In the International Symposium on Ambient Intelligence 2011, Salamanca, Spain, 6th - 8th April 2011 (ISAMI'11), Springer-Verlag, Advances in Intelligent and Soft Computing ISSN 1867-5662

Social Presence in Immersive 3D Virtual Learning Environments

Minjuan Wang[1], Sabine Lawless-Reljic[1], Marc Davies[2], Victor Callaghan[2]

[1]San Diego State University & University of San Diego (U.S.)

[2]University of Essex (U.K.)

mwang@mail.sdsu.edu, sabinereljic@yahoo.com, midavi@essex.ac.uk, vic@essex.ac.uk

Abstract: Ambient Intelligence (AmI) has historically addressed the interaction of people with computer controlled physical worlds. More recently, there has been interest in their virtual counterparts, such as Second Life in which humanoid avatars interact with each other and their worlds in ways that are analogous to our relationship with the physical world. Virtual and physical worlds can have complex relationships ranging from either each augmenting the other, to the provision of services, such as eLearning. Virtual-Reality extends eLearning environments (eg regular audio, video, and text,) by enabling abstract concepts and entities to be given tangible forms within the virtual world. Also, students and teachers take the form of avatars allowing them to employ avatars to establish their social presence in a wide variety of ways. This paper introduces two popular virtual reality tools, presents a comprehensive review of the literature related to social presence and describes our practical work in progress towards constructing a mixed reality iClassroom.

Keywords: social presence, virtual learning environments, Second Life

1 Introduction

Ambient Intelligence (AmI) describes environments in which intelligent computer processes mediate and enhance the interaction between people and technology. Initially the focus was on controlling physical environments but more recently there has been interest in their virtual counterparts, such as Second Life which are mirrors of the physical world based on 3D dimensional *multiple-user virtual environments* (MUVE). Such online immersive systems have their roots in earlier simulation and games technology and represent the convergence of the internet, social networking, simulation, and online gaming. Online applications are becoming increasingly social, offering multiple-participant options and social implications as typified by social networking games (e.g. World of Warcraft and Final Fantasy) and smart classrooms (e.g. the SJTU "Natural Classroom" [1]). The growing importance of online virtual environments is illustrated by reports such as that from Gartner, Inc. analysts [2], which predicted that "80% of internet users will be active in a virtual world by the end of 2011" and by the Pew Foundation which reported that "97% of teens play computer, web, portable, or console games" and that their gaming experiences "include significant social interaction and civic engagement" [3].

In the International Symposium on Ambient Intelligence 2011, Salamanca, Spain, 6th - 8th April 2011 (ISAMI'11), Springer-Verlag, Advances in Intelligent and Soft Computing ISSN 1867-5662

Another trend in virtual worlds is to provide more intelligent and engaging characters and environments together with more social iteration and an increase in user-generated content, effectively strengthening the users' sense of ownership and belonging in the environment [4].

2. The Technological Tools - Virtual Environments

In our work we use Second Life, and its derivative, RealXtend, as our virtual environment. However, these were not the first 3D social virtual worlds to be launched. Active Worlds came online in 1997 and quickly developed Active Worlds Educational Universe (AWEDU) to support its growing educational community. More recently, with the arrival of free open-source virtual world construction toolkits such as RealXtend, Unity 3D, Open Cobalt, OpenSim, Wonderland and Metaplace there is a growing number of virtual worlds that have been developed by individuals. In this paper we focus on Second Life and RealXtend (derived from Second Life), that we will introduce in the following sections.

2.1 Second Life

Second Life® (SL), launched in 2003, is a three-dimensional virtual world which, as of July 2009, had about 19 million users. The SL platform can be regarded as a merger of social networking tools (eg MySpace and Facebook) and online massively multi-player video games technology (eg Neverwinter Nights, the first truly graphical multi-user role-playing games introduced in 1991 or EverQuest, released in 1999, and credited for introducing massively multiple-user online role-playing games mainstream to the West).

