Hardware and Software in Smart Decision Rooms

Carlos Freitas[1], Goreti Marreiros[1,3], Ricardo Santos[1,2], Carlos Ramos[1,3]

[1] GECAD – Knowledge Engineering and Decision Support Group
Porto, Portugal
carlosfilipefreitas@gmail.com
{goreti,csr}@dei.isep.ipp.pt
[2] College of Management and Technology– Polytechnic of Porto
Felgueiras, Portugal
rjs@estgf.ipp.pt
[3] Institute of Engineering – Polytechnic of Porto
Porto, Portugal
{goreti,csr}@dei.isep.ipp.pt

Abstract. Since the last decade research in Group Decision Making area have been focus in the building of meeting rooms that could support the decision making task and improve the quality of those decisions. However the emergence of Ambient Intelligence concept contributes with a new perspective, a different way of viewing traditional decision rooms. In this paper we will present an overview of Smart Decision Rooms providing Intelligence to the meeting environment, and we will also present LAID, an Ambient Intelligence Environment oriented to support Group Decision Making and some of the software tools that we already have installed in this environment.

Keywords: Smart Decision Rooms, Group Decision Making, Ambient Intelligence, Ubiquitous Computing.

1 Introduction

The increasing competitiveness present in the business world lead people/organizations to take decisions in a short period of time. As those decisions have to be the most advantageous, taking into account the quality of the final results, the researchers have developed several decision support systems. At the beginning developed systems aimed to support face-to-face meetings [10]; today's the aims is to develop systems that support distributed and asynchronous meetings, naturally allowing a ubiquitous use that can add flexibility to the global organizational environment of nowadays [6].

Such orientation in software development was followed by the design and building of rooms with specific hardware that could raise the ubiquitous needs. This kind of rooms is commonly named by Smart or Intelligent Meeting Rooms (SMR).

Group decision making is for definition an excellent area to demonstrate the potential of smart meeting rooms [14][20]. If we consider a distributed meeting involving persons in different places (some in a meeting room, others in their offices, others in different countries) with access to different devices (computers, PDA's,

mobile phones) and with a common goal (making a decision), they will need some technological support.

The identified needs on the previous paragraph lead us to the smart environment definition in order to understand what kind of necessity we pretend to cover. A smart environment is defined as one that is able to acquire and apply knowledge about the environment and its inhabitants in order to improve their experience in that environment [5]. To enable the meeting environment to perform such tasks it is necessary to define the components that support it.

Smart Meeting environments are a discipline of Ambient Intelligence (AmI) among others such as: distributed intelligence, computer vision, speech recognition, robotics, information fusion, hardware design, computer wearables, social sciences, ethics and law [19]. On the same way AmI also depends on large technological solutions which can be grouped in ten groups. They are: Networks and Communications, Software, MicroSystems and Electronics, Screens, Interfaces, Knowledge Management, Artificial Intelligence, Robots, Trust and Safety, Power Sources.

To build intelligent environments it is vital to design and make effective use of physical components such as sensors, controllers and smart devices. Then using the information collected by these sensors the software e.g., intelligent agents, can reason about the environment and can make actions in order to change the state of the environment which can be executed through actuators. Such sensors/actuators networks need to be robust and self-organized in order to create a ubiquitous/pervasive computing platform. The IEEE 1451 studies formalized the notion of a smart sensor as one that provides additional functions beyond the sensed quantity, such as signal condition or processing, decision-making functions or alarm functions [18]. This lead to devices that do not intend to solve the entire intelligent environment problems, however they provide intelligent functionalities confining a single object and task.

The design of these sensors/actuators leads us to some pervasive computing and middleware issues. Here we can find challenges as invisibility, service discovery, interoperability and heterogeneity, pro-activity, mobility, privacy, security and trust [11].

In this way, to design and build a SMR becomes fundamental a selection of middleware that decrease the development and usability effort of software solutions that bring together all the data collected by the sensors, and them reasons about the environment and acts on him. However in this peculiar AmI environment, the SMR, the desired functionalities are focused on solutions that could collect, organize and distribute the data from the meeting process to the different participants taking in order their minimal effort.

