Presence in Shared Virtual Environments and Virtual Togetherness

Abstract

This Forum article discusses the relationships among people, their avatars, and their virtual environment workstations in a shared virtual environment. It introduces the notion of togetherness, the sense of people being together in a shared space, which is the counterpart for shared VEs to the presence of an individual in a VE. The role of tactual communication is emphasized as being fundamental to togetherness.

1 Introduction

The subjective sense of presence has received substantial attention from engineers, computer scientists, and psychologists concerned with virtual environments, teleoperators, and human-machine interfaces. (See, for example, Draper, Kaber, and Usher (1998) and the references cited in that article.) Important unresolved issues concerning presence include the definition of presence, the methods of measuring presence, the identification of factors creating (or destroying) presence, and the relation of presence to task performance.

In this note, we ignore these unresolved issues and focus instead on a topic closely related to the sense of presence—namely, the sense of being with other people in a shared virtual environment or, equivalently, the sense of *togetherness.* This topic is not only of theoretical interest; it has great practical importance. Telecommunication companies would probably invest billions of dollars to know how to artificially effect this sense of togetherness, and airline companies would probably do likewise to prevent this knowledge from being discovered. This notion of togetherness, which is assumed to have varying degrees of realization, is taken as the fundamental variable of interest in this work.

A diagram illustrating the complexity and richness of the context in which togetherness in a virtual environment should be considered is shown in Figure 1. It is assumed in this diagram that there are three human participants (S1, S2, and S3), each with his or her own VR station (VR1, VR2, and VR3) and avatar (A1, A2, and A3).

In the simplest case, each avatar is totally guided by the corresponding human; that is, the avatars have no autonomy whatsoever, and the human ''driver's'' viewpoint is that of the corresponding avatar. To the extent possible, the avatar functions as the driver's body in the virtual world. It is also possible, however, for the avatars to be only partially guided, (to exhibit some degree of autonomy) and / or for the viewpoint to be displaced from the avatar. This was used, for example, by Vilhjálmsson (1997), who created avatars that exhibited a degree of autonomy in the BodyChat system. Avatars representing their driving humans carry out low-level activity such as breathing and blinking to give an impression of life. Also, however, the avatars could be put into a state of being available or not available depending on whether the driving human wished to enter into conversation with others in the virtual environment. Depending on this state, the avatars would autonomously negotiate with others that might be met. At an appropriate moment, the driving human would be able to engage in a successfully negotiated chance for a conversation with someone else who also happened to be in the available state.

In general, each human participant will interact with and develop a relationship with his or her own avatar,

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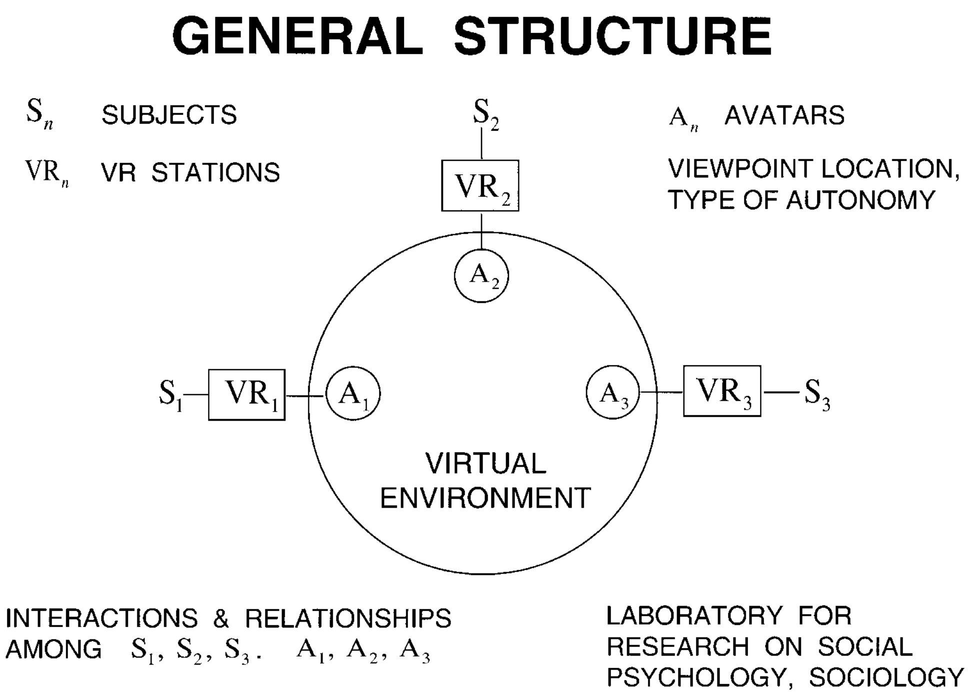

Figure 1. *General structure of relationships in a shared VE.*

with the other avatars, and with the other humans. Clearly, the kinds of structures possible in such a system provide a very fertile ground for research in the areas of sociology and social psychology, as well as psychology. The multifaceted relationships between VR and psychology, both experimental and clinical, are discussed in Glantz et al. (1997). Comments on the relationships between VEs and sociology and social psychology are included in Schroeder (1997) and, more recently, in Kollock and Smith (1999).

In the following paragraphs, unless stated otherwise, we assume for the sake of simplicity that the avatars have no autonomy and that the viewpoint of each human participant (in all sensory modalities) is that of the corresponding avatar. Also, we focus in these paragraphs on two topics that we believe are directly relevant to creating a sense of virtual togetherness: the sense of being present in a common virtual environment, and communication among participants in a common virtual environment. In considering the latter topic, special attention is given to haptic interactions among the participants.

