Studying the Features of Collaboration in the VirCa Immersive 3D Environment

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Abstract

Collaborative examination and use of shared documents often happens in a common physical space like in a tourist office. We developed a 3D immersive space to study collaboration on an information task in a virtual environment. In our paper, we present the qualitative results about cooperative work in the VirCA virtual environment. Our research is aiming to show that a 3D virtual environment can appropriately support collaborative information interpretation and sharing activities.

Keywords: Collaboration, Information search, Virtual Reality Cave, Observation

Introduction

Information-rich collaborative tasks can greatly benefit from tangible representations of information that the collaborators can easily share. However, sharing a physical space is often difficult and expensive when collaborators are distantly located. We set out to address this problem by developing a collaborative immersive 3D space with shared digital representations of documents.

We chose immersive 3D environments over 2D solutions for several reasons. First and foremost, we feel that 3D immersive environments can best replicate and improve on the advantages of shared physical spaces. Second, immersive 3D environments allow large amount of information to be displayed. 2D displays can also create high-density information displays, however, we assumed that more realistic 3D immersive environments would make it easier for users to browse, manipulate, interpret and use the information [5]. Third, a shared virtual space where both users are represented through avatars can help the users create common ground and would bring emotional commonality.

Shared virtual reality systems offer remote collaboration to geographically dispersed collaborators. Not only hearing but also seeing another person (or at least an avatar representing that person) will create a higher sense of presence, interpersonal trust and perceived communication quality [2]. The more realistic is the environment is the more effective is the spatial search [5,6]. Such collaborative virtual reality environments have been developed for various purposes. Among others, immersive 3D virtual environments can afford the shared viewing and manipulation of digital representations of documents in a common virtual space. An example of these systems and closest to our focus is VR VIBE [1], a collaborative virtual reality system in which users can browse and search web content in a 3D immersive space while at the same time seeing other users in the space using the same information. While we did not locate studies on collaborative information seeking tasks in immersive virtual reality, Raja and colleagues [7] found that immersive environments support individual information visualization tasks well. Our virtual space is similar to VR VIBE in its purpose and setup, however, our space supports the second half of the information process: the interpretation and use of information. Three important elements of our space are: 1) physical representation of information in posters; 2) user actions to manage these posters; 3) collaborative editing surface to create a new document based on the interpretation of the information contained in the posters. Typical actions necessary for the interpretation of are: reading, structuring and organizing, highlighting, commenting, and creating new content.

While immersive 3D environments have their challenges for users, such as disorientation and fatigue [8], they afford interaction patterns that are similar to shared physical spaces and thus they have the potential to support collaborative information tasks well. User interaction methods and information displays possess more flexible characteristics than physical spaces. In addition to physically moving and organizing information items, users can take advantage of digital capabilities, such as full text search, digital annotations, and different access levels for different users, exporting and importing digital formats, and so on. Another advantage of these spaces is that the number of documents, or information items, is theoretically limitless. The flexibility of the virtual environment allows users to browse, view, move, group, and annotate a large number of documents. While this is a great opportunity for users, designers have to carefully create the environments to make interaction natural and address the challenges of disorientation and fatigue for users of 3D immersive spaces.

The task and the environment are analogous to the real-life situation where travellers have to plan a trip in a tourist office. In a tourist office, information is displayed on the walls around the room in the form of brochures and posters. Tourists have to select, collect, and organize these pieces of information in order to make decisions based on them. Similar to a real tourist office, the virtual environment in VirCa (Virtual Collaboration Arena) [10] consists of the following: (1) Posters containing information on restaurants, sights, and events (see Figure 2 and 3). This information includes opening hours and addresses that are essential for the planning task. (2) A city map with numbers denoting the location of the restaurants, sights, and events from the posters. (see Figure 2). (3) Sticky notes that are note windows available for both collaborators to write in and attach to posters. (see Figure 3). (4) A jointly editable document where participants described their planned tour schedules. (see Figure 4). These objects were placed in a 3D room model that was accessed by the two collaborating participants. One participant was placed in a 3D Cave thus experiencing an immersive environment. The other participant joined the partner though a desktop computer that provided a less immersive environment. This mixed structure of Virtual Reality interfaces were designed to compare and analgise the features of information usage of collaborators and usability of interfaces in the future research similar to Tan, Gergle, Scupelli, & Pausch [9].