In this paper we aim to present a survey on SMR in order to identify the hardware and software necessities and issues in such spaces. For this we start in next section to present the Ambient Intelligence directions and issues. In section 3 are identified the main components of SMR. At this point we also present some meeting rooms projects present in literature. In section 4 it is presented the Laboratory of Ambient Intelligence for Decision (LAID) that is a smart meeting room environment for Group Decision Support that we are implementing. Finally some conclusions and further orientations are presented.

2 Ambient Intelligence

The concept of ambient intelligence was built on early ideas of ubiquitous computing introduced by Mark Weiser [22], anticipating a digital world which consists of many distributed devices that interact with users in a natural way.

Ambient Intelligence (AmI) deals with a new world where computing devices are spread everywhere (ubiquity), allowing the human being to interact in physical world environments in an intelligent and available way whenever we need it, enabled by simple and effortless interactions, attuned to all our senses, adaptive to users and context and autonomously acting. AmI environments may be diverse (e.g. decision room, hospitals, stores), but the idea behind is to provide a better support to the human being and the access to the essential knowledge in order to make better decisions when interacting with those environments. So those environments should supply high quality information and content, available to any user, anywhere, at any time, and on any device.

As thinking in development of environments that provide AmI, becomes necessary to clarify the generic and normal issues and tendencies of solutions. In our search we detach the following alerts.

In [5] are presented the hard problems that research will have to focus in order to meet AmI goal and develop realistic AmI-based systems. They are Distributed Intelligence, Hardware Design, Information Understanding, Communication Modelling. In Distributed Intelligence are included techniques that use modular units of intelligence, known as agents, to create a pervasive and distributed layer of intelligence. These kinds of solutions were already implemented in [6] [14] [7] [12] [9]. The Hardware Design issue is focused on development of new hardware technologies, most of the times a little limiting because the search for enhance peoples lives. Information Understanding**,** speaking of AmI information it implies the gathering and cataloguing on the fly data from heterogeneous networks sources of sensors. Communication Modelling**,** distributing intelligence is possible only if an intelligent layer can be built on the top of a robust seamless communication infrastructure. An agent based technology is pointed as a possible solution to this issue.

The intrinsic communication, distributed and diversity requisites of AmI applications lead several times to pervasive computing and middleware issues. Here we are challenged for example invisibility or (user/device) unawareness, interoperability and heterogeneity, proactivity, mobility, privacy or trust. In [19] agent interaction and collaboration is an integral part of pervasive (intelligent) environments where agents are able to decrease the enormous resource limitations present in some devices.

Smart environments also need to consider issues such as the usability of the interface, the extent to which the interface is end-user friendly, and the adaptiveness of the interface.

3 Smart Meeting Rooms

Intelligent or Smart Meeting Rooms (SMR) should support efficient and effective interactions among their occupants. The generic goal of such systems [15] is normally referred as a system that supports multi-person interactions in the environment at real time, but also as a system that is able to remember the past, enabling review of past events in an intuitive and efficient way.

The infrastructure which can be used for such rooms include a suite of multimodal sensory devices, appropriate computing and communications systems. In [5] the components of a smart environment and their connection are identified (Fig. 1).

