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Collaborative Interprofessional Education for Critical Care Teams with Augmented E-Learning Environments Engaging Advanced Imaging Devices

[1] Organization

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[2] Progress of the research

The purpose of the 2014 Cooperative Research Project (Research Institute of Electronics, Shizuoka University), titled *Collaborative Interprofessional Education for Critical Care Teams with Augmented E-Learning Environments Engaging Advanced Imaging Devices* was to continue and expand upon an ongoing collaborative research initiative between researchers from several institutions in Japan and Canada that is examining various aspects of novel display technologies including tabletop computing displays, that will be used to develop interactive and engaging virtual simulation and e-learning applications. In addition to their use in education and training, the developed virtual simulations and e-learning applications will also be used as test-platforms to easily examine the effect of simulation realism/fidelity and multi-modal interactions on learning.

Within the scope of the current funding, our work focused on the design and development of an innovative, unique, strategy-based, learner-centered, interactive, display system that combined a tabletop computing device with mobile devices (tablets, smartphones) to provide a novel system capable to facilitating a learner-centered approach to simulation-based, interprofessional medical-based education (IPE) (see [3] for a discussion on the use of virtual simulations and serious games for health professions education and training). We focused on the application of the developed system for anatomy education but the system can be used for a wide variety of training applications including those intended for interprofessional education (that will be examined in future work). In addition to the development of this unique tabletop-tablet system, within the scope of the project, an experiment was conducted that examined audio-visual interactions (and more specifically, the effect of sound on visual realism perception). The results of this experiment brings us closer to developing an understanding of simulation realism/fidelity and the effect of multi-modal interactions on learning

Below is a summary of the progress made during this funding period.

1. Developed a novel tabletop display that incorporates mobile devices (e.g., tablets, mobile phones), to facilitate deliver learner-centric

education whereby the instruction is customized to each learner, accounting for their prior knowledge level, etc.

2. An experiment was conducted that examined audio-visual interactions and more specifically, the effect of sound on visual realism perception within a cel-shaded virtual environment.
3. An international workshop was held at Shizuoka University where a number of researchers from Japan, Canada, Brazil, and Colombia participated and presented their work related to virtual environments.

[3] Results

(3.1) Research results

Below, greater details regarding the three areas of progress over the last project year are provided.

(3.1.1) Development of the Novel Tabletop-Tablet System for Learner-Centric Education

Tabletop computers (also known as surface computers, or smart tables), allow users position themselves around a horizontal computer screen in a manner similar to sitting around a "traditional" table allowing multiple users seated (or standing) around the computer display interacting with the display itself. Tabletop computers naturally promote interaction amongst users, providing an engaging environment and making them an appealing option for applications beyond entertainment. They allow for the opportunity to develop novel and unique interaction-based applications across a wide variety of areas. Tabletop computers/displays when coupled with a mobile device (e.g., tablet or mobile/smart phone) provided to each of the users may provide an effective physical infrastructure for promoting learner-centered medical education whereby the information presented to each user is customized to each user to account for their level of learning (e.g., beginner, intermediate, advanced) and presented to them on a as-needed basis. This can present novel learning opportunities in areas such as teaching human anatomy to medical students.

Although tabletops naturally promote multi-person interaction and collaboration, on their own, they do not allow for the individualization of the presented content; in other words, all of the users will see the same thing. This is particularly problematic when considering educational applications where the learners may have varying educational backgrounds and experience. To overcome this problem, our current work has coupled the use of virtual reality, tabletop, and tablet/mobile display technologies and has thus developed an innovative, system to support learner-centric anatomy education and training. Our system includes a tabletop computer where a "global" view of an anatomical model is provided (the model can be the entire human body or one or more body parts). This global view is available to all of the users (instructor and students/trainees) and each of the users can interact with it via the touch-sensitive tabletop display surface.

Figure 1. Conceptual overview. Rendered image of a human body on the tabletop display. The trainee is able to obtain a personalized view of the patient's heart on their personal tablet even though the heart is not visible on the tabletop display (global view).

Although useful, the tabletop display and the supported interactions do not facilitate learner-centric education where the instruction is tailored to each individual learner and accounts for their prior knowledge level, background and learning styles. As outlined in Figure 1, with our system, in addition to this "global" view, each of the users (instructor and students) makes use of a mobile device (e.g., tablet or mobile/smart phone) that is synchronized with the global view but is able of providing each user with an individualized ("local") view of the scene displayed on the tabletop. Now, in addition to the global view, users can manipulate the local view to obtain further information. For example, a novice user may choose to view a labeling layer of the global view to label the key components of the anatomical model being displayed while a more advanced user can choose to view further anatomical information that includes more specific features than what is presented in the global view.

