Multimedia Interaction Interfaces in Collaborative E-learning Environments

[1] Organization

Leader: *Noriyuki Matsuda* (Faculty of Systems Engineering, Wakayama University, Japan)

Representatives at RIE: *Kamen Kanev & Hiroshi Inokawa* (Research Institute of Electronics, Shizuoka University)

Participants:

Hirokazu Taki (Faculty of Systems Engineering, Wakayama University, Japan)

Hidetoshi Nonaka (Graduate School of Information Science and Technology, Hokkaido University, Japan)

Julita Vassileva (University of Saskatchewan, Canada)

Michael Jenkin (Department of Computer Science and Engineering, Faculty of Engineering, York University, Canada)

Magdalina Todorova (Department of Computer Science, Faculty of Mathematics and Informatics, Sofia University, Bulgaria)

Karen Collins (Canadian Centre of Arts and Technology at the University of Waterloo, Canada)

Bill Kapralos (Faculty of Business and Information Technology, University of Ontario Institute of Technology, Canada)

Andrew Hogue (Faculty of Business and Information Technology, University of Ontario Institute of Technology, Canada)

Sanshiro Sakai (Department of Computer Science, Faculty of Informatics, Shizuoka University)

[2] Progress of the Research

This cooperative research project explores possibilities for combining expertise from different research and fostering the design and development of innovative interfaces and environments for e-learning based on natural interaction paradigms that are adjustable to the needs of specific user groups. Smart table computer interactions have been identified as a main vehicle of this project and sound interface design for smart tables was addressed in (1) where users position themselves around a horizontal computer screen and a combined audio/vision-based interface is employed for sound source and user tracking in real-time.

We are currently focusing on the application of horizontal versus vertical-screen placement for collaborative activity and our research includes the following four areas: i) the use of video games to conduct usability tests on several spatial sound (amplitude panning) techniques and thus examine their effectiveness, ii) the collection of reference data for audio-visual table top displays, iii) incorporating visual cues in audio-visual interactive displays and examining the interaction of audio and visual cues in enhancing the user experience, and iv) localization (head tracking) for auralization in acoustic tabletop displays.

In two experiments conducted by the Canada-Japan research team, virtual sound sources were spatialized over a tabletop display surface using a bi-linear interpolation (see [3]). In the first of the two experiments, four loudspeakers were arranged one at each at one of the four table corners in a standard Quadraphonic arrangement (the loudspeakers faced inwards towards the surface of the table). Sounds were spatialized to a location on the surface of the table using a bi-linear interpolation amplitude panning method whereby sound was panned between loudspeaker pairs (see [3]). For each trial of the experiment, the sound was spatialized to correspond to one of 25 pre-defined locations on the surface and the participants' task was to localize the sound. Results of the experiment revealed that the method is prone to varying error across individuals particularly for the virtual sound source positions that are closest to the participant (user). For the positions resulting in the largest error (those closest to the participant), it was hypothesized that the error was due to the fact that the two loudspeakers were facing away from the participants. The second experiment was conducted to test this hypothesis and was similar to the first experiment except that the loudspeakers were "flipped" upwards so that they emanated sound in an "upwards" direction thus ensuring that there are no loudspeakers facing away from the participants. However, the results of the second experiment did not support the hypothesis.

A series of further experiments are scheduled to collect "ground-truth" data with respect to sound source localization on a surface and such data will allow us to compare the results of our previous experiments and draw meaningful conclusions (for example, if the "ground-truth" experiments reveal

that a large sound source localization error then it may not be worth pursuing other amplitude panning methods and techniques). To gather the "ground-truth" data, small (physical) loudspeakers will are placed facing upwards at each of the 25 virtual sound source locations examined in the previous experiments. The experiment will involve participants localizing sound source positions but rather than using amplitude panning to spatial a sound to one of the 25 virtual sound source positions, a sound will be out from the corresponding loudspeaker instead. Since the sound will emanate directly from the position of interest via an actual loudspeaker at that position, any errors cannot be a result of the amplitude panning method. This will allow us to quantify the errors that the previous two experiments revealed. Construction of the physical apparatus is conducted in Japan, led by Dr. Kanev and supported by Canadian visiting researcher Mr. Hodge. An application for an "Invitation Fellowship Programs for Research in Japan" (offered by the Japan Society for the Promotion of Science) has also been submitted by Canadian researcher Dr. Michael Jenkin. If awarded, Dr. Jenkin will visit Shizuoka University for one month in the summer to further support the ongoing "ground truth" experiments. On the Canadian side, Dr. Karen Collins and Dr. Bill Kapralos are developing a number of audio-only video games that can be used to examine the effectiveness (through user-based experiments) of the previously developed amplitude panning techniques for the table-computer. Experiments will be carried out in both Canada and Japan.

[3] Results

(3.1) Research results

The interaction between sound and image plays an important role in instructional software. For instance, multimodal information (i.e. sound and image) can increase or decrease cognitive load, depending on whether or not information is redundant. Furthermore, it is known that presenting information in multi-modes (when they do not conflict with each other) helps a user to overcome misinterpretations, improve memory, and respond more quickly. But new technologies present new problems when it comes to the use of multiple modalities. We are exploring ways (see 1-4) to test emergent and disruptive technologies that we anticipate will be particularly important in future learning experiences (i.e. smart tables).