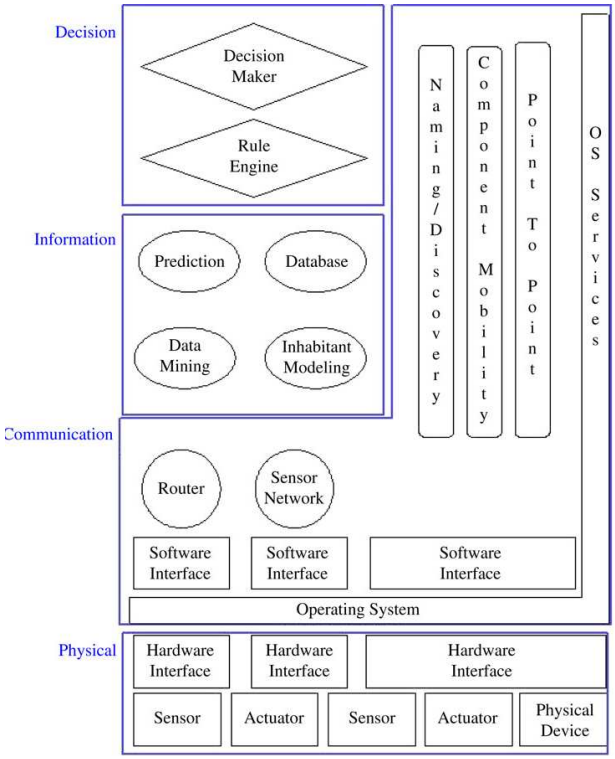

Fig. 1. Components of a smart environment

A smart environment is viewed as a bottom-up process [5] in a cycle of perceiving what is happening through sensors in the environment, communicating the state collected, gathering this information together among task goals and outcomes followed by a reasoning and outcomes of possible actions and then acting with the environment in a perspective of top – down (action) in order to activate the actuators to transform the environment into the inferred state.

In the field we can find interesting projects as SMaRT [21] which intends to provide meeting support services that do not require explicit human-computer interaction, enabling the room to react appropriately to users needs maintaining the focus on their own goals. It supports human-machine, human-human, and human-

computer-human interactions providing multimodal and fleximodal interfaces for multilingual, multicultural meetings.

Literature also refers M4 (Multi Modal Meeting Manager) project as a large-scale project funded by the European Union in its 5th Framework Programme [16]. M4 aim is to design a meeting manager that is able to translate the information that is captured from microphones and cameras into annotated meeting minutes that allow for high-level retrieval questions, as well as summarization and browsing. It is concerned with the building of a demonstration system to enable structuring, browsing and querying of an archive of automatically analyzed meetings.

There is also AMI (Augmented Multi-party Interaction) project [16] concerned with new multimodal technologies to support human interaction, in the context of smart meeting rooms and remote meeting assistants. It aims to enhance the value of multimodal meeting recordings and to make human interaction more effective in real time. Similar objectives are shared with Meeting Room project from Schultz in 2001.

More recently several researches are proposing the integration of ontologies and Semantic Web in the agents assigned to Smart Meeting Rooms [3] [2].

Next we will present some details of referred systems that implement components of a smart environment in order to make smart decision rooms. We will focus first in a physical perspective (hardware) and then in a logical perspective (software).

3.1 Hardware - Physical

With this sub section is intended to present an overview of physical components included in some Smart Meeting Rooms projects.

The IDIAP smart meeting room [17] [4] can receive meetings containing up to six participants. The hardware is composed by a table, whiteboard, computer projection screen, 24 microphones configured as lapel microphones, in the ears of a binaural manikin, and in a pair of 8 channel tabletop microphone arrays, three video cameras, and equipment for capturing time-stamped whiteboard strokes (Fig. 2).

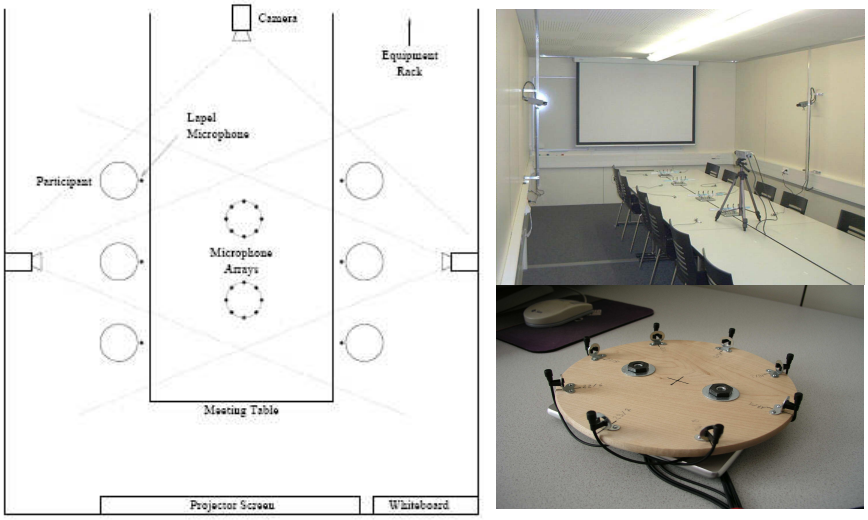

Fig. 2. IDIAP Smart Meeting Room perspective and microphone arrays

The AVIARY system [15] take as input four static cameras with highly overlapping fields of view, four active cameras (pan/tilt/zoom), two microphones and 2 personal computers.