Second Life was created using the Linden Scripting Language (LSL), a scripting language similar to C. In January 2007, Linden Lab opened the source code to its client software, which runs on Windows, Mac OS X, and Linux. It is this client that users download on their PC to log into the virtual world of SL (for system requirements, see http://secondlife.com/support/system-requirements). SL exists on server farms which use Intel and Advanced Micro Devices computers located in geographically distributed facilities in the USA. Linden Lab' servers run Debian Linux and the MySQL database.

SL is a simulation based on physical metaphors of virtual worlds on virtual lands (geographic areas). Each geographic area represents a 256x256 meter region which runs as a single instantiation of a software process, called a simulator or "sim.. As the user's avatar moves through the world, it is handled off from one simulator process to another. When users buy or rent virtual lands in SL, they are indeed leasing software resource on a server.

Although used as a game by some users, SL was not built as a game platform, rather as a social interaction environment. SL, like Active Worlds and China's HiPiHi, is a socially-driven system. Although some scholars may disagree, Meadows has argued that users enter a completely metaphor-free environment in which rules are emergent and roles are entirely social [5]. Following the current gaming trend to

increase content authoring by users, SL allows players to create content with user interface (UI) tools and modification software, and even 'hack' certain aspects of the platform's operating system to modify media and architecture, and the behavior of the avatars.

In order to *be* in SL, users must create a 3D alter ego called an avatar. Once logged in, the user has access to a UI that gives the avatar a rich sense of presence 'in world,' in the sense that SL allows people to interact via several senses such as creation of objects and landscapes, the manipulation of their appearance and behaviors and a rich array of communication modes between user/avatars including text, speech and avatar body language. This paper explores the effects of avatar social presences in the context of distance education.

2.2 RealXtend

For the practical development of our mixed reality *iClass* we use *RealXtend* [6]. This is open-source virtual world software, (programmed mainly using C# and Python). Its derived from the *OpenSim* (a.k.a. *Open Simulator*) project [7] which was based on code from *Second Life* [8] which allows us to benefit from the detailed graphics (i.e. realistic avatars and landscaping) of the popular online virtual world. As *RealXtend* is open-source we have complete access to modify any part of the software code. While *RealXtend* by itself solved our problems for landscaping worlds and avatars, it didn't contain models for creating realistic three-dimensional objects. To overcome these issues we turned to two free services provided by *Google*, specifically the *Google SketchUp 7* graphics editing suite, and *Google 3D Warehouse*, a vast online repository of three-dimensional models created by people using *SketchUp*, most of which are also free to use [9].

2.3 A Mixed Reality Intelligent Environment

Previous research applied AmI to creating smart-classrooms which have both a physical and online form [10]. Interaction both in, and between these environments can be undertaken using what is labeled mixed-reality. Using *RealXtend* we designed and built a three-dimensional virtual world to act as half of a mixed reality iClassroom the other half being the physical iClassroom. The physical iClassroom contained numerous hollow walls and ceilings which were outfitted with a myriad of embedded-computer based technologies, including both sensors and effectors. All of the technologies used in the iClassrom are wrapped into a generic OSGI UPnP framework. *RealXtend* can be augmented through the addition of Python scripts to add advanced features into the default world. Most of these function by being attached to specific prims (objects) in the virtual world. Whenever a prim is interacted with it then automatically runs the attached script code associated with the interaction method. Several Python scripts were created, including a bridge allowing real-world X-10 enabled devices (wrapped into a OSGI UPnP framework) to be remotely controlled using virtual counterparts and vice versa.

As *RealXtend* is based on *Second Life* the software has inherited the multi-user properties of an online virtual world, which have been passed on to the iClassroom's

In the International Symposium on Ambient Intelligence 2011, Salamanca, Spain, 6th - 8th April 2011 (ISAMI'11), Springer-Verlag, Advances in Intelligent and Soft Computing ISSN 1867-5662

virtual environment. By allocating each online student with their own client avatar the *iClassroom* can be simultaneously inhabited by a collection of local and remote students, both of whom can interact with the class from anywhere in the world (via a computer or smart-phone with an internet connection), potentially allowing users from multiple age-groups and/or culture access to the environment.