To enhance this research, two other grants (through Canadian organizations) were applied for, including one large-scale Social Sciences and Humanities Research Council of Canada, Partnership Grant that would include members from around the world in a larger research network to explore the role of new technology on immersion and learning.

(3.2) Future work

We continue to add more members to our project to enhance our research, and to report obtained results at international conferences on a regular basis. We have discussed arranging for exchange students between Japan and Canada to train these students in cooperative research projects and in communication skills in addition to the specifics of the technology, methods, and practice. Dr. Collins has already sent one student over for one month, and we anticipate further exchange.

We are currently revising our research plan based on our preliminary findings, including exploring new methodological approaches to the integration of sound and image.

Our next stage is to explore the ability to spatialize sound in relationship to an image on a horizontal and vertical screen. We have already determined how to run experiments, and we are in the process of building appropriate screens.

[4] Publications

(1) Collins, K., Kapralos, B., Kanev, K., Smart Table Computer Interaction Interfaces with Integrated Sound, *The Journal of Three Dimensional Images*, Vol. 24, No. 3, 2010, pp. 58-67.

(2) Collins, K., Kanev, K., Kapralos, B., Using Games as a Method of Evaluation of Usability and User Experience in Human-Computer Interaction Design, In *Proceedings of the 13th Int. Conf. on Humans and Computers HC'10*, Aizu-Wakamatsu, Japan, December 8-10, 2010, pp.5-10.

(3) Lam, J., Kapralos, B., Collins, K., Hogue, A., Kanev, K., Amplitude Panning-Based Sound System for a Horizontal Surface Computer: A User-Based Study, In *Proceedings of the International Symposium on Haptic Audio-Visual Environments and Games*, Phoenix, AZ. USA, October 16-17, 2010, pp.174-178.

(4) Collins, K., Kapralos, B., Hogue, A., Kanev, K., An Exploration of Distributed Mobile Audio and Games. In *Proceedings of the ACM FuturePlay 2010 Int. Conf. on the Future of Game Design and Technology*, Vancouver, British Columbia, Canada, May 6-8, 2010, pp.253-254.

Traveling report

Name: Karen Collins
Affiliation: Canadian Centre of Arts and Technology at the University of Waterloo, Canada
Period of time: December 3, 2010 – December 12, 2010
Destination: Shizuoka University, Japan
Purpose: *(Please see the description in the bottom of the page)*
Name of receiver: Prof. Kamen Kanev

Name: Bill Kapralos
Affiliation: Faculty of Business and Information Technology, University of Ontario Institute of Technology, Canada
Period of time: December 3, 2010 – December 12, 2010
Destination: Shizuoka University, Japan
Purpose: *(Please see the description in the bottom of the page)*
Name of receiver: Prof. Kamen Kanev

Name: Hidetoshi Nonaka
Affiliation: Hokkaido University, Japan
Period of time: February 20, 2011 – February 23, 2011
Destination: Shizuoka University, Japan
Purpose: To discuss the research and project organization, to schedule future work, and to make a presentation entitled "Prototyping of Non-planar Multi-touch Interface".
Name of receiver: Prof. Kamen Kanev

Name: Michael Jenkin
Affiliation: York University, Canada
Period of time: March 1, 2011 – March 8, 2011
Destination: Shizuoka University, Japan
Purpose: To discuss the research and project organization, to plan publications, and to participate in a collaborative research seminar organized at RIE with a presentation entitled "Building and Interacting with Models of Complex 3D Environments"
Name of receiver: Prof. Kamen Kanev

Name: Alexander Hodge
Affiliation: University of Waterloo, Canada
Period of time: February 1, 2011 – March 11, 2011
Destination: Shizuoka University, Japan
Purpose: To build a smart table for research experiments and to further address various hardware and software issues.
Name of receiver: Prof. Kamen Kanev

The purpose of the visit of Dr. Collins, Dr. Kapralos (December 2010), and Dr. Jenkin (March 2011) was three-fold:

- For Dr. Karen Collins and Dr. Bill Kapralos to attend the Humans and Computers 2010 conference and present two research papers including a paper outlining the research being conducted by Dr. Karen Collins, Dr. Bill Kapralos (Canada) and Dr. Kamen Kanev (see [2]). In addition, Dr. Collins provided a keynote address/presentation during at the start of the conference.

- To further build upon and expand the research collaborations between the University of Waterloo, the University of Ontario Institute of Technology (UOIT), and York University which are in Ontario, Canada and the Research Institute of Electronics, Shizuoka University, Japan. This included i)

developing a research plan, ii) discussing the details of future experiments to be conducted both in Japan and Canada, and iii) discussing future grant opportunities. Funding opportunities included working on a Notice of Intent for a large Social Sciences and Humanities Research Council of Canada Partnership grant (led by Dr. Karen Collins and includes Dr. Kamen Kanev and Dr. Bill Kapralos amongst other investigators), and also on an application for an "Invitation Fellowship Programs for Research in Japan" (offered by the Japan Society for the Promotion of Science) by Canadian researcher Dr. Michael Jenkin (this was submitted January 2011 and if awarded, Dr. Jenkin will visit Shizuoka University once again for one month in the summer of 2011).

- To discuss potential collaborations beyond research and more specifically, the development of a student exchange program between Shizuoka University and the university of Waterloo and UOIT. To facilitate this, Dr. Kanev has applied for Adjunct Professor status at UOIT. This will allow him to co-supervise Canadian (UOIT) students and makes the process of establishing formal university relations (exchange programs) easier.