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Social Presence: The Role of Interpersonal Distances in Affective Computer-Mediated Communication

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Abstract

Emotions and interpersonal distances are identified as key aspects in social interaction. A novel Affective Computer-Mediated Communication (ACMC) framework has been developed making the interplay of both aspects explicit to facilitate social presence. In this ACMC framework, the displays can be arranged in virtual space manually or automatically. We expect that, according to empirical findings, the social relation as well as momentarily affective appraisals will influence this arrangement. The proposed concept extends from desktop devices to fully immersive Virtual Reality interfaces.

Introduction

A major question driving computer-mediated communication (CMC) research is how to facilitate an experience of social presence which resembles those found in face-to-face social interactions.

In social interactions, social relationships are found to be reflected in spatial behavior, e.g. when maintaining interpersonal distances [1]. Interestingly, these findings hold true even when encountering agents in Virtual Environments, where no direct physical presence is experienced [2].

In the PASION project we are investigating ways to increase the social presence users experience in CMC. We thereby augment existing CMC solutions in an approach that could be coined affective computer-mediated communication (ACMC). Recently we suggested interactive social displays (ISDs, Figure 22) as a concept for an ACMC user-interface [3]. ISDs augment traditional communication channels with affective cues derived from sensory input such as facial expressions, pupil size or psychophysiology.

Our investigations up to now focused on the question of how the displays are augmented by presenting information, e.g. about the affective state of the interlocutor, at the display, e.g. using audio, video or graphs. However, inspired by the aforementioned findings, here we want to pose a different

Figure 22 The ISDs in the immersive Virtual Reality set-up. Interlocutors are represented by scroll-like panels floating in the air. The layout of the ISDs can be arranged by the user

question: *What, if the display's position is used to convey, e.g., the affective state or the social relationship?*

A small example might help to illustrate the principle idea: Imagine a user being engaged in a discussion with a personal friend represented by a specific ISD. The initial location of the display is thus established within the personal area of the user. As the discussion develops, the tension increases. The ACMC solution detects the negative emotions in the face of the interlocutor and tries to act appropriately: the ISD is moved away from the user to reduce emotional and social stress. This could help to reduce the tension within the situation and thus provide active affective support. In another situation, the user herself might change the position of the interlocutor's display. Such spatial interactions could tell the system something about the current attitude of the user towards the interlocutor. Besides direct interactions, similar inferences might be drawn from the distance the user tries to preserve towards individual displays.

A non-exhaustive background will be given, before we go into more detail about the concepts of the ACMC framework and how this concept can be realized on different target platforms, such as desktop computers or Virtual Reality systems. We also show pictures of a realization of the concept on a HoloPro™, a very interesting Mixed Reality device with touch functionality. We then conclude with a discussion of the ACMC concept.

Related Work

Emotions are essential for social interaction in the real world. In virtual communication scenarios, however, our possibilities are restricted when it comes to expressing emotions, identifying the emotions of the interlocutor or reacting adequately to them. An adjustment of the spatial layout of interlocutors' displays in reaction to their current affective state, either manually or automatically, could further improve social presence. Relevant contributions that could inform this line of research are from research on social presence, emotional closeness, and physical co-presence as well as research regarding similar approaches in computer-supported cooperative work.

Social Presence

Social presence describes the profoundness of the sensation of being engaged in a social interaction [4]. Rüggenberg and colleagues identified emotional closeness, physical co-presence, behavioral contingency, and mutual attention as the four main dimensions contributing to social presence [5]. We are mainly interested in the interaction between the dimensions emotional closeness and physical co-presence, as we seek to identify user preferences in the spatial arrangement of ISDs either based on long-term relationships or as a reaction to the current affective state.

Physical Co-Presence

In CMC physical co-presence can only be mediated. A profound model for the interaction between social interaction and the spatiality of physical presence has been introduced by E.T. Hall [1] with his proxemics model. It investigates the reception and use of different spatial areas in human-human interaction. Especially in a conversation the distance between talking people is important for their reactions and behavior. But are these rules transferable to a mediated communication scenario? Various studies have found that they are. More precisely, social and emotional immersion is assumed to be very similar to the real world both in terms of content-based and formal properties of information presentation.

