

## **Thesis Proposal – In Situ**

### **Title : Remote Collaboration in Large Interactive Spaces**

#### **Context**

New interactive spaces such as wall-sized displays and large interactive rooms emerged in the past few years to help users deal with the increased complexity of the processes and masses of data managed by science, industry, business and society. Large interactive spaces offer new opportunities to manage extremely large and complex datasets and computations. For example, they can be used for analyzing scientific data, visualizing complex physical simulations, reviewing large CAD models of aircrafts or scheduling complex events. Large interactive spaces are also powerful tools to support creativity and can be used for brainstorming and combining ideas in the context of product design, artistic creation or crisis management.

Most of these tasks do not involve a single participant, but require a strong collaboration between groups of users in order to deal with complexity of the tasks and distribution of expertise. More often than not, the participants involved in a same task are not in the same location and need to collaborate remotely: remote experts want to analyze a common dataset together, a professor wants to teach remote students or remote artists want to create an artistic performance such as a concert with remote musicians. Even though these new practices emphasize the increasing need for remote collaboration, they are still poorly supported by current systems. Currently, collaboration support is mostly an add-on to existing tools, and as a consequence none of the above examples can be conducted effectively today. In particular, the existing systems enable users to see each other, but they do not enable users to easily share the same data or artifacts and to interact together with this shared content. This PhD thesis will explore new ways to support collaborative interaction within and across large interactive spaces in order to make true sharing and collaboration a fundamental feature of the digital world.

The thesis will be conducted in the context of the DIGISCOPE project. DIGISCOPE is an EquipEx project funded by the French national research agency (ANR). Its goal is to create a high-performance visualization infrastructure for collaborative interaction with extremely large datasets and computations. This infrastructure will consist of 9 interconnected interactive spaces such as large virtual reality systems, 3D display devices, and various wall-sized displays and interactive surfaces. Supporting remote collaboration between these interconnected interactive spaces is the main goal of DIGISCOPE. The project provides only funding for equipment, and is designed to foster research projects in interaction, visualization and collaboration. Consequently, this PhD thesis fits the context of DIGISCOPE perfectly and will use the platforms provided by the project. The thesis will be useful to researchers from other scientific disciplines who use the DIGISCOPE platforms for their own needs and therefore will lead to multidisciplinary collaborations.

#### **Work program**

The goal of the thesis is to create novel collaborative systems that support remote collaboration within and across large interactive spaces. These new systems will enable users not only to see each other as in standard videoconferencing systems, but also to share the content they work on, to act together on this content and to perceive nonverbal cues in order to support richer interaction and social presence (the feeling of “being together”). The thesis will explore both the case where users interact together within the digital world, e.g. collaborative interaction on the same datasets, and the case where users interact together in the physical world through the computer, e.g. remote design or fabrication of physical objects.

The work will be organized in three main tasks:

- Integrating suitable telepresence capabilities in large interactive spaces,
- Providing new ways to perceive rich communication cues in remote collaboration systems,
- Supporting collaborative interaction on shared content such as large datasets, documents or physical objects.

Adding telepresence capabilities to large interactive spaces is an open research question because users want to move around in the space. For example, displaying a static 2D window with the video of the remote users on part of a wall-sized display is not suitable for a user who interacts and moves in front of it. In particular, the acquisition of the video is challenging since the camera should follow the user. The thesis will focus both on the acquisition part (how to capture the video of the users) and on the restitution part (how to display the remote users in the visualization system). For the acquisition part, solutions such as an array of cameras or mobile cameras will be investigated. For the restitution part, solutions that accommodate users' movements and actions will be studied. Telepresence robots will also be considered.

Nonverbal communication cues are critical to human communication and to collaborative work. While some cues can be perceived in current telepresence systems through the visual feedback of remote users, others are missing, such as the sense of proximity (social vs. personal space) or rituals such as handshakes when starting a conversation. The student will explore how to overcome these missing situations in the digital world and study how new social conventions emerge in such remote collaboration settings.

The third main task of the thesis will focus on supporting collaborative interaction on shared content such as datasets, media or documents. Collaborative interaction includes direct manipulations of such content by several users, but also involves all interactions that enable users to communicate about the content: showing something to the others, annotating content, sharing viewpoints, etc. Here again, this is an open research question since, beyond simplistic screen sharing and document sharing tools, current systems do not support rich interaction on and about shared artifacts. In this thesis, the use of tangible interaction on the visualization display itself to enable users to organize and share content with remote users will be investigated in conjunction with purely software solutions.

The prototypes developed during the thesis will be implemented and evaluated for collaborative tasks between users located in the WILD room (<https://www.lri.fr/~mbl/WILD/>) and the new Inria WILDER room, both featuring large ultra-high resolution wall-sized displays. Then, they will be extended to other DIGISCOPE platforms, especially the nearby 3D immersive rooms of CNRS (EVE) and CEA.

The student will conduct both qualitative and quantitative studies with users to uncover specific user requirements and to evaluate the proposed solutions for remote collaboration.

## **Expertise**

Required skills:

- Experience in Human-Computer Interaction and designing interactive systems;
- Ability to design, conduct and analyze controlled laboratory experiments;
- Strong programming background, preferably in java and C/C++.

The following skills are a plus:

- Knowledge of web technologies (javascript and html5 programming);
- Experience with video processing (webcam or Kinect);
- Experience with motion tracking devices (VICON, ART).

## **Location**

InSitu lab, Inria & LRI (Univ. Paris-Sud & CNRS), bâtiment 650, Université Paris-Sud  
<http://insitu.lri.fr>

## **Advisors**

Michel Beaudouin-Lafon, Professor, InSitu, scientific director of DIGISCOPE – [mbl@lri.fr](mailto:mbl@lri.fr)  
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