New HCI Based on a Collaborative 3D Virtual Desktop for Surgical Planning and Decision Making

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Abstract. Today, diagnosis of cancer and therapeutic choice imply strongly structured meeting between specialized practitioners. These complex and not standardized meetings are generally located at a same place and need a heavy preparation-time. In this context, we assume that efficient collaborative tools could help to reduce decision time and improve reliability of the chosen treatments. The European project Odysseus investigates how to design a Collaborative Decision Support Systems (CDSS) for surgical planning. We present here an activity analysis and the first outcomes of a participatory design method involving end users. Especially a new concept of Graphic User Interface (GUI) is proposed. It tries to make use of Virtual Reality technologies to overcome issues met with common collaborative tools.

Keywords: 3D Graphic User Interface, Collaborative Decision Support System, Surgical planning, Virtual Reality Technologies.

1 Introduction

Today, diagnosis of cancer and therapeutic choice imply strongly structured meeting between specialized practitioners. These complex and not standardized meetings are generally located at a same place and need a heavy preparation-time in order to take the best decision as promptly as possible with the available part of the medical history.

However, a lot of reasons such as delocalised skill centres, home constraints or busy schedules, don't allow practitioners to attend all the meeting they could be expected for. Thereof, several overview studies [1] or technical experiments [2] underline the potentiality of collaborative tools to reduce decision time and improve reliability of the chosen treatments. Indeed looking for the most experienced second opinion is crucial in decision making activity. But despite striking needs, a large deployment of distance collaborative tools didn't really yet occurred in medical communities, even though tremendous tools are easy to implement and exist since several years. From our point of view, this situation could be partly explained by unsuitability of the available tools as well as a lack of network infrastructures to share efficiently medical histories.

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In the European project Odysseus (Eureka 3184) INRIA, IRCAD and France Telecom R&D investigate how to design a Collaborative Decision Support Systems (CDSS) for surgical planning. And the project priorities are focused on adequacy of the CDSS with both activity and infrastructure aspects.

We present here ergonomic requirements pointed out from several analysis. Then we explain how we assume that 3D and more generally Virtual Reality techniques could contribute to overcome unsuitability of existing collaborative tools. And finally, we describe a first prototype of Graphic User Interface (GUI) designed to contribute to an iterative participatory design method [3] involving end users.

2 Activity Analysis and Requirements

2.1 Decision Making Is Not a Lonesome Activity

Practitioners we have interviewed in several hospitals are requested each day if not several times a week for medical opinions. The majority of these opinions are asked in order to talk about a complex situation or to reach a consensus in the close practitioners' circle. And whether they are inside or outside the hospital, they are used to talking by phone. It is the only collaborative tool really used between dispersed practitioners.

In the specific context of cancer treatment, structured and co-localised meetings are usually organised in the majority of the French and European hospitals. The aim of these meetings is to provide a reliable diagnosis and follow therapeutic choices along the treatments.

Odysseus project focuses on this last specific use case activity. Indeed, we assume there is a strong need of distance collaboration before, during and after these meeting. Before the meetings, practitioners need to prepare relevant elements of the medical histories with a team physically dissipated. During the meeting skill centres could be delocalised as well. And after a meeting practitioners could need to call for details about a treatment or a surgical operation.

In order to determine delocalised activity requirements, we first investigated co-localised ones. Features we have observed are the following:

- Number of the attendees
- Length of the meeting
- Time dedicated to each patient
- Non-usual attendees number for each meeting
- Time dedicated to remind each patient history
- Content of the medical history
- Collaboration steps
- Rhythm of a meeting

2.2 Iterative Participatory Design Method

From our opinion, introduce a collaborative system for distance decision making activity, requires at least do not change the way of working. That is to say it is mandatory to keep in mind to fit with the original co-localised activity. Then in a second time latent needs will appear progressively and changes of way of working could be consider. Indeed we assume that using a CDSS might imply not easy to anticipate changes in the way of working.

However only co-localised decision meeting exist today. Thereof it is very difficult to obtain from practitioners expected functionalities for such a system. The main reason comes from the difficulty for everybody of projecting himself onto other way of working. Above all, these difficulties increase when opportunity of making use of new technologies such as 3D are mentioned.