The similarity of content-based aspects of proxemics in real and virtual situations is shown by Friedman, Steed, and Slater [2]. They analyzed spatial social behavior in the game Second Life™ by Linden Lab and found out that also the content of interaction causes spatial distances of the avatars which resemble those in real life, which indicates that people project their behavior into the virtual world.

Emotional Closeness

Social relationships are established by iterated social interactions over a long-term period. Users will therefore enter a specific CMC session with a certain disposition towards the interlocutors. Then, during such a short-term interaction, these dispositions will be modified by the affective dynamics of the session to a degree depending on the experienced emotional closeness.

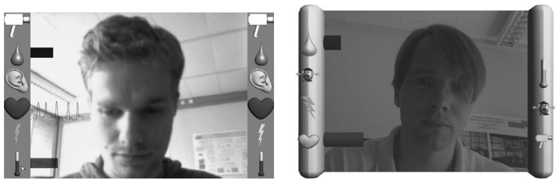

Figure 23 The ACMC display concept is portable from desktop to mixed and fully immersive Virtual Reality scenarios (left: desktop version, right:

Results from Reeves and Nass [9] as well as from Lin, Imamiya, Hu, and Omata [10] show formal properties like larger display size and field of vision of the user lead to better subjective and objective emotional immersion. The larger the situation is presented to a person the smaller the distance appears and this reinforces the impression of being involved [10]. Especially the size of presented faces and their transferred emotions have a great effect on the reception of the user. Closer proximity (bigger presentation of faces) leads to better reception, because closer users receive more attention and are more highly valued [9].

Interpersonal distances thus also affect the emotional closeness that can be experienced in a CMC session.

Interpersonal Distances as a Measure

Humans convey their emotions in their verbal and non-verbal behavior. Measuring these behaviors could provide essential information, e.g. about the current feeling of presence of users, in a non-obtrusive way. Typical measures are prosody, eye gaze [6, 7], body language or gestures and proxemics. Bailenson, Aharoni, Beall, Guadagno, Dimov, and Blascovich [8] show differences in spatial behavior towards virtual agents of different status. However, they did not find a direct correlation to well-established questionnaire ratings for co-presence.

We follow this idea of unobtrusive measurements of presence that would allow user interfaces for ACMC to react in a timely fashion and in a way that fosters social presence in the ongoing interaction. Interpersonal distances and their dynamics within a session could be such a measurement.

The ACMC Framework

Our presumption is that the social presence users experience will be positively affected if they can adhere to established behavioral patterns. We thus believe that social presence can be facilitated by enabling users to adopt and maintain interpersonal distances in ACMC that resemble those they would adopt in social face-to-face interactions.

The ISDs are the central part of our ACMC framework. They represent participants in a mediated communication situation [3]. The framework targets multi-party conferences with audio, video and augmentations – cues that represent indices derived from sensory measurements.

The basic idea is that all incoming and outgoing channels of a single participant are anchored at a single ISD with a specific location in space. The visual appearance of the ISD is that of a scroll (Figure 23). The main area of the ISD provides room for displaying graphs, images and video content. The handles can be used for positioning, orienting and resizing the scroll. In addition they provide buttons for enabling/disabling individual channels.

For the following discussion, we want to skip the questions about how measurements are performed technically, as well as how the data is transmitted and how cues are presented. The essential presumption is that the user should at least be enabled to estimate the affective state of the interlocutor. Instead we want to focus on the interaction of the user with the spatial distances of the displays. Specific implementations of the ACMC framework will thereby exhibit different capabilities to realize at least an impression of spatiality and we will discuss three such implementations, for the desktop, for Mixed Reality and for Virtual Reality.

Some of the concepts are currently difficult to realize in physical devices. Working prototypes, though, have been realized for desktop computers (Figure 23), immersive Virtual Reality environments (Figure 22 and Figure 23) and for a Mixed Reality setting on the HoloPro™ device (Figure 24). The HoloPro™ is a semi-transparent touchscreen with back-projection developed by G+B pronova GmbH.

