iRoundTable
A COLLABORATION PLATFORM FOR VIRTUAL AEC ORGANSIZATIONS

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ABSTRACT

In this paper we give a short overview of ongoing research and development of *iRoundTable*, a collaboration platform for efficient execution of large complex AEC projects with geographically dispersed interdisciplinary teams. *iRoundTable* will allow for convenient and task related access to the distributed heterogeneous information of the virtual organization. A suite of tools will support the multi-media communication between the project stake holders. The system will be realized using a grid of loosely coupled software services which can be combined freely at request. User will connect to the platform either via sophisticated multi-media conference systems or via simpler mobile devices. The development of a task-oriented intuitive user interface will be of central importance to allow getting access to decision related information efficiently. A new wireless 3D tracing system will be integrated in the conferencing systems and will provide new methods to browse through the project information spaces and histories to combine relevant information for decision making processes.

The development is organized as follows:

- provision of a service-based grid infrastructure for the integration of the

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distributed and heterogeneous information sources
- development of a suite of software services supporting the preparation, monitoring, documentation and archiving of decision meetings
- development of the 3D tracking system and the related software services for information browsing

KEY WORDS

Collaborative Teamwork, Grid, Human Computer Interaction, Decision Making

INTRODUCTION

Multimedia infrastructures used today in AEC projects are usually closed systems. They either work on intranets or offline systems, or are based in proprietary technologies, implying therefore a considerable investment for companies to use them. This limits the use of such systems to local participants with similar infrastructures. These restrictions prevent using these systems efficiently in virtual organizations, in geographically distributed groups or in heterogeneous infrastructures, hence in situations which are frequently found in large AEC projects.

We therefore make first developments towards an advanced system that we call *iRoundTable*. This system will be tailored to support typical everyday processes encountered in AEC projects. To reach this objective we will merge our experience form AEC projects, from interface design with our experience on distributed systems and data grids. Based on this background, we are currently developing a prototypal, Internet based system, which will capture, integrate and manage information of various types from distributed parties in order to support the AEC work processes. To test and evaluate the prototype, students from different universities are working with it on real world projects in international, multidisciplinary and geographically distributed teams (project- and process- based learning).

iRoundTable

OVERVIEW

Currently, *iRoundTable* is designed to provide the following five packages:
- *iRoomAssistent*: An interface to connect users to the system easily via Internet and to configure the heterogeneous local environments like workstations, notebooks, PDA's, sensors and the like
- *iRoomRegie*: a suite of software tools supporting the preparation, monitoring, documentation and archiving of meetings for decision making
- *iRoomGrid*: a service-oriented grid infra structure collecting and organizing sources of information and providing them to appropriate users
- *iRoomImmerse*: a 3D User Interface bringing Augmented and Virtual Reality functionalities into conferencing systems

- *iRoomVideo*: a digital library, allowing storing, annotating and searching of video streams of decision making processes

In the following, we briefly highlight each package.

iRoomAssistant

In AEC industries experts often draw sketches if they have to explain issues or if the negotiate in meetings. The paradigm of a blackboard in combination with a touch sensitive computer screens was the idea of a Smartboard. Thus, to any kind of computer generated multi-media content user can add his or her comments, remarks and ideas simply through writing and sketching with *electronic ink* on the board on a transparent layer on top of the displayed information. This *black board interface* is especially intuitive for architects and engineers who are used to communicate with the means of drawings and therefore reduces the threshold to man computer interaction. Often ideas get *shaped* or become *existent* in the course of the drawing process. The concept of the iRoom is to let users assemble, move and interact with any kind of multi-media information e.g. several drawings and documents which are relevant for a decision topic on large display panels which are positioned close together. In an iRoom meeting, people with different professional backgrounds and even laymen can participate.

Figure 1: Use of the iRoom in the Project Oriented Learning Environment during the final presentations

Thus we define an iRoom as an interactive information platform for supporting decision making processes of interdisciplinary teams. On big screens i.e. three SmartBoards or beamers information from various sources, such as computer, laptops, PDAs, tablet PCs etc, but also from participants which are connected to the meeting via the Internet can be presented and modified. All information such as plans, documents, databases, spreadsheets animations, simulations as well as 3D and 4D models may be arranged for a certain purpose and can be interactively modified or annotated with electronic ink.

Under the name iRoomAssistant, we are currently developing a graphical interface to connect and to configure the access of users and their various hardware and operating

systems to the iRoom platform in an intuitive way – thus allowing for quick set-ups of meetings in the iRoom.

iRoomAssistant manages topology of the iRoom which may change as the SmartBoards an other available display can be arranged freely due to the requirement of the meeting. Through the graphical user interface meeting participants can direct and control the information flow in the iRoom, regardless if the user attends the meeting locally in the iRoom or remotely via the Internet.

We build our application on top of Tidebreak teamspot software which evolved from the *iRos* project at Stanford University (Johanson, Fox, Hutchins and Winograd (2001)) Tidebreak implements a message heap system on the iRoom server – which is a robust iRoom operating system, where ubiquitous computing devices can freely connect or disconnect at any time to the system, without destabilizing the whole system. Furthermore pointRight offers a pointer/keyboard redirection system to control the connected devices with one mouse or keyboard.