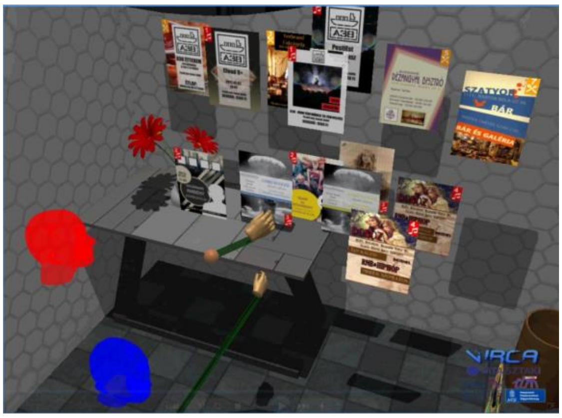

Figure 1. Collaborative review of the posters in the VirCA 3D cave.

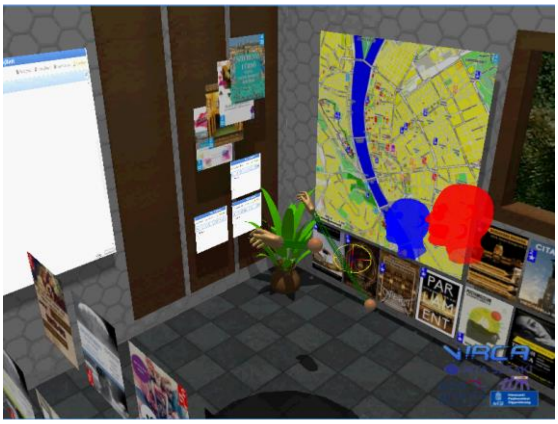

Figure 2. Avatars in the VirCA 3D cave

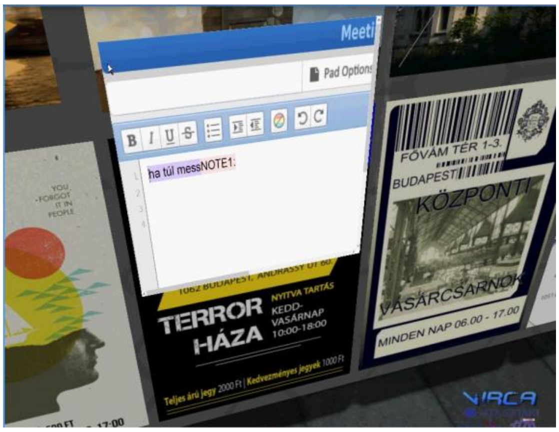

Figure 3. A sticky note in the VirCA 3D cave.

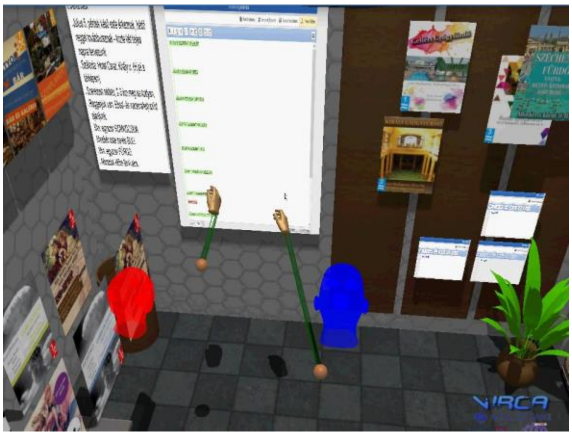

Figure 4. Collaborative editing in the VirCA 3D cave.

In this study, we aim to examine whether and how the 3D immersive environment can support a collaborative information management and use task analogous to a real world problem of planning tours of a city [3] in tourist office. This task serves as an example of joint document viewing and interpretation activities. In this paper we report the first descriptive results from an on-going larger study. As part of this research we are also exploring the usability of collaborative 3D virtual spaces based on our earlier work [4].

Method

Forty students (20 pairs) participated in the study. Participants were paired randomly; there was no matching of gender or age. In each pair, one participant was seated in front of a desktop personal computer (equipped with a Tobii T120 eye-tracker for further analyses not reported here), while the other was in the immersive 3D virtual cave.

Video recordings

Three video recordings were created from each session. One recording was a screen capture of the desktop participant’s view. Another recoding was from an external video camera capturing the other participant’s interactions in the immersive space. A third virtual and invisible “cameraman” was also used. This view was an invisible participant set up at a second desktop personal computer with a view into the virtual space. The viewpoint and thus the recording camera angle were controlled by one of the experimenters and were dynamically moved in the room to provide the best view on the interaction between the two participants. All three recordings contain the audio of the participants’ conversation. The third recording was selected for analysis purposes as it captured the movements of both participants in the space.

