RAVE-10 Abstract

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Social Experiment in Heterogeneous Mixed Reality Environments

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Abstract

This paper describes an experiment on social interaction within three heterogeneous mixed reality systems based at three separate locations. The experiments were conducted at three locations with heterogeneous systems:

1. University of Cambridge, where participants are tracked in a real environment using a 3D ultrasonic system (BatSystem, Figure 1). Remote participants can be viewed on a fixed computer screen in the alcove.
2. University College London, where participants are tracked in an immersive virtual environment system (CAVE™-like Immersive Projection Technology, Figure 2) comprising three 2.2 by 3m walls and a 3m by 3m floor. Each wall is projected in stereo. When viewed through lightweight shutterglasses, the left/right stereo images are presented separately to the left and right eyes respectively, producing the illusion of 3D objects appearing both within and beyond the walls of the CAVE.
3. Universitat Pompeu Fabra, where participants are tracked in an eXperience Induction Machine (XIM, Figure 3) using the pressure sensitive floor and overhead cameras, whereas remote visitors are interfacing to the virtual world over the network by means of a local client connecting to a VR Server..

Three participants, one in each system, collaborated on a three-person task that involves solving puzzles. The puzzle involves reading words from posters laid out in space. The task is designed to be difficult to complete on one's own, and thus it requires the participants to divide up the task. Dividing up the task can be done in a number of ways, but one common way is to divide up space so that each participant takes a different area; this then requires good communication of spatial position. Consequently, the experiment investigates how users of different heterogeneous systems communicate with each other through the technology that interfaces them. Furthermore, this paper describes the architecture of the middleware tracking framework, based around the Ubitrack/OpenTracker framework [1].

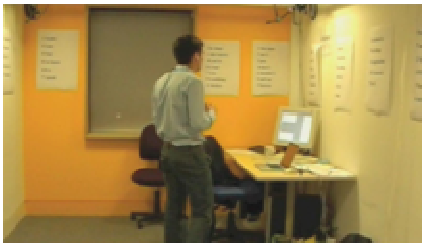

Figure 1: Real-world setup (BatSystem tracking)

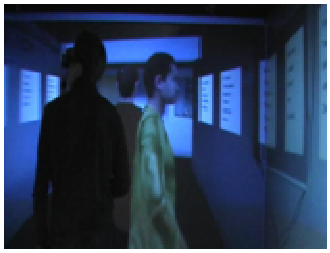

Figure 2: CAVE™-like IPT setup

Figure 3: XIM Setup

System Architecture

The architecture of the Ubiquitous Tracking (Ubitrack) Framework is shown in Figure 5. There is a single

centralised service called the Ubitrack Server, which is responsible for coordinating the flow of data and world state between clients. A client shares tracking events with its local DFG by communicating to all the other clients via their respective DFGs in a peer-to-peer fashion. To create the virtual world, a model is created in 3DS Max using high-quality photographs of DTG Space. The coordinate system is established and a map defined indicating origin and cardinal axes (Figure 4) to enable accurate representations of the room in the CAVE and the XIM.

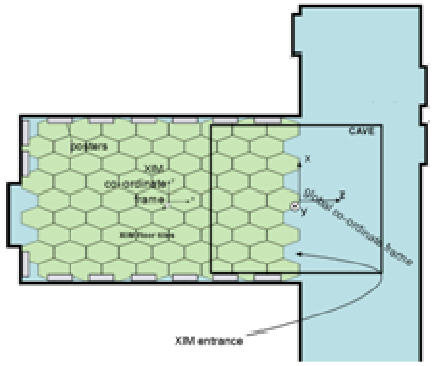

Figure 4:Mapping of Co-ordinate Systems (X_{min} = -1.5; X_{max} = 1:5; Z_{min} = -4.9; Z_{max}=2.4)

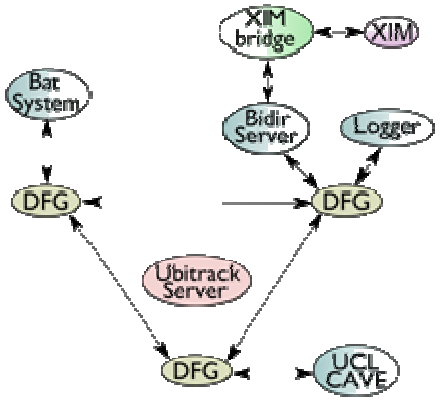

Figure 5: Architecture of the Ubitrack Framework

Experiment

Five participants were recruited at each site to make three groups of five (15 participants). The three users meet in the room that has a series of posters stuck on the wall. On each poster is a set of words or phrases each prefixed by a number. The participants have to rearrange all the words/part-phrases with the same number in order to form a witty saying. The task has been chosen because it requires collaboration between the participants since it is difficult for one participant to remember all the words in the complete phrase. Participants were instructed to work together to formulate the complete sentences.

Questionnaires, videos and logfiles were recorded with permission. A questionnaire was used to elicit information regarding user experiences, performance ratings, accord, presence and co-presence measurements. The intuitiveness of the system, the naturalness of control and interaction as well as the extent they felt present in each system was assessed. A summary of the results is presented in **Table 1**.

Table 1: Mean and standard deviation of the questions assessed.

	Age			English Fluency			Presence			
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Std. Dev.
CAVE	24	27	25.4	80	100	94	1	7	5.13	1.83
DTG	23	27	24.6	75	100	92.8	1	7	4.18	2.20
XIM	24	32	27.6	50	100	81.6	1	7	4.31	1.79

Participants' ability to perform the task successfully within the systems and the overall assessment of the presence questions were indicative of the success of the research. More statistical analysis is planned on the dataset acquired, in terms of task performance, space utilisation, video observations and further questionnaire analysis.

References

[1] Reitmayr, G., Schmalstieg, D., December 2005. OpenTracker – A Flexible Software Design for Three-Dimensional Interaction. Virtual Reality 9 (1), 79-92.