2 The Sense of Being Present in a Common Environment

For a number of individuals to feel present in a common environment, they obviously must both share a common environment and have a sense of presence in the place depicted. Presumably, the criteria for establishing a common environment are essentially the same as the criteria for defining a common environment in the real world. That this problem is not entirely trivial, however, is indicated by the extent to which individuals with different backgrounds, interests, viewpoints, and sensitivities can be exposed to the same physical environment and yet come away wondering ‘‘what world is that other person living in?’’ In principle, one could measure the extent to which the synthetic worlds experienced by the different individuals (S1, S2, and S3 in the figure) via their VR stations (VR1, VR2, and VR3) constitute a common world by examining the extent to which each individual judges these worlds to be common when they are rotated sequentially through the different VR stations. The task of developing a model for predicting subjective ''degree of commonality'' on the basis of the properties of the VR stations and the worlds experienced through these VR stations would clearly be a challenging one.

Given that the virtual environment is perceived as a common one, the extent to which the participants feel present in this common environment will depend on the same factors that determine presence in individual virtual environments that are not shared by the participants. Thus, for example, the literature has reported high graphics-update rate, low latency, wide field of view, and high degree of interactivity as some of the factors that contribute to a high sense of presence (for example, Barfield & Hendrix (1995)). Because the environment is shared, however, additional factors will be relevant. In particular, it seems likely that the sense of presence in a shared virtual environment will be increased by fostering interactions with the environment in which alterations of the environment caused by actions of one participant are clearly perceived by the other participants. Even more potent might be interactions with the environment in which the environmental changes are not only perceived by many or all of the participants, but are also the result of collaborative work on the environment by the participants. Thus, for example, the sense of presence in the common environment (and thus the sense of togetherness) might be enhanced by rearranging heavy furniture in the virtual environment which requires cooperative lifting by the participants.

3 Communication Among Participants in the Common Virtual Environment

The sense of togetherness in the common virtual environment will obviously be enhanced by the extent to which rich, multimodal, real-time, intraspecies communication takes place. The main form of intraspecies communication—speech—carries both abstract and emotional information and is easily made available to the participants of the shared virtual world. The only problem with this is that people are so accustomed to this form of virtual togetherness from ordinary telephone usage that its importance often tends to be ignored.

The visual communication that takes place via facial expression and body posture also plays an important role in the real world. However, its use in the shared virtual world is more problematic. In particular, one must choose between the use of direct, pass-through video of the participants (comparable to the use of microphones to sense the participants' own voices in the speech-communication case) and the use of special sensing systems to extract the relevant visual information about the participants, and the use of special algorithms to generate the appropriate expressions and postures for the avatars (comparable to the use of speech analysis and synthesis systems for creating artificial speech). If one chooses the former approach, then one is faced with the problem of appropriately blending the video output with the graphical images while maintaining correct occlusion. (Apparently, this problem is much greater in the visual domain than in the auditory domain, in which the task of blending real sounds with synthetic sounds is relatively easy.)

Perhaps the channel with the greatest potential for enhancing the sense of togetherness in shared virtual worlds is the tactual channel. Our belief that this is in fact the case is based on two factors.

First, it appears that touching and manipulating objects in virtual environments increases the general sense of presence. Although few, if any, experiments have been conducted specifically to test this notion, it is consistent with the well-known importance of the role played by interaction in creating a sense of presence, a variety of anecdotal reports on the impact of haptic experiences in virtual environments, and our own personal experiences in this area. A recent study has added support to this view (Basdogan et al., 1998). In addition, this idea seems reasonable on theoretical grounds. Touch is not, like audition and vision, a ''distance sense.'' In the natural world, one must be very close to an object in order to be able to touch it. Furthermore, whereas technology has provided all of us with substantial amounts of past experience in hearing and seeing events and objects in the real world at supernormal distances via the telephone and television, it is only recently that one has been able to extend one's ability to touch and manipulate objects at supernormal distances via teleoperators. Both of these features suggest that touching and manipulating objects in virtual environments is likely to increase one's sense of presence.

Second, beyond increasing the general sense of presence, the sense of touch obviously plays a unique and important role in human interaction. Touching is not only closely linked to sexual activity and to notions of closeness and intimacy, but, as evidenced in our language, is often used as a metaphor for emotional impact (''I was really touched by her story''). Furthermore, as evidenced in the research on social touch, touching plays a role, albeit sometimes subliminal, in a much wider variety of social transactions than is ordinarily appreciated (see, for example, Lewis et al. (1997) and Nilsen and Vrana (1998)). In general, it seems clear that the inclusion of touching in shared virtual environments will strongly increase the sense of togetherness.

Given that this is the case, the question then arises as to which aspects of touch are the most important to include or, from the viewpoint of VR interface design, in what ways will the sense of togetherness in shared virtual environments depend on the type of haptic interface employed? For example, to what extent can the potential increase in the sense of togetherness be realized by haptic interfaces based solely on vibratory or electrocutaneous displays? To what extent can it be realized solely by the use of force feedback without such displays? To what extent are both interface components needed? More generally, what is the most cost-effective haptic interface for increasing the sense of togetherness in shared virtual environments, and how is the answer to this question influenced by the events taking place in the auditory and visual channels?

With respect to the last question, it should be noted that substantial subjective / emotional reactions can be elicited by representations of touch in the visual sense. Even when avatars are highly simplified and cartoonish, substantial reactions occur when these avatars are seen to touch each other. In the study by Slater et al. (2000), subjects were found to be truly upset when their avatars were seen to pass through each other (due to the absence of adequate collision detection). In general, the strength of reactions to visually perceived touch between avatars raises questions about the added value of haptically perceived touch by the human participants. At present, our knowledge in this area is very limited.

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