Task and procedure

After participants arrived at our location, they were introduced to the goals and procedures of the study and they signed consent documents. Next, they received a brief introduction to the virtual reality space and the interaction tools at their disposal. They had a chance to ask any questions they wished and practiced using the space for a few minutes. Before starting the task, the connection between the two locations (one with the desktop computer and the other with the immersive cave) was established and the participants were introduced to one another. The task in the study was to plan a schedule of tours for a foreign student group spending a weekend in Budapest, Hungary. This task is similar to the problem discussed by Crabtree and colleagues [3]. In order to create the plan, participants had to use information (tourist attractions, restaurants, opening hours and location) displayed on posters that were placed on the walls of the virtual environment (Figure 1, 2, 3, 4) The detailed instruction of the constraints of the two-day trip schedule was also placed on the wall of the virtual room as a reminder. The plan itself had to be written in a shared editable document in the immersive space (Figure 4). This task is natural and familiar for students, as they confirmed in their post-interaction interviews. The participant in the 3D cave had a Lenovo N5902 mouse and keyboard combined tool as an input device. The task started with an instructed practice phase in order to become familiar with the environment and the functions. Than after the task completion came that had no time limit. Right after participants declared that they have finished the task, they were interviewed about their experience. Participants also completed a test of mental rotation (Paper Folding Test), filled out a demographic and gaming/virtual reality experience questionnaire, and two satisfaction questionnaires, one about the quality of the collaboration and another about the usability of the space. Finally, participants were asked to report their familiarity with Budapest and especially the locations presented in the posters. As described above, in each pair, one participant completed the task in an immersive environment, while their partner at a desktop computer. The two participants could see each other as an avatar in the space (Figure 2) and communicate verbally through headphones. The avatar was represented as a head and an adjustable arm (Figure 4). The ethical committee of the university approved the experiments.

Qualitative results and discussion

Our initial review of the observation notes and the video recordings resulted in a qualitative description of the collaborative behaviours exhibited by our participants and a high-level usability analysis. These results are reported here as foundations of further structured analyses.

There were cooperative activities around three elements of the 3D cave: (1) around the map for determining the location of the sights and events proposed; (2) around the posters while collecting information, including collecting possibly interesting posters as it can be seen on Figure 1; (3) and around the editable document where the participants shared the task of writing the final schedule (Figure 4). These three elements were crucial to the problem at hand and our participants decided to collaboratively interacting with the elements by viewing them at the same time and using their avatar arms to point at the objects. These patterns demonstrate that even the limited avatars allowed for a shared experience similar to a real world physical space. These results are the first indications that this 3D virtual space indeed allowed effective collaborative management and use of documents.

Interestingly the participants did not use the highlighting function in order to emphasise certain posters, e.g., by priority. Instead they used spatial location to organise the events and sights: they usually collected the selected posters in one place and discussed them afterwards. The highlight feature is redundant because the avatars are able to communicate synchronously in real time by auditory and visual channels. Pointing and mentioning an object is much more natural than highlighting it.

One of the most frequent usability issue participants had was tied to typing. Most participants reported that typing seemed difficult and immersion breaking. Participants both in the cave environment and at the desktop computer reported this. Thus, this finding was not uniquely related to the wireless keyboard device, although that device was not familiar for most of our users. The issues regarding typing point to differences between virtual and real world interactions. In a virtual environment, the need to look down at a keyboard is extraneous and immersion breaking. One solution could be providing a virtual keyboard, where participants would be able to type with their hands. The other direction would be based on the usual type of interaction participants displayed in the virtual space, and that is direct graphical manipulation. The posters already contain all the information they possibly know about a certain event. Writing this information out into another medium is most likely not the most efficient way. Instead having them organize the posters themselves into a two-day plan might be less immersion breaking and more natural in a visual environment. In general we can conclude that the environment reached that level of resemblance to reality that could serve the collaborative problem solving. According to the findings of Meijer and colleagues [5] the highly realistic virtual environment supports navigation and tasks inside them we conclude that the tourist office setting was realistically modelled in the VirCa. This is supported by the interviews also where none of the participants mentioned that the environment was hindering, or unrealistic.

Conclusions and future work

In our paper, we presented preliminary qualitative results about cooperative work in the VirCA virtual environment that mixed the cave and the desktop interfaces in this phase. We found that users successfully completed a collaborative information management and use task and exhibited effective collaborative behaviours. We identified three usability problems and described possible solutions to them. In the further phases of experiments in VirCa environment we may apply these solutions. Through these results we have shown that collaborative information seeking and used tasks can be successfully supported in shared virtual environments. We plan to provide further and more detailed evidence in our continued analysis of the data based on eye tracking analysis and sequential analysis of actions observed.

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