The iRoomAssistant communicates with a data base to handle the manipulation of information during a meeting. All supported applications, like word processors, spreadsheets, pdf-viewers and 3D/4D CAD application need to have a plug-in for sending and receiving the events from the heap and to processing them, due to predefined event in the iRoom.

iRoomRegie

We observe a steady grow of AEC projects executed by interdisciplinary and geographically distributed teams where significant parts of the work will be outsourced. To address the increasing demand of planning, coordination and cooperation work, we have started to develop a set of software tools called iRoomRegie to support the preparation, monitoring, documentation and archiving of the decision making process in meetings. With the help of these tools meetings of interdisciplinary, distributed teams should be based on actual process data and become more efficient and effective. The meeting results should be accessible and retraceable without big efforts at a later state.

iRoomRegie uses an Agenda-based approach to organize the meetings in the iRoom environment. Meeting participants receive a meeting agenda as invitation and can provide multi-media documents assigned to specific meeting topics or if necessary only the placeholder descriptions for documents, which will be provided later. With iRoomRegie these documents can be arranged and displayed in the iRoom by the meeting moderator to provide the information which is related to the topic in question. This is done by simple drag and drop actions in the user interface (figure 2). The meeting moderator can prepare the meeting information arrangement in the iRoom in advance. Documents which have been suppield via Internet will be displayed directly, the other show a template with the placeholder description. The actual documents can be synchronized on the fly when the meeting participant connects his or her computing device through iRoomAssistant.

So far only annotations to the documents using the red lining features of the smart board are considered. They will be saved together with the documents and can be recognized in the meeting protocol and the to-do list of the meeting.

iRoomAssistant will be used and tested in the coming POLE Europe projects (see below) to gain experiences and user feed-back in realistic interdisciplinary work settings. Especially

the review sessions of the geographically dispersed interdisciplinary team will show, if the handling of the iRoomRegie is intuitive enough.

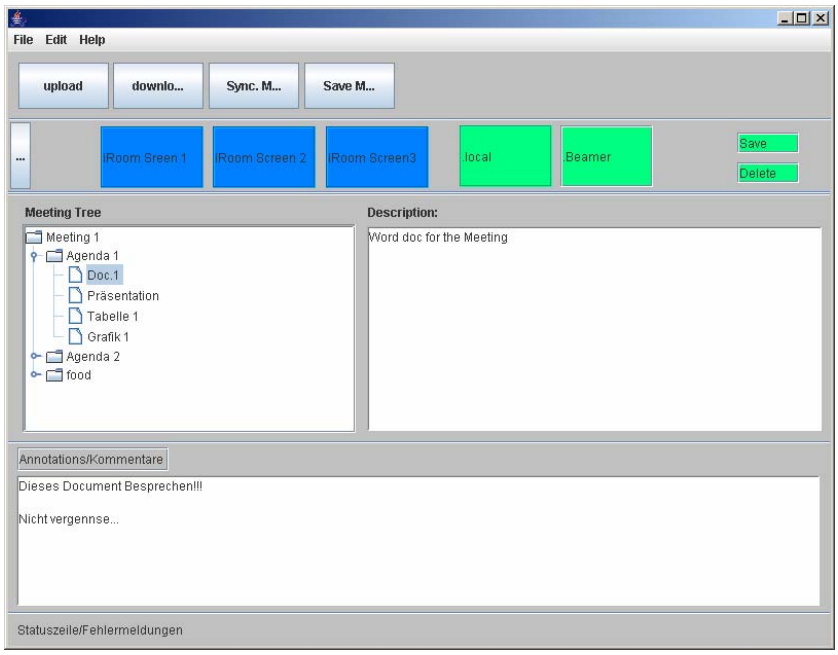

Figure 2: Prototype iRoomRegie for the meeting moderation

iRoomGrid

The grid package of *iRoundTable* is basically a fit of existing technologies to the needs of the AEC community. In a first phase, we will provide a configurable Infrastructure based on Globus or AccessGrid, which are generic middleware systems designed for this purpose. In a second phase, we will expand the infrastructure to support basic tasks. In this phase the infrastructure will be fitted to the specific needs of the other packages. In particular, special attention will be required for the integration of both the multimedia conference systems and the mobile devices. The system will be tested continuously on our test-bed (see below).

iRoomImmerse

iRoomImmerse provides 3D User Interfaces for the use in collaborative working environments (Bowman et al. 2005). The two major goals of our development are the design of the 3D data spaces and the integration of the 3D technology into *iRoundTable*. Thus, the concept of *iRoomImmerse* includes the integration of stereoscopic projection technology and 3D optical tracking (Advanced Realtime Tracking GmbH, 2006).