3. The Pedagogical Issues - Virtual Reality and Social Presence

Previous research has emphasized the importance of presence in face-to-face education and of instructor presence in distance education. Virtual Reality goes some way to enabling presence as it enables users to engage in mediated social interaction including a full range of social interaction and contacts [9]. The popularity of SL has inspired many colleges and universities to explore usage of SL for hybrid and distance education, although, to-date, there has been very little research to justify the adoption and many questions remain unanswered regarding the educational value of social 'presence' in the form that virtual reality enables and even whether and how it might benefit institutions of higher education and their students [10] [11]. However, within a wider context researchers have demonstrated that computer-mediated communication (CMC) and multi-user virtual environments (MUVE) are capable of projecting social presence. It has also been argued that MUVEs offer more presence affordances than other forms of CMC in that they are designed to foster social interaction and the formation of groups and communities. They have the potential to "significantly reduce the subjective feelings of psychological and social distance, often experienced by distance education participants" [10]. Thus, offering courses via SL would allow for a rich and compelling learning environment while maximizing distance learning benefits, such as reaching nontraditional students and promoting international collaborations.

The 'distance' in distance education implies that physical and geographical separation is correlated with psychological and social distance. It is therefore tempting to assume that students feel disconnected and isolated from the instructor as the physical distance grows between them. However, the nature of the technology or medium used in delivering instruction possesses its own distance measure [12] and Moore suggests it being more useful to consider distance education as pedagogical distance [13]. Moore also argues that pedagogical, or 'transactional distance' (TD) is a function of two sets of variables, *structure* and *dialogue* ('constructive interaction'). Hence, the manner in which a program is designed and conducted can result in higher or lower levels of dialog between the learner and the instructor.

3.1 Immediacy

While TD refers to pedagogical distance, and is dependent on three dimensions—structure of the program, dialogue between teacher and learner, and social presence—immediacy focuses more on the dialogue part of TD. Immediacy is the perception of physical or psychological closeness between communicators and is observed by approach and avoidance mannerisms which include verbal and non-verbal behaviors [14]. Within this framework, immediacy is a set of measures of behaviors employed

in association with instructional transactions. Research on instructor immediacy suggests strongly that teachers adopting appropriate immediacy behaviors facilitate interaction and reduce psychological distance [15]. New interactive and immersive technology such as SL may enable more immediate instructional transactions between teacher and learners than traditional online platforms. Immediacy is a variable of social presence, a construct that is also influenced by the amount of information transmitted, words conveyed, and the context of the communication.

3.2 Social Presence

In some ways, the rise of virtual realities and allied new media reopen debates of the 1980s and 90's between Richard Clark, Robert Kosma and others [16] in which advocates Clark's position generally claimed that media functions primarily as conduits for instructional strategies and had few instructional effects of themselves. Kosma and his supporters [12] argued that different media enabled different and often specific instructional strategies and that some media were more effective enablers of some strategies. More importantly, Kosma believed that emerging digital multimedia would be able to approximate or stimulate many media modalities (e.g., audio, video, text, print, photos, video). These arguments foreshadowed current debates about what a 3D persistent virtual world adds to the teaching and learning experience. We are now questioning how to achieve quality and effectiveness of presence in education when mediated in SL. Arguably, the "immersiveness" of SL would constitute a psychological advantage.

Social presence reflects the degree to which a person is perceived as 'real' in a mediated communication. Social presence theory is a seminal theory of the social effects of communication technology [17]. Social presence is conceived to be a subjective quality of a medium that cannot be defined objectively. Short et al. [23] regard social presence as a single dimension that represents a cognitive synthesis of several factors such as capacity to transmit information about facial expression, direction of looking, posture and non-verbal cues as they are perceived by the individual to be present in the medium. These factors affect the level of presence that is the extent to which a medium is perceived as sociable, warm, sensitive, personal or intimate when it is used to interact with other people. Virtual reality (VR) technology is about 'being there': presence is therefore partly to do with the technology and partly to do with the users' state of mind.