In such a situation an iterative method seems to be appropriated. Therefore we have decided to design a prototype bound to initialize an iterative participatory design method [3] involving end users.

2.3 Expected Functionalities of a Collaborative Tool

Without real requirements from practitioners, the first step of the design method is to draw up hypothesis on activity expectations. Hereunder are the ones identified during several interviews with practitioners:

- Allow diagnosis and decision (e.g. therapeutic choices) in a short time for each patient
- Reduce memory efforts by introducing persistency of context between meeting
- Combine in the same interface face to face communication and data sharing phases
- Maintain confidentiality of medicals information
- Allow connectivity both within the Hospital Information System (HIS) and outside
- Ensure compatibility across different HIS application formats
- Bring in the patient in the loop

Seeing that these requirements depend strongly on the efficiency and the acceptability of the user activity, we decided to focus our efforts on the Graphic User Interface (GUI) design. Especially we decided to explore the potentiality of VR technologies to improve the efficiency and the acceptability of collaborative tools. And in a second time we tried to find technical solutions about the infrastructure aspects.

3 Prototype of Collaborative Virtual Desktop for Decision Making

3.1 GUI Based on VR Technologies

We have noticed through several interviews with practitioner the wish to keep richness and expressiveness found in the co-localised working environment. This striking need lead us to investigate current studies that try to explore alternative design to the pervasive desktop paradigm (i.e. WIMP [4]) by using 3D. For instance desktops such as Task Gallery [5], Looking Glass (http://www.sun.com/software/looking_glass/), or more recently BumpTop [6] try to recapture real word capabilities to work with documents.

However these previous works don't take care of group activity. Thereof our approach consist not only in following existing works but also in taking into account collaborative decision requirements in the GUI design.

The main result of this work is a prototype of shared desktop developed upon a collaborative middleware [7]. It allows sharing medical contents such as DICOM pictures, office data format or 3D models of patients. Let us see how 3D technologies could contribute to bring closer a real and a virtual shared activity.

Hereunder two snapshots of the prototype's GUI (figure 1). The left snapshot shows a shared space of the desk (i.e. a public view). And the right snapshot shows a "private" point of view in which the user can see the shared space (i.e. right bottom corner of the snapshot) and is own working space. In the both view, documents are represented either opened by an applicative windows or by icons (i.e. partial data view). In the "public view" icons could be moved between a helical menu, a desktop or an auto-distorting visual display represented as half-circle wall. The principles are the same in the "private view".

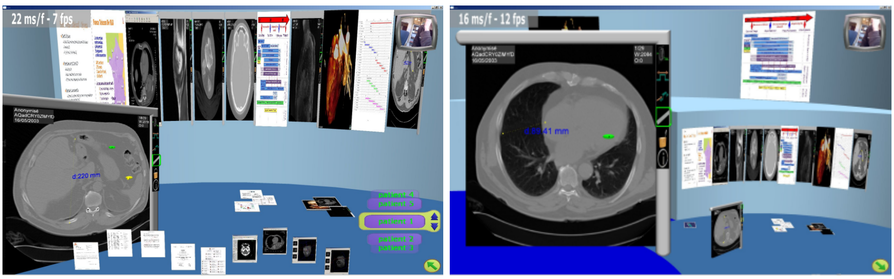

Fig. 1. CDSS user interface – Left image: public space; Right image: private space

Such a 3D dynamic space organisation gave us the opportunity of imagine new kinds of interactions. Various benefits in relation with practitioner's activity are expected from the following set of proposal:

Quick reminder. For each patient electronic record available in the public view, the spatial organization is get back as left at the previous meeting. We think that's a good mean to remind rapidly the patient context.

Optimized interactions. A new "drag and throw" technique is proposed in order manipulate document almost as quickly as in reality. It's a mean to avoid the time lost with the common windows interactions (i.e. close, minimize, etc.).

All patient electronic record at a glance. Data are represented on a dynamic helical menu. This new mean of setting data allows a direct interaction in a delimited display surface whatever the number of data and the number of hierarchical levels.

Smooth transition between a public and a private space. By the mean of a camera movement, user can extend is point of view between both public and private spaces.

Smooth transition between a face to face communication and sharing phases. A scalable display of users' videos allows focusing the activity either on the communication or on the study of the patient electronic records.

