Experiments with collaborative blended-reality laboratory technology for distance learners

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Abstract. Traditionally laboratory work for distance learners has been limited to video recordings, simulations using software interfaces and other solutions that restrict the possibility of interaction with real equipment and collaboration with other learners. In previous work we proposed a different approach using mixed-reality to enable collaborative laboratory activities. This paper presents preliminary results on the user evaluation of our proposed conceptual model and architecture, thereby extending our previous progress towards the creation of a blended-reality distributed system for educational uses.

Keywords. Mixed reality, blended reality, virtual laboratory, xReality objects, Multi-user virtual environment (MUVE), constructionism.

1. Introduction

In previous papers [1], [2] we proposed an innovative conceptual model and architecture to interconnect multiple mixed-reality learning environments based on a distributed computing architecture, allowing bidirectional communication between environments, smart objects and users; managing multiple dual-reality states and creating blended-reality spaces. Blended-reality can be defined as a space "*where the physical and the virtual are intimately combined (blended not merely mixed)*" [3]. The goal of the proposed architecture is to enhance laboratory activities for distance learners based on a constructionist perspective [4].

Each blended-reality learning environment is formed by 3 components:

- The **physical world**, where the user and the xReality objects are situated. xReality objects [1] are smart networked objects coupled to a 3D virtual representation of them; creating a dual-reality state that is updated and maintained in real time.
- The **virtual world**, where the real-world data will be reflected using 3D virtual objects.
- The **inter-reality portal**, a human-computer interface (HCI) able to receive, and process in real-time data generated by the physical environment, so it can be mirrored by its virtual counterpart, thereby linking both worlds.

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2. User evaluation

User evaluation took place with 52 students from Essex University (UK), Anglia Ruskin University (UK), Leon Institute of Technology (Mexico), San Diego State University (USA), Shijiazhuang University (China), Shanghai Open University (China), Etisalat BT Innovation Center (UAE) and Monash University (Malaysia) between March and May 2015. The study used a sample of students pursuing different academic degrees (PhD 23.08%, Master degree 40.38%, Postgraduate certificate 9.62%, Undergraduate degree 26.92%) and different courses, ranging from Computer Science (69.24%) and related subjects such as Electronic and Electrical Engineering, to Learning Design and Technology (21.15%) and a broader range of topics (9.61%) (e.g. Economics, Linguistics, Politics, Graphic Design, etc.). The laboratory activity undertaken by students was to create as a team, a set of IF-THEN-ELSE behavioural rules to control a shared xReality object using the 3D virtual interface. After the trial, participants' views were collected using an online survey and the data was analysed using Statistical Analysis System (SAS). Preliminary results showed that 88.46% of participants found it easy to use the proof-of-concept implementation and 76.92% of participants answered that the blended-reality principles were not difficult to them to understand. User's reasons given for not using the technology were related to interface design issues, worries about Internet reliability, and team communication issues. Overall, the users' comments were positive, explaining that they enjoyed the experience and 80.77% answered they were very likely to use the technology if it was available to them in their schools and universities. These preliminary results show that user's acceptance towards the use of blended-reality and xReality objects in collaborative laboratory scenarios open up new opportunities for collaboration and development, which aims to provide real benefit for distance learners.

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References

[1] A. Peña-Rios, V. Callaghan, M. Gardner, and M. J. Alhaddad, "Interactions within Distributed Mixed Reality Collaborative Environments," in *10th International Conference on Intelligent Environments*, Shanghai, 2014.

[2] A. Pena-Rios, V. Callaghan, M. Gardner, and M. J. Alhaddad, "Remote mixed reality collaborative laboratory activities: Learning activities within the InterReality portal," *Proc. IEEE/WIC/ACM Int. Conf. Web Intell. Intell. Agent Technol. Work. WI-IAT 2012*, pp. 362–366, 2012.

[3] K. Hoshi and J. a Waterworth, "Tangible Presence in Blended Reality Space," *Interfaces (Providence)*. pp. 1–10, 2009.

[4] S. Papert, I. Harel, and B. S. Papert, "Situating Constructionism," *Constructionism*, vol. 36, pp. 1–11, 1991.