

# Chapter 19

## Medical Data Visualization via a Pervasive Multi-Agent Platform

**Antonio Coronato**  
*ICAR-CNR, Italy*

**Luigi Gallo**  
*ICAR-CNR, Italy*

**Giuseppe De Pietro**  
*ICAR-CNR, Italy*

### ABSTRACT

*Pervasive healthcare is the field of application emerging from the combination of healthcare with pervasive computing, which is the computing paradigm that provides users with access to services in a transparent way, wherever they are and whichever their interacting device is. In this paper, a software infrastructure for pervasive healthcare is presented. Such an infrastructure aims at supporting medical practitioners with advanced pervasive access to medical data, which is also context-aware in the sense that the modality to fruit data depends on the device used by the operator and on his or her physical position within the environment. The paper also describes a service for high quality 3D rendering of medical volume data, which takes advantage of the software infrastructure to distribute the computational load upon the devices available in the environment in a completely transparent way to users.*

### INTRODUCTION

Pervasive computing and ambient intelligence technologies are more and more frequently

adopted to develop innovative solutions in the field of healthcare. As a matter of fact, pervasive healthcare is the emerging computing paradigm that appears to be able to provide both solutions to many existing healthcare problems and new opportunities for better healthcare services.

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Pervasive healthcare aims to provide healthcare to anyone, anytime, and anywhere, in a transparent way, by means of innovative interaction metaphors. It is opening a wide range of innovative applications, from remote monitoring of elder people or ill patients, to new environments like advanced surgery rooms, smart spaces for doctor consulting, assisted living homes, and smart hospitals, which relies on the application of ambient intelligence technologies. Generally speaking, ambient intelligence concerns the ability of a software system to be sensitive, adaptive and responsive to the change of status of the physical environment (Cook, Augusto & Jakkula, 2009). As a specialization of ambient intelligence, Ambient Assisted Living (AAL) regards the realization of smart environments to monitor elderly and ill people. A generic definition for AAL can be found in (Steg, 2006): "AAL aims to prolong the time people can live in decent way in their own home by increasing their autonomy and self-confidence, the discharge of activities of daily living, to monitor and care for the elderly or ill person, to enhance the security and to save resources". The development of such a kind of applications presents new criticalities depending on their intrinsic characteristics, as for an example the dependency of the system behavior from the user and resources location and movements. It has been emphasized the need of having a formal methodology and the advantage of adopting a structured approach to design in (Coronato & De Pietro, in press) and (Lee, Chen, Hsiao & Tseng, 2007). It is also clear the need of tools for rapid integration of technologies and prototyping AAL applications (Cook & Das, 2007).

In this paper, a software infrastructure for a smart medical environment is presented. Specifically, such an environment aims at supporting medical staff with advanced pervasive access to medical data, which is also context-aware in the sense that the modality to fruit data depends on the device used by the operator and his physical position within the environment. As a specific case

study, it is presented a service for high-quality volume ray casting of large medical datasets. This service: i) identifies the kind of device that is used by the operator to issue the request; ii) locates the operator to know if a better visualization device is in the proximity of him (e.g. a wall monitor); iii) customizes the service depending on the user location and the visualization device; and, iv) exploits the software infrastructure to distribute the rendering load among the common resources available in a completely transparent way to users.

What about the underlying agent-based middleware infrastructure, it is able to transparently handle the distribution of inherently parallelizable tasks in a networked grid of both fixed and mobile devices. This infrastructure can conveniently be applied in scenarios like hospitals, in which a large number of personal computers and mobile devices are available and typically only partially used. In this kind of scenario, users want to execute intensive computing tasks, but they are neither expert nor willing of being aware about task distribution among the available resources. With the approach we describe in this paper, both wired PCs and wireless mobile devices can participate the computing platform in a quite simple and transparent way. Volunteers have just to download and install a lightweight middleware bundle. Users do not have to select, reserve and coordinate any resource. The software infrastructure realizes a P2P network over which tasks can be executed after having been embedded in mobile agents, which, in their turn, chose where to start the execution of the encapsulated task, migrate in order to balance the load, or try to recover in case of failures. Main characteristics of the infrastructure are:

- **Transparent integration of mobile devices as active resources:** This feature grants that, whenever a mobile device enters the environment, it becomes an active resource for the community;

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