Haptic communicative functions and their effects on communication in collaborative multimodal virtual environments

Jonas Moll[1], **Eva-Lotta Sallnäs Pysander**[2]

[1]*Department of Information Technology, Uppsala University*

[2]*Department of Media Technology and Interaction Design, KTH Royal Institute of Technology*

evalotta@csc.kth.se

Technology mediated haptic communication has been studied for decades. In the beginning, special hardware devices, like e.g. the HandJive (Fogg et al., 1998) and the Shaker (Strong & Gaver, 1996), were designed for very specific tasks and narrow purposes. In the beginning of the 21st century this situation changed when collaborative functions for haptic communication started being used in multimodal virtual environments for e.g. joint object manipulation (Sallnäs et al., 2003; Kjölberg and Sallnäs, 2002; Sallnäs et al., 2000) and as a complement to a shared text editor designed by Oakley et al. (2001). The haptic devices used in all these studies were the nowadays widely known Phantom devices. The use of these functions in virtual environments enabled the study of when and why users choose to use haptic functions to communicate. In the case of the shared text editor the functions could e.g. be used to move to the other user's position or drag the other user to one's own position in the shared interface, which was much larger than the screen size.

Two specific functions for haptic communication we have been studying in our research on collaboration in multimodal virtual environments (see e.g. Moll (2013), Sallnäs and Zhai (2003) and Sallnäs et al. (2000)), are a function for holding on to the same virtual object and a function for holding on to each other's avatars. The first function is realized through virtual rubber-bands which are created between a virtual object and the respective avatars when the users grasps and lift an object by pushing a button on the Phantom device handles. As long as both users are holding on to the object, they feel each other's pushing and pulling forces through the rubber bands. The second function is realized by a magnetic force between the two avatars, created when the Phantom button is pushed at the same time as the avatars are in close proximity. This function can be compared to virtually holding hands.

Both these functions have been shown to affect collaboration and most of all the communication between a sighted and a visually impaired user, during collaborative problem solving, in a number of different ways (Moll and Sallnäs, 2013; Moll et al., 2012). For collaborative problem solving, between visually impaired and sighted users, that involves moving objects to work efficiently and in a way that involves both users a common ground about the shared work space and the task solving process is vital. We have showed that haptic communicative functions can indeed be used to develop the necessary common ground and include both the visually impaired and the sighted user in all parts of the task solving process. The most important effect is that these functions make it possible for one user, often the sighted one, to guide the other to different places in the virtual environment. This guiding action has been shown to substitute for verbal communication in that complex verbal directions are not needed to communicate about navigation - all relevant information is provided through the haptic channel, making navigation a lot more efficient. For example, while using communicative haptic functions to navigate and move objects together, deictic references like "here" and "this one" were commonly used and almost completely replaced the need for series of navigation directions like "up, up, no too much, go down again…". We have also shown that this, in turn, makes the dialogue more goal focused, since all participating pairs focused their discussions on objects and task solving instead of navigation.

We argue that for effective collaboration and communication to take place in virtual environments by means of haptic feedback the haptic functions need to be designed as to allow for reciprocal exchange of information. That is, both users need continuous feedback from each other during e.g. a guiding process or joint object handling. This can be seen in contrast to e.g. the "forced" haptic functions used by Oakley et al. (2001), mentioned above, by which one user is dragged to a location without being able to communicate anything, haptically, to the other user or in any means affect the movement.

References

Fogg, B.J., Cutler, L.D., Arnold, P., and Eisbach, C. (1998). HandJive: a device for interpersonal haptic entertainment. *Proceedings of the SIGCHI conference on Human factors in computing systems (CHI'98)* (Los Angeles, California, April 1998). pp. 57-64.

Kjölberg, J., and Sallnäs, E-L. (2002). Supporting Object Handling and Hand Over Tasks in Haptic Collaborative Virtual Environments. *Proceedings of Eurohaptics 2002* (Edinburgh, UK, July 2002).

Oakley, I., Brewster, S., and Gray, P. (2001). Can you feel the force? An investigation of haptic collaboration in shared editors. *Proceedings of Eurohaptics 2001* (Birmingham, UK, July 2001). pp. 54-59.

Strong, R., and Gaver, W.W. (1996). Feather, scent, and shaker: supporting simple intimacy. Proceedings of CSCW'96 (Boston, Massachusetts, November 1996). pp. 29-30.

Moll, J. (2013). *The influence of Modality Combinations on Communication in Collaborative Virtual Environments*. Doctoral thesis, School of Computer Science and Communication, Royal Institute of Technology, Stockholm.

Moll, J., Huang, Y., and Sallnäs, E-L. (2010). Audio makes a difference in haptic collaborative virtual environments. *Interacting with Computers (22; 6)*. pp. 544-555.

Moll, J., and Sallnäs, E-L. (2013). A haptic tool for group work on geometrical concepts engaging blind and sighted pupils. *ACM Transactions on accessible computing (4; 4).* Article 14.

Sallnäs, E-L., Rassmus-Gröhn, K., and Sjöström, C. (2000). Supporting presence in collaborative environments by haptic force feedback. *Transactions on Computer-Human Interaction (7; 4)*. pp. 461-476.

Sallnäs, E-L., and Zhai, S. (2003). Collaboration meets Fitts' law: passing virtual objects with and without haptic force feedback. *Proceedings of the IFIP TC13 International Conference on Human-Computer Interaction (Interact 2003)* (Zurich, Switzerland, September 2003). pp. 97-104.