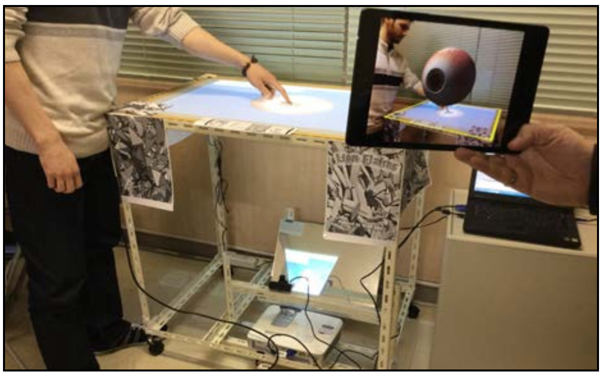

Figure 2. Overview of the actual system.

Figure 2 provides an actual view of our system. The tabletop was constructed completely “in-house” at Shizuoka University as part of our prior work that investigated a number of issues with tabletop displays including presentation of spatial sound [1].

Although our system will be applied to facilitate a simulation for interprofessional education of medical teams, currently we are focusing on the eye and its anatomy only to simplify the application while we develop the hardware and sort out potential issues. Our system can be used to represent any body part (or any 3D model whether it be related to the human body or not), but there are good reasons to focus on the eye and apply our system to ophthalmology education and training. More specifically, the discrete anatomy of the eye’s intricate oculomotor system is conceptually difficult for novice trainees to grasp and this can be very problematic given that this group of muscles is one of the most common sites of clinical intervention in the treatment of a variety of eye disorders. Furthermore, despite the presence of the several existing simulators that do allow for 3D viewing (described below in greater detail), the majority of ophthalmic simulators demonstrate the equipment setup and three-dimensional image perception within a two-dimensional viewing environment and thus do not simulate the three-dimensional nature of the eye and its structure. This leads to problems for the trainee with respect to depth perception and spatial awareness, both of which are very important given that that the manipulation of instruments within the eye involves distances that are microscopic. It is critical that ophthalmologists learn in three dimensions.

Currently, we have developed a functioning prototype at Shizuoka University. Development of the system was led by Dr. Michael Jenkin (York University, Canada) and included team members Dr. Kamen Kanev (Shizuoka University, Japan), Dr. Bill Kapralos (UOIT, Canada and JSPS Visiting Research Fellow), and Dr. Alvaro Uribe (Mil. University, Colombia), as well as graduate students Robert Codd-Downey (York University, Canada; supervised by Dr. Jenkin) and Robert Shewaga (UOIT, Canada; supervised by Dr. Kapralos). Both of the graduate students were funded by Dr. Jenkin and Dr. Kapralos to visit Shizuoka University for one week to explicitly work on this project.

Development on the system is continuing and we are currently preparing a manuscript outlining the construction of the novel tabletop-tablet display. The manuscript will be submitted for consideration to the *International Conference on Artificial Reality and Telexistence* (ICAT), which is being held in Kyoto, Japan, October 28-30, 2015.

(3.1.2) Audio-Visual Interaction Experiments

In our previous studies, visual quality was defined with respect to texture resolution, polygon count, or blurring of the scene (to approximate texture resolution). However, there are many ways to define a virtual visual scene and many ways to define visual quality. Here, we have chosen to define visual quality primarily with respect to levels of cel-shading (also known as toon-shading), a popular 3D rendering technique that attempts to recreate the look of traditional 2D animation with the use of flat colors to light 3D surfaces in an unrealistic way. Using cel-shading instead of photorealism (as commonly done within virtual simulations and serious games) can save game developers both time and money. More specifically, cartoon style environments and characters generally require less surface detail than photorealistic settings, thus leading to significant reductions in development time and rendering (computational) resources (cel-shading is relatively simple to implement for real-time rendering). Animated cartoons are often shaded using a discrete number of color values or brightness levels as sharp lines are easier to animate than smooth gradients.

Results showed that sound does influence visual quality perception in some cases and more specifically, when the auditory cues provided are not contextually related to the scenario/environment at hand. Results also showed that the gray scale visual condition reduced participants’ task completion time; participants performed the task faster when compared to the other visual conditions that included color. Whether or not this reduction in completion time impacts knowledge retention has yet to be determined. Noise distracts in both simulations and real-life operating theatres. While this suggests that we can increase learning through reducing distractions, we can also use such distractions in a simulation to train surgeons to focus during distracting moments.

These findings are important to serious game designers and developers and to the gaming industry in general. They must carefully consider the use of sounds within their games and understand that sound can have an effect on the visuals and intended visual effects. The results of this experiment were recently submitted to an IEEE referred conference [8].

