixels, sensor signals, etc., and that one that is inferred in a higher level; for example, washing dishes.

Different works propose a characterization and a definition of human activity in smart environments. In particular, an activity can be considered in terms of space (activity location), of time (temporal patterns), of goals (intentions) and in terms of ethnographic data (Aldrich, 2003). On the other hand, activities are directly linked with human acts that can be specified by constructing a probabilistic context-free grammar (PCFG) whose alphabet consists of poses, as Figure 1(a) illustrates (Ogale et al., 2005). Then activity recognition is based on successive abstraction processes. Ogale et al. (2005) define human activities from the visual observation of body poses obtained from video data and proposes three levels of abstraction (Figure 1): continuous signal (optical flow), discrete event (body pose) and activity (sequence of discrete events). In Muhammad (2008), activities depend on temporal, logical and causal constraints linked with an intention, and three “abstraction levels” are also presented: low level sensory stimuli, notion of causality amongst some qualitative activity descriptors and notion of context-sensitive intent. Similarly, Pantic et al. (2007) proposes three levels of abstraction defined as “semantic levels”: movements as low-level semantic primitives, activities as sequences of states and movements and human behavioral actions as high level semantic events.

In the MavHome project (Youngblood & Cook, 2007), once again, three levels of abstraction are proposed (discrete events coming from sensors, event sequence and activity) and the move from an abstraction level to the other is based on models that are produced using a process of Knowledge Discovering from Databases (the Apriori algorithm) (Srikant & Agrawal, 1996) or Hidden Markov models (Figure 2). A similar approach is used in the CASAS project (Rashidi & Cook, 2008a, 2008b, 2009, 2010), but with a temporal point of view.
Brazilian Occupational Therapy Perspective about Digital Games as an Inclusive Resource to Disabled People in Schools
www.igi-global.com/chapter/brazilian-occupational-therapy-perspective-digital/73872?camid=4v1a

Exploring the Social Dynamics of Implementing Self-Managed Web-Based Wellness Tools: A Structuration Analysis
www.igi-global.com/article/exploring-social-dynamics-implementing-self/75147?camid=4v1a