The similarity between these Smart Room systems and others [21] are the gathering of audio and video inputs as well as the notes and presentations made by the users.

3.2 Software

With this sub section it is intended to present the software components of some Smart Meeting Rooms projects.

On IDIAP [17] the recorded data is precisely synchronized so that every microphone, pen-stroke, and video sample can be associated with simultaneously captured samples from other media streams. The software component uses XML to catalogue all the data and it is mentioned an off-line media interactive browsing system. (Fig.3). A similar meeting browsing project is Memetic [1] (Fig.4).

In M4 project [16] the software goal includes the analysis and processing of the audio and video streams, robust conversational speech recognition, to produce a word-level description, recognition of gestures and actions, multimodal identification of intent and emotion, multimodal person identification and source localization and tracking (Fig.3). This inferred data can be acceded from the M4 meeting manager.

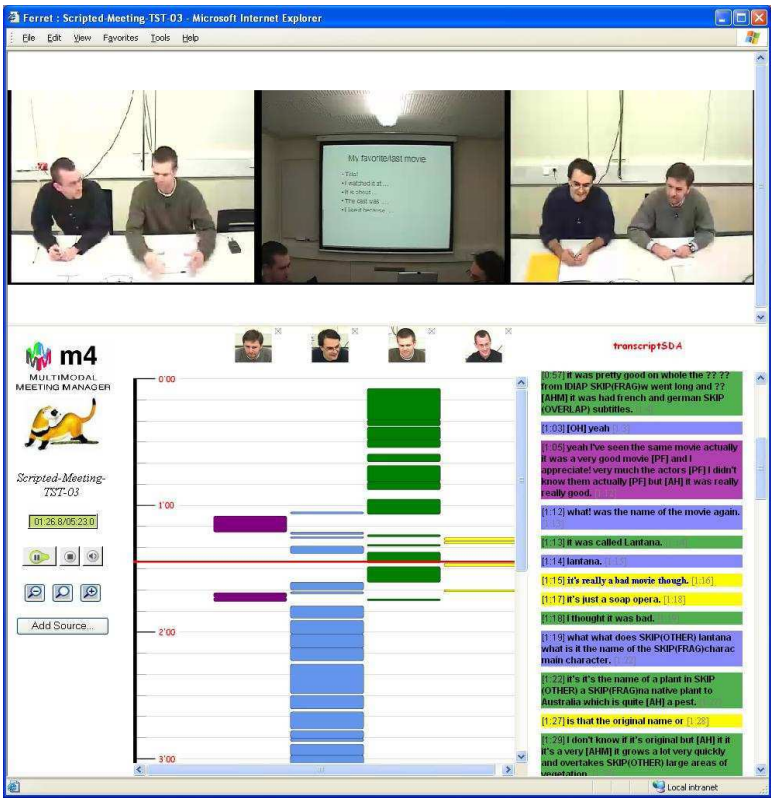

Fig. 3. M4 meeting browser

AMI project [16] focuses between others in Understanding Meetings, Uni and Multi modal Recognition, Content Abstraction and Multimedia Presentation, and Remote meeting assistant. A similar meeting browsing project is Memetic (Fig. 4).

The software system developed in [16] focuses on using the hardware to 3D centroid tracking, person identification and current speaker recognition, event recognition for directing the attention of active cameras, best view camera selection, active camera control and in the Graphical summarization/user interface.