Allow exchanges between the private and the public spaces. The double view (private and public) allows a seamless functionality of uploading. This could contribute to a feeling of "non-computerized" activity, which could help to transpose real meeting habits.

3.2. Infrastructure and HIS compatibility

To preserve the benefit of a shared virtual desk approach, infrastructures issues should be "hidden" to end user, whether they are inside or outside the hospital. Thereby, Figure 2 proposes to integrate two network equipments: the HIS connector and a conference service. These equipments are designed to be integrated in common HIS architectures.

HIS connector. By the mean of a such kind of equipment, practitioners outside the HIS are able to upload or download patient electronic records in agreement with HIS security policy.

Conference service. All the data and the communication flow pass through this equipment. This kind of equipment could contribute to enhance planning decision meeting activity throughout new functionalities such as automatic staff report or dedicated data storage. Indeed data storage becomes increasingly a real brain-teaser for HIS administrator.

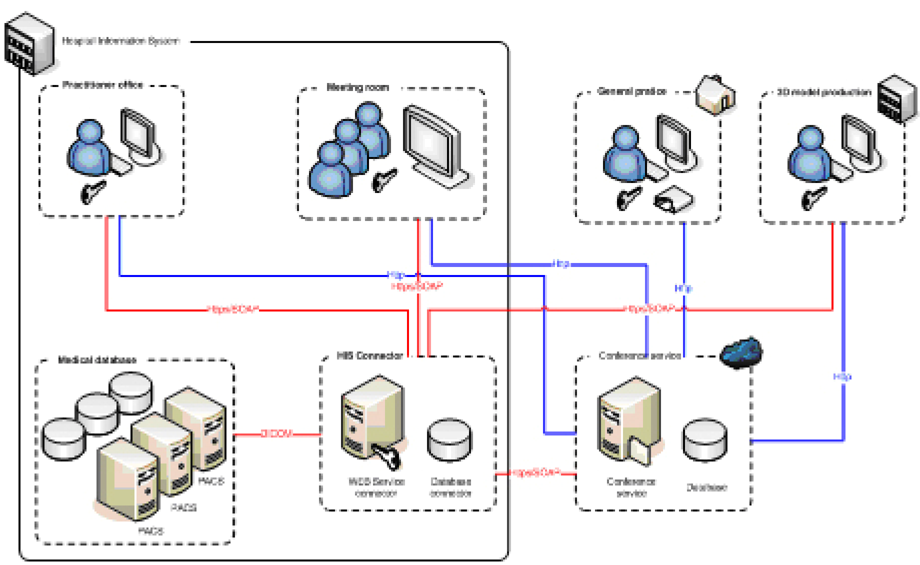

Fig. 2. Service architecture for distance activity

4 Discussion and Future Works

Throughout this study, we have catch sight of the activity's complexity. We have brought to light the profound reshaping needed by distance collaboration as well. But most of all we are now confident in the benefit of a suitable tool for surgical planning and decision making.

The main question we are now addressing is the value-added of our 3D GUI in comparison with common collaborative tools. Indeed our prototype seems to by efficient (i.e. reliability, compatibility with HIS data format, etc.) for a clinical experiment inside the hospital. However a lot of obstacles exist to evaluate and improve the concept of 3D collaborative desktop as CDSS for surgical planning.

Indeed, some practitioners are very reluctant to computerize their activity for performance or schedule reasons. What could be easy to understand. However clinical experiment requires the agreement of a whole team to give interesting results.

Given that the level of acceptability of our system is not easy to evaluate. In order to avoid an experiment breakdown, future works will focus on a participatory design method with small groups of practitioners. We intend to take things step by step. Firstly we will examine co-localised collaborations using the virtual desk as visual display support (e.g. using large tactile screen). And in a second time we will investigate distance collaborations upon patient electronic records previously studied by instance. Thanks to these methods we hope to answer the question of the suitability of a collaborative 3D desk.

5 Conclusion

We have designed a 3D collaborative virtual desktop dedicated to surgical decision activity. The system seems to by efficient regarding expected functionalities, technical reliability and compatibility with HIS aspects. We are now going to investigate a participatory design method in order to work on usability aspects and value-added of 3D GUI in comparison with common collaborative tools. In view of the fact this collaborative 3D desktop could not be only dedicated to CDSS for surgical planning, we will examine other use-cases such as mobility too.

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