Maintaining Interpersonal Distances in ACMC

There are at least three different but not exclusive ways to establish a comfortable interpersonal distance between users and ISDs in an ACMC scenario.

Firstly the user can change her own position towards the display. This approach can be applied to almost all settings, unless the displays need to be held by the user (e.g. with mobile phones), the interaction space for the user is limited (e.g. in a CAVE™) or the user is engaged in a multi-party conference where it may be impossible to satisfy all constraints for interpersonal distances between interlocutors.

Secondly the user may manually alter the position of individual displays. This approach solves the problem with multi-party conferences that altering the position of the user affects the distances to all displays at once. However, it may be restricted by physical constraints, e.g., there is in principle only a single depth-plane in desktop systems. Thus other ways have to be found to provide at least the impression of depth/distance, and we will enumerate some possibilities later on when we discuss the desktop interface.

Figure 24: Example interaction with the HoloPro™ prototype: the right ISD is sent to the back with a tap of a finger (perspectively correct for the user's view, however not for the camera taking the picture)

Thirdly the system itself may be enabled to maintain specific interpersonal distances. Again, this approach is restricted to specific settings, e.g., it seems difficult to be realized on mobile phones. However, it is quite attractive, as it could provide a realistic and lifelike feedback to the user and increase social presence.

Although we are specifically interested in following the third approach, as it is the most challenging, we also acknowledge that we might not do without the others. On the one hand we will need data on the preferences of users regarding the interpersonal distances to inform the algorithms. On the other hand it is well known that one user's liking is the other's disliking and thus viable alternatives should be provided.

At this point it should be clear that enabling the user to follow the first two approaches, self-placement and manual placement, could facilitate more than the experience of an increased social presence. The actions the users perform to establish and maintain interpersonal distance within the ACMC framework can be used to infer the preferred interpersonal distance between users. The changes in distance can also be correlated with other sources, such as information about the affective state of the interlocutor, to derive a model for the dynamics of these interactions.

In the following, we want to discuss ways to support the adoption of interpersonal distances on different platforms.

Conveying Distances on Desktop Systems

As a desktop system we consider an off-the-shelf workstation. Special purpose workstations equipped with 3D hardware, such as shutter-glasses or autostereoscopic displays, to convey stereo impressions of distances, we count as Virtual Reality systems (see section 3.4).

Only the self-relocation approach for maintaining interpersonal distances is directly applicable in desktop ACMC systems. While horizontal and vertical arrangements of the ISDs on the computer screen are possible, moving them in depth is not – at least with common desktop user interfaces. However, there are technical means to create an impression of depth that can be applied; most of them have been developed in the context of 3D computer graphics: zooming/scaling in or out (Lin, Imamiya, Hu, and Omata [10] on the effects this may have) and occlusions might be the strongest, others are blurring or fog of depth. If motion capturing technology, e.g. via webcam or the Wii™ remote, is available, motion parallax can be used as a strong depth cue. For this, all ISDs are moved contrarily to the movements of the user; the more distant an ISD is supposed to be, the less it is moved.

While we already have an implementation of a prototype of the ACMC framework for desktop computers, we have so far not implemented depth cueing to mediate interpersonal distances. By cooperation with the ZMMS in Berlin, we had access to a more advanced display system: the HoloPro™. Besides this we used a CAVE™-like immersive Virtual Reality installation in our own lab. We thus concentrated our investigations on those systems, as they provide a higher level of immersion and we expect larger effect sizes. Nevertheless, we are planning to transfer and test our findings to the desktop platform in the future.

Conveying Distances on the HoloPro™ System

The HoloPro™ system is a transparent projection surface supporting single-touch interaction. In our set-up, we cascaded a HoloPro™ system with a normal projection surface (Figure 24) to provide two levels of depth: one, the HoloPro™ system, within intimate or personal space, depending on the position of the user, and the other at social space. This allows us to switch the ISDs between two interpersonal distances. The projections are set up to be at eye level and the interlocutors can be presented life-sized. This system is quite appealing, as it is robust and not obtrusive, i.e. there is no tracking technology that has to be attached to the user.