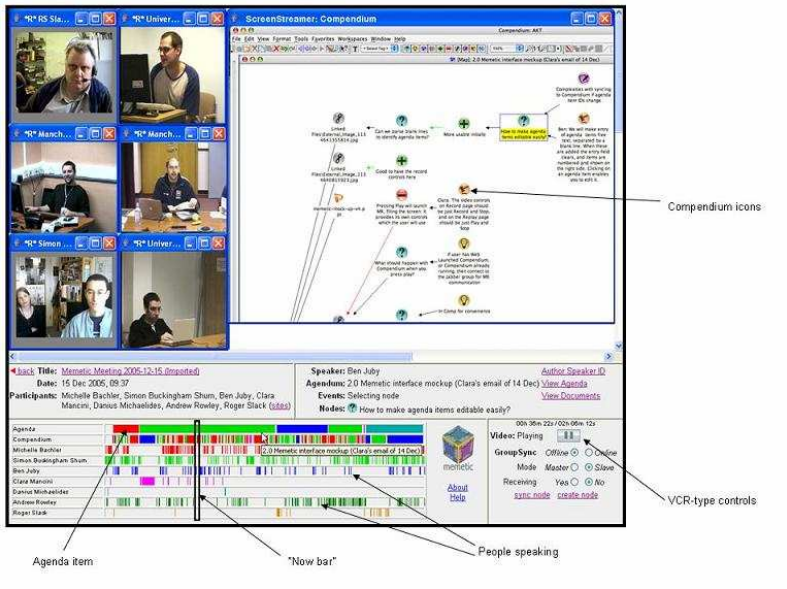

Fig. 4. Memetic meeting browser

In a brief the research efforts run to store the meetings essential data available for future use. Emotional factors are also a question that various systems are already taking into account. For now the main targets are middleware solutions to solve audio and video processing. The future tends to the appliance of ontologies in the information/decision layer in order to automate the machine semantic interpretation of the meeting. With such features the capabilities of SMR use the past knowledge will be much more simplified.

4 LAID - Intelligent Decision Environment Room

LAID (Laboratory of Ambient Intelligence for Decision Making) [8] is an Intelligent Environment to support decision meetings.

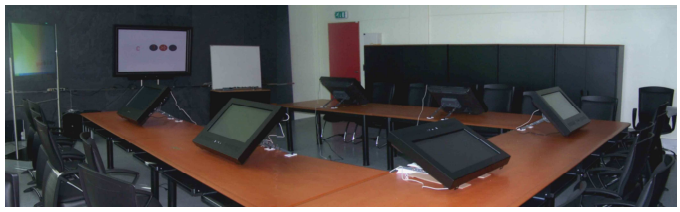

Fig. 5. GECAD Ambient Intelligent Decision Lab

Fig. 5 shows the Laboratory of Ambient Intelligent for Decision with several interactive Smartboards. The meeting room support distributed and asynchronous meetings, so participants can participate in the meeting where ever they are.

The software included in this meeting room for now is composed by 4 main modules IGTAI, WebMeeting, a relational database system and pervasive (Fig. 7). In these applications emotions handling were also included.

The middleware used is in line with the live participation/supporting on the meeting. It is also able to support a past review in an intuitive way however the audio and video remember features are steel underway.

4.1 Hardware

The GECAD Intelligent Decision Room is composed by the followed hardware (Fig. 6):

- Interactive 61'' plasma screen (vertical lines fill)
- Interactive holographic screen (doted fill)
- Mimio® Note grabber (pyramids fill)
- One interactive 26'' LCD screen (Six of this) used by 3 decision points (horizontal lines fill)
- 3 cameras, Microphones and activating terminals controlled by a CAN network.

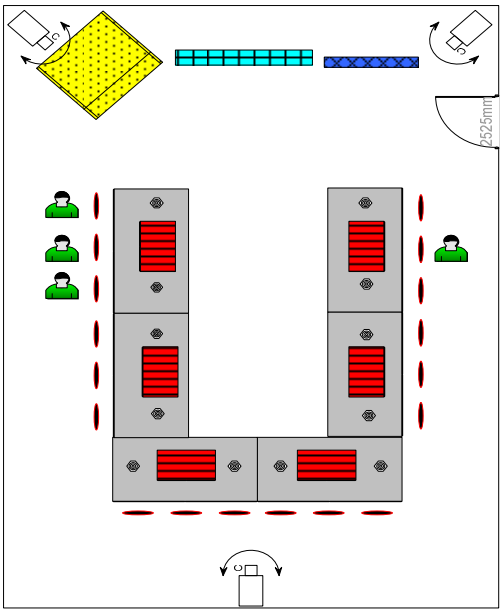

Fig.6. GECAD Intelligent Decision Environment diagram

With this hardware we are able to gather all kind of data produced on the meeting, and facilitate their presentation to the participants and minimizing the middleware issues to the software solutions that intend to catalog, organize and distribute the meeting information.