3D data spaces: Providing understanding and insight of heterogeneous information and multidimensional data structures is one of the major goals of 3D User Interface Design. Studies have shown that head tracked stereo viewing can increase the size of an abstract graph that can be understood by a factor of three (Ware and Franck, 1996). Therefore we use

stereoscopic real-time graphics and 3D optical tracking systems as known from Augmented or Virtual Reality Environments for the representation of the data. We also design the aesthetic impression of the virtual space to achieve a higher sense of presence - although presence is somewhat anomalous in a task-based classification of spatial information, a number of practical applications require a sense of presence (Ware, 2004). This also includes 3D interaction techniques that describe how the user can interact with the data.

3D technology: As we design a new workflow in a collaboration platform using 3D User Interfaces, we have to take care of keeping the Interface intuitive and understandable for the user. Therefore, the challenge is to integrate all hardware components into a sound arrangement of the physical environment (Prince et al. 2002). Main components are the stereoscopic projection wall, the 3D input devices and the 3D tracking system. The tracking is used for

a) the users head, to give him the perspective correct view of the stereoscopic data presented on the projection wall
b) the input devices, to enable the user to interact in the 3D data space.

Thus one has to take care, that the tracking area matches with the main position of the tracked users and components.

We actually develop to types of input device concepts. The first one provides a completely new developed device with a simple interaction concept. This keeps 3D interaction intuitive and easy for the user; although he has to interact with a device he is not familiar with (Simon and Doulis 2004). The second concept uses optical targets fixed to existing devices like PDA's or cell phones that are now used as interaction devices for the 3D User Interface (Watsen, Darken and Capps 1999 and Wagner, 2004). The user interacts with devices, he has become familiar with via an interface concept. In a next step we evaluate both concepts for the use in *iRoundTable*.

Figure 3: 3D Input devices

iRoomVideo

During the course of every AEC project, extensive knowledge is being generated. Once the project is closed, however, merely a very small part of this knowledge is visible and represented in the final product. Therefore, most experiences are lost and wasted because they are not apparent in the documentation. This is exactly the point on which *iRoomVideo* focuses; the users shall be able to:

- recall information from digital libraries (technical, formal knowledge) and
- create and store process-related knowledge (informal knowledge), so that other development groups as well as the users themselves will profit from exemplarily using the saved information at a later stage.

Figure 4: iRoomVideo trace all ocurrences of the word "productive" in the video recording of a review session in the POLE Europe project

In the iRoom we regularly record video sequences of team meetings. Once these video data is captured, we face the problem to find the desired information for later use, e.g. for redesign purposes. To get an overview of the data in the video database *iRoomVideo* allows

searching with keywords after spoken words and getting to the queried position. For this purpose a transcript is generated automatically with a large vocabulary speech recognition system and stored in a database.

With more annotation of the video stream like slide synchronization, abstract, text and chapter track it is possible to describe the decision making processes or points of interest. The digital video sequences can be labeled by means of indexes and annotations. This new methodology is an ideal complement to existing (static) libraries. The combination of the two technologies, however, offers a quick and target-oriented access to both forms of knowledge.

USE CASE – TEST BED

We continuously test and evaluate our developments, the interfaces, interaction concepts and software prototypes in POLE and LAKE projects, two initiatives established and carried out in a network of international universities.

POLE–Europe (Project Oriented Learning Environment, www.pole-europe.ch) is an educational project of University of Applied Sciences Northwestern Switzerland in collaboration with several national (ETHZ, EPFL, University St. Gallen, HTA Lucerne) and international universities (Stanford University, Aalborg University, TU Delft, NTNU Trondheim, ETSA Barcelona, Bauhausuniversität Weimar, Helsinki University of Technology, FH Trier, Politecnico Milano, Brno University of Technology, …). Based on real projects students from different universities have the chance to learn and experience the cooperation in international, multidisciplinary and geographically distributed teams (project- and process- based learning). Via modern ICT, the student teams communicate and are guided by their faculty coaches and supported by industry mentors.

The aim of LAKE (Libraries for Advanced Learning Environments, www.lake-europe.ch) is the development, implementation and evaluation of an integrated learning environment. LAKE expands the POLE framework by implementing digital libraries (static ones as well as dynamic databases recorded and automatically annotated of decision making processes) into the design process. LAKE is also a collaboration with several Swiss and international Universities (ETHZ, University St. Gallen, Stanford University, University of Strathclyde).

Both projects, POLE and LAKE provide ideal test beds for testing, evaluating and improving *iRoundTable*, since they engage interdisciplinary team work of geographically dispersed organizations.

CONCLUSIONS

By definition, virtual organizations are aimed at integrating information from heterogeneous sources. This project of an AEC specific virtual organization will be dedicated to bring information to people in a form that is intuitively understandable. A main challenge will therefore be to integrate all aspects of *iRoundTable* (use, work flow, technical, spatial, personal, system components and configurations, auxiliary devices) into a sound interface concept.

We address a number of new issues in the domain of man–machine interaction and decision support systems that will contribute significantly to this emerging field in the AEC community. We are convinced that the Internet based project planning is among the biggest successes of the information technology.

We further believe that our approach with a service-orientated architecture in a grid infrastructure better fits the current status quo of heterogeneous data and applications in the AEC industry. Although our developments of *iRoundTable* are by no means finished, we have proven that the system is ready for use in real world projects.

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