(3.1.3) 2015 Serious gaming = Serious Business International Workshop

The rising popularity of video games has seen a recent push towards the application of video game-based technologies to teaching and learning. Serious games, that is, games with a primary purpose of education and training as opposed to entertainment, take advantage of the power of computer games to captivate and engage players/learners for a specific purpose. The widespread use of serious games can be observed within an array of educational and training settings (e.g., health professions education, emergency response and disaster management training, patient education, business training, amongst others), particularly given the current generation of learners who are growing up spending a large amount of time playing video games. In fact, according the French consulting company iDate, as of 2010, serious games represented a US$1.5 billion dollar market globally and it has been suggested that the market will increase ten-fold, becoming a US$15 billion global industry in 2015. Not only do serious games provide a cost-effective training alternative to many existing training approaches, they also present a large business potential.

During this year of the project, we organized the *First International Workshop on Serious Gaming = Serious Business* (SG=SB 2015), an international workshop dedicated to serious gaming, virtual simulation, and the corresponding business implications. The workshop was held in conjunction with the Humans and Computers (HC-2014) conference chaired by Prof. Muira from Shizuoka University, Hamamatsu, Japan. The venue provided an opportunity for the demonstration and study of the ways in which virtual simulation, serious games, and gaming technologies are transforming the educational and business landscape. It provided a platform for disseminating innovative research and development work on game, entertainment, media technologies, and related cost-effective business solution, applying lessons learned, and developing new ideas through audience interaction.

The workshop was held on March 5, 2015 at Shizuoka University and saw a number of presentations made from various researchers across the world including Canada, Brazil, and Colombia who visited Shizuoka University specifically for the workshop.

(3.2) Future Work

We are continuing to build-upon and expand our Japan-Canada collaboration. More specifically, we are continuing to develop our novel tabletop-tablet system and once we finalize all of the minor issues that still need to be sorted out, we will conduct a series of user-based experiments to examine its effectiveness in facilitating learner-centric interprofessional education with medical trainees.

We will also continue our work that is examining spatial sound and multi-modal interactions with tabletop computers in addition to the work we recently started that involves the use of spatial sound and augmented reality for toy-based computing (an article outlining this work will appear in an edited book [2,4].

[4] Publications

(1) A. Dubrowski, B. Kapralos, K. Kanev, and M. Jenkin. Interprofessional critical care training: Interactive virtual learning environments and simulations. 7th International Conference on Intelligent Technologies for Interactive Entertainment, June 10-12, 2015, Torino, Italy. Short paper – Works-in-progress. Submitted March 2015.

(2) P. Hung, K. Kanev, M. Jenkin, and B. Kapralos. Augmented reality (AR) toys. In *Technologies of Inclusive Well-Being*. In P. Hung (Ed.), Mobile Services for Toy Computing, Springer, to appear 2015.

(3) B. Kapralos, F. Moussa, and A. Dubrowski. An overview of virtual simulations and serious games for surgical education and training. In *Technologies of Inclusive Well-Being*. In A. Brooks, S. Braham, and L. Jain (Eds.), *Springer Series Studies in Computational Intelligence*, Heidelberg, Germany, Chapter 14, pp. 289-306, 2014.

(4) Kapralos, K. Kanev, and M. Jenkin. Spatial sound for virtual and augmented reality environments: Problems, limitations, and implications for mobile devices, In P. Hung (Ed.), Mobile Services for Toy Computing, Springer, to appear 2014.

(5) J. Lam, B. Kapralos, K. Kanev, A. Hogue, and M. Jenkin. Sound localization on a horizontal surface: Virtual and real sound localization. Virtual Reality, Special Issue on Spatial Sound in Virtual and Augmented Reality. Submitted February, 2015

(6) J. Lam, B. Kapralos, K. Collins, A. Hogue, and K. Kamen. Amplitude panning-based sound system for a horizontal surface computer: A user-based study, *ACM Computers in Entertainment*, 12(2), Article 4, 2014.

(7) S. de Ribaupierre, B. Kapralos, F. Haji, E. Stroulia, A. Dubrowski, and R. Eagleson. Healthcare training enhancement through virtual reality and serious games. In M. Ma, L. Jain, and P. Anderson (Eds.), *Virtual, Augmented Reality and Serious Games for Healthcare 1*, Springer-Verlag (to appear 2015)

(8) D. Rojas, B. Cowan, B. Kapralos, K. Collins, and A. Dubrowski. The effect of sound on visual quality perception and task completion time in a cel-shaded serious gaming virtual environment. 7th International Workshop on Quality of Multimedia Experience, Messinia, Greece, May 26-29 2015.

(9) M. Tawadrous, A. Hogue, B. Kapralos, and K. Collins. An interactive in-game approach to user adjustment of stereoscopic 3D settings. In *Proceedings of Stereoscopic Displays and Applications XXIV*, February 3-7, 2013, San Francisco, CA, USA, pp. 1-6.

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Traveling Report

None