4.2 Software

At this time the software included on LAID Smart Meeting Room is composed by a toolkit that is able to support the whole decision making process.

The referred toolkit is named by TAmI [7] and is composed by 4 main modules: IGTAI, WebMeeting, a relational database system and the pervasive hardware already referred (Fig. 7).

IGTAI is an Idea Generation Tool to support a ubiquitous group decision meeting dedicated to the idea generation task. It is a tool designed to users with little experience in informatics systems, with group knowledge management, ubiquitous access, user adaptiveness and pro-activeness, platform independence and the formulation of a multi – criteria problem at the end of a work session.

WebMeeting is a tool that aims helping geographically distributed people and organisations in solving multi-criteria decision problems namely supporting the selection of alternatives, argumentation, voting techniques and meeting setup.

The relational database maintains the information of the whole system and will allow the reutilization of past meetings knowledge.

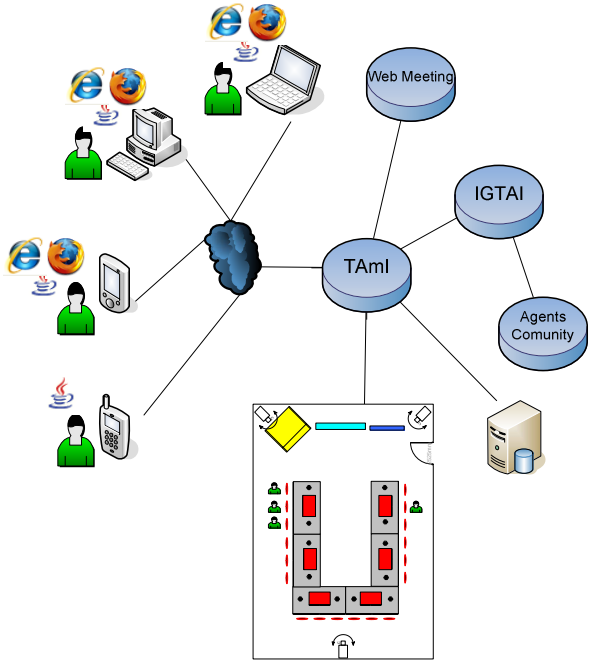

Fig. 7. TAmI. High level architecture

There are other software components available in our Lab. We have for instance an agent based simulator of group decision (ABS4GD) [13] and we are developing a new version of WebMeeting, the WebMeeting Plus [14]. ABS4GD is a multi-agent simulator system whose aim is to simulate group decision making processes, considering emotional and argumentative factors of the participants. WebMeeting Plus is an evolution of the WebMeeting project with extended features for audio and video streaming. In its initial version, based on Web-Meeting, it was designed as an Group Decision Support System that supports distributed and asynchronous meetings through the Internet.

5 Conclusions and future directions

The survey presented on this paper represents our effort on creating a Smarting Meeting Room on compliance with the research efforts of all Ambient Intelligence community with innovative ideas in certain points.

The software toolkit of LAID has been currently designed and implemented being now in the test phase. Once the laboratory tests are concluded, experiments, with homogenous and heterogeneous groups will be executed in LAID and out of it. With this it will be possible to observe the impact of ubiquitous access to different kind of meetings in the decision making process.

As future work our researches will also tend to add video and audio synchronized along the time with the documents and tree of problem from the meeting. Then we intend to improve the characteristics of the IGTAI agent community allowing these to work with automate machine semantic interpretation of meeting acts. We are also planning the updating to WebMeeting plus and to perform a better integration with the ABS4GD (Agent Based simulator of Group Decision).