3.3 Co-Presence

Social presence is the feeling that other persons are present even though the characteristics and behaviors of those persons may be represented and observed via mediated communication rather than physical proximity and direct observation. Schroeder [22] suggests that more immersive VR systems enable a greater sense of presence and co-presence. However, the technology of the virtual environment can influence what the participant does: "the person using the desktop system [such as Second Life] may focus on communication, whereas the more immersed person may focus on navigating and manipulating the objects". Technological effects also exist

In the International Symposium on Ambient Intelligence 2011, Salamanca, Spain, 6th - 8th April 2011 (ISAMI'11), Springer-Verlag, Advances in Intelligent and Soft Computing ISSN 1867-5662

within lower-end systems such as internet-based desktop virtual worlds: bandwidth, communication capabilities, and ease of navigation. Consequently, certain technology, social factors and personal skills might interfere with the creation and maintenance of interpersonal relationships and reduce co-presence. Schroeder [21] also identifies differences in co-presence variables based on short-term interaction or long-term interaction. Research on short-term interaction might investigate common foci of attention, mutual awareness and collaborative task performance whereas research on long-term interactions might investigate phenomena such as persistence of character, of groups, and of the environments; choice of social rules and conventions; and the relation between real and virtual.

3.4 Instructor Immediacy

Although co-presence is essential to the creation of a sense of classroom communities or learning communities, the role of the teacher or the instructor (as a co-present agent) in virtual learning environments is not well-researched. Mehrabian [14] introduced the concept of immediacy as an indicator of attitudes in verbal communication. He defines immediacy as the measure of the psychological distance which a communicator puts between himself and the object of his communication [19]. He also refined the concept of immediacy in terms of 'principles of immediacy,' which states that "people are drawn toward persons and things they like, evaluate highly, and prefer; and they avoid or move away from things they dislike, evaluate negatively, or do not prefer" [20]. Just as instructor behaviors or lack thereof may influence physical approach and avoidance behaviors, they can also be conceived as an influence on the psychological distance between people [15][20]. Thus, immediacy can be thought somewhat metaphorically as the perception of physical and psychological closeness between communicators. Verbal immediacy behaviors include calling students by name, using inclusive pronouns (e.g., 'we' rather than 'I'), inviting the use of one's first name, participating in unrelated small talk, using humor, providing feedback to students, and asking students for feedback. Nonverbal immediacy behaviors include gestures, vocal variety, smiling at students, displaying a relaxed body posture, moving around the classroom, speaking with outline only, removal of barriers, appropriate touch and professional casual dress [15] [21] [22].

3.5 Presence in Second Life

Second Life provides similar audio presence to video conference style online learning but differs in that there is no video of the participants, rather people are replaced by their graphical animations; avatars. The simulated physicality of virtual worlds and the embodied presence of avatars as agents of users facilitate behavioral displays and the appropriate adjustment of these displays to psychological circumstances in real time. This enables user expression via the avatar of behaviors communicating internal states. The avatar may also display behaviors (as an actor would) that are appropriate to a situation, but are acted or faked. User vocal expressions can be projected almost unaltered into Second Life and appear to other observers to be collocated with the user's avatar. Body language and facial expressions are either expressed autonomously by the avatar's software routines (e.g.,

low-level gesturing with hands, blinking and slight smiling), Eyes generally gaze in a direction determined by cursor location, reflecting mouse position. More explicit facial displays and body movements such as laughing or frowning, hand waving, or pointing require explicit execution by the user of keyboard short cuts. Thus, with current SL technology, the appropriateness of avatar expression is to a considerable degree a practiced keyboard skill rather than a direct projection of bodily movements. One implication of this current state of the art, is that instructors might exaggerate expressions, or alternatively elect expressions that do not reflect their current 'true' dispositions. In any case, instructors skilled in SL technique are well equipped to control the display of immediacy behaviors of their avatars and thus potentially control the psychological distance between them and the students.

4. CONCLUSION

In this paper we have explained how there is an increasing interest in extending the use of technically enabled environments commonly found in AmI, from physical to the virtual. We have introduced tools such as Second Life and its derivative, RealXtend that enables virtual worlds to be built. We also explained how regular physical AmI environments can be linked to their virtual counterparts creating so-called mixed reality environments. We described an important application of such environments, distance learning, and discussed the issues