Chapter 8.17
Human-Based Models for Ambient Intelligence Environments

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ABSTRACT

Ambient intelligence gathers best results from three key technologies, ubiquitous computing, ubiquitous communication, and intelligent user friendly interfaces. The functional and spatial distribution of tasks is a natural thrust to employ multi-agent paradigm to design and implement AmI environments. Two critical issues, common in most of applications, are (1) how to detect in a general and efficient way context from sensors and (2) how to process contextual information in order to improve the functionality of services. Here we describe an agent-based ambient intelligence architecture able to deliver services on the basis of physical and emotional user status captured from a set of biometric features. Abstract representation and management is achieved thanks to two markup languages, H2ML and FML, able to model behavioral as well as fuzzy control activities and to exploit distribution and concurrent computation in order to gain real-time performances.

INTRODUCTION

When designing ambient intelligence (AmI) environments (Aarts, 2004), different methodologies and techniques have to be used, ranging from materials science, business models, network architectures, up to human interaction design. However, as key technologies, AmI is characterized by:

- **Embedded:** Devices are (wired or unwired) plugged into the network (Ditze, 2004). The resulting system consists of several and multiple devices, compute equipments and software systems that must interact among them. Some of the devices are simple sensors; others are actuators owning a bunch of control activities in the environment (central heating, security systems, lighting system, washing machines, refrigerator, etc.). The strong heterogeneity makes it difficult a uniformed policy-based management.
- **Context awareness:** This term appeared for the first time in Schilit (1994), where the authors defined the context as locations, identities of nearby people and objects, and changes to those objects. Many research groups have been investigating on context-aware applications, but there is no common understanding on what context and context awareness exactly means.
- **Personalized:** AmI environments are designed for people, not generic users. This means that the system should be so flexible as to tailor itself to meet human needs.
- **Adaptive:** The system, being sensible to the user's feedback, is capable of modifying the corresponding actions that have been or will be performed (Astrom, 1987).

We have designed and implemented an intelligent home environment populated by intelligent appliance agents skilled to perform distributed and adaptive transparent fuzzy control. The agents interact and coordinate their activities using the Fuzzy Markup Language (FML) (Loia, 2005) as an abstract protocol over shared resources independently from hardware constraints. The agents compose an abstract layer that binds the instrumental scenario with the services, ensuring efficiency and adaptivity. This approach allows AmI designers to achieve useful goals:

- to customize the control strategy on a specific hardware through an automatic procedure;
- to distribute the fuzzy control flow in order to minimize the global deduction time and better exploit the natural distributed knowledge repositories; and
- to acquire at run time the user's behavior and the environment status in order to apply context-aware adaptivity.

This chapter proposes an ambient intelligence architecture being able to distribute personalized services on the basis of physical and emotional user status captured from a set of biometric features and modeled by means of a markup language based on XML. This language, namely *H2ML*, is a new tool to model human information usable at different abstraction levels inside the AmI architecture so as to reach transparency, uniformity, and abstractness in bridging multiple sensors properties to flexible and personalized actuators.

In this chapter we show that several layers composing the overall AmI architecture are used to achieve the aforesaid goal. Different layers serve to link the low-level details (the hardware layer) with the high-level view (software layer) by employing two classes of markup languages: FML and H2ML.

FUZZY MARKUP LANGUAGE

Initially, FML has been designed to act like a middleware between the legacy fuzzy environment and the real implementation platform. Legacy fuzzy environment module allows creating a fuzzy controller using a legacy representation (Acampora, 2005). An example of legacy fuzzy environment module is Matlab™ that produce a