References

[1] Shum, S., Selvin, A., Sierhuis, M., Conklin, J, Haley, C. and Nuseibeh, B.: Hypermedia Support for Argumentation-Based Rationale: 15 Years on from gIBIS and QOC, in Rationale Management in Software Engineering, Springer-Verlag (2006) 111-132

[2] Chen, H., Perich, F., Chakraborty, D., Finin, T., Joshi, A.: Intelligent agents meet semantic web in a smart meeting room, in Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems (2004) 854- 861

[3] Chen, H., Perich, F., Finin, T. and Joshi, A.: SOUPA: standard ontology for ubiquitous and pervasive applications in The First Annual International Conference on Mobile and Ubiquitous Systems: Networking and Services (2004) 258- 267

[4] Moore, D.: The IDIAP Smart Meeting Room, *IDIAP Comm. 02-07,* (2002).

[5] Cook, D. and Das, S.: How smart are our environments? An updated look at the state of the art, in Pervasive and Mobile Computing, Volume 3, Issue 2, Design and Use of Smart Environments, March (2007) 53-73

[6] Freitas, C., Marreiros, G. and Ramos, C.: IGTAI - An Idea Generation Tool for Ambient Intelligence, in 3rd IET International Conference on Intelligent Environments, Ulm, Germany (2007)

[7] Freitas, C., Marreiros, G., Ramos C.: TAmI – A Toolkit for Ambient Intelligence in Inter Symp (2007)
[8] Gecad – www.gecad.isep.ipp.pt
[9] Hagras, H., Callaghan, V., Colley, M., Clarke, G., Pounds-Cornish, A., Duman, H.: Creating an ambient-intelligence environment using embedded agents, in IEEE Intelligent System, Vol.19, No.6, (2004) 12-20
[10] Nunamaker, J., Dennis, A., Valacich, J., Vogel, D. and George, J.: Electronic Meeting Systems to support group work, Communications of the ACM, Vol. 34, No. 7 (1991)
[11] Satyanarayanan, M.: Pervasive computing: Vision and Challenges IEEE Personal Computing and Communications, Vol. 8 (2001) 10-17
[12] Dertouzos, M.: The future of computing, Sci. Amer, vol281,no.2, pp. 52- 55, (1999)
[13] Marreiros, G., Santos, R., Freitas, C., Ramos, C., Neves, J. and Bulas-Cruz, J.: Modeling Group Decision Making Processes with Artificial Societies considering Emotional Factors, Symposium on Artificial Societies for Ambient Intelligence, Newcastle, UK, (2007).
[14] Marreiros, G., Santos, R.; Ramos, C.; Neves, J. Novais, P.; Machado, J. e Bulas-Cruz, J.: Ambient Intelligence in Emotion Based Ubiquitous Decision Making. in *International Joint Conference on Artificial Intelligence (IJCAI)*, 6-7 January, Hyderabad, Índia, (2007)
[15] Mikic, I.; Huang, K. and Trivedi, M.: Activity monitoring and summarization for an intelligent meeting room, in Workshop on Human Motion (2000) 107-112
[16] Nijholt, A.: Meetings, gatherings, and events in smart environments. In Proceedings of the 2004 ACM SIGGRAPH international Conference on Virtual Reality Continuum and Its Applications in industry (2004) 229-232
[17] Wellner, P., Flynn, M. and Guillemot, M.: Browsing recordings of multi-party interactions in ambient intelligence environments, in Proc. CHI Workshop Lost in Ambient Intelligence, Vienna, Austria, (2004)
[18] Frank, R.: Understanding Smart Sensors, Artech House, (2000)
[19] Remagnino, P. and Foresti, G.L.: Ambient Intelligence: A New Multidisciplinary Paradigm, in IEEE Transactions on Systems, Man and Cybernetics, Part A, Vol.35, Iss.1, Jan. (2005) 1- 6
[20] Santos, R.; Marreiros, G.; Ramos, C.; Neves, J. e Bulas-Cruz, J. Multi-agent Approach for Ubiquitous Group Decision Support Involving Emotions. in *Lectures Notes for Computer Science* Vol. 4159, pp. 1174 – 1185
[21] Waibel, A., Schultz, T., Bett, M., Denecke, M., Malkin, R., Rogina, I., Stiefelhagen, R., Jie Yang, SMaRT: the Smart Meeting Room Task at ISL, in IEEE International Conference on on Acoustics, Speech, and Signal Processing (2003) 281-286
[22] Weiser, M.: The Computer for the Twenty-First Century. Scientific American, September (1991).