In addition to this, the haptic interaction with the touchscreen offers a straight forward way to implement the second approach, the manual arrangement of the ISDs: the user is able to alter the distance of an ISD by tapping on the corresponding area on the touchscreen.

Conveying Distances in a Virtual Reality System

Immersive Virtual Reality systems (Figure 22) provide the most degrees of freedom for positioning the ISDs. A stereo projection system based on polarized light in combination with an optical tracking system allows for a realistic 3D impression. The ISDs can be placed anywhere in space manually, both within the interaction area of the user on this side of the projection surfaces and beyond. With our multimodal interaction interface, the user is able to grasp the ISDs and position them at her desired interpersonal distance. The Virtual Reality system also has the largest screen space and thus allows for a presentation of a large group of ISDs.

The flexibility of this system comes at a number of costs. Besides financial aspects, the optical markers for the tracking system and the glasses for the projection system constitute obtrusions the users have to accept.

Conclusions

Maintaining interpersonal distances is a strong social behavior. It is so strong that it can be found even in Virtual Realities where physical laws not naturally pertain. The degree to which this behavior is expressed by users of an ACMC system could be a viable indicator for their experience of social presence. Moreover, providing an ACMC system with capabilities to support and maintain interpersonal distances could also facilitate the experience of social presence.

We presented our concept of an ACMC framework that is aware of interpersonal distances and described how these distances can be conveyed on different target platforms. The appeal of the concept is its simplicity: the ISDs are easy to realize and compatible with existing teleconferencing standards (SIP, H323). In contrast to conferencing solutions which provide a shared virtual environment, such as SecondLife™, the presented approach can be integrated in existing workspaces.

An interesting idiosyncrasy of the presented approach is that in contrast to real-life or shared virtual environments, the ACMC framework allows for an asymmetric representation of interpersonal distances: users can arrange the ISDs according to their own desire. The same pair of interlocutors could therefore arrange for quite different interpersonal distances on their local sites.

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References

[1] E. T. Hall, *The Hidden Dimension*. New York: Anchor Books, 1966.

[2] D. Friedman, A. Steed, M. Slater. Spatial Social Behavior in Second Life. *LNCS: Intelligent Virtual Agents*, 4722, 252–263. 2007.

[3] T. Pfeiffer, M. E. Latoschik. Interactive Social Displays. In: *Proceedings IPT-EGVE 2007, Virtual Environments 2007, Short Papers and Posters*, 41–42. 2007.

[4] F. Biocca, J. Burgoon, C. Harms, M. Stoner. Criteria and scope conditions for a theory and measure of social presence. In: *Proceedings of the 4th International Workshop on Presence*, URL: http://www.temple.edu/ispr/prev_conferences/proceedings/2001/papers.htm. Philadelphia, USA. 2001.

[5] S. Rüggenberg, G. Bente, N. C. Krämer. Virtual encounters. Creating social presence in net-based collaborations. In: *Proceedings of the 8th International Workshop on Presence 2005*, 97–102. London. 2005.

[6] R. Vertegaal. The GAZE groupware system: mediating joint attention in multiparty communication and collaboration. In: *Proceedings of the SIGCHI conference on Human factors in computing systems, CHI '99*, 294–301. May. 1999.

[7] J. Gemmell, K. Toyama, C. L. Zitnick, T. Kang, S. Seitz. Gaze Awareness for Video-Conferencing: A Software Approach. *IEEE MultiMedia*, 7, 26–35. 2000.

[8] J. N. Bailenson, E. Aharoni, A. C. Beall, R. E. Guadagno, A. Dimov, J. Blascovich. Comparing Behavioral and Self-Report Measures of Embodied Agents' Presence in Immersive Virtual Environments," in *Proceedings of the 7th Annual International Workshop on Presence*, 216–223. Valencia, Spain. October 2004.

[9] B. Reeves and C. Nass, *The Media Equation*. Stanford: CSLI Lecture Notes, 2003.

[10] T. Lin, A. Imamiya, W. Hu, M. Omata. Display Characteristics Affect User's Emotional Arousal in 3D Games. *LNCS: Universal Access in Ambient Intelligence Environments*, 4397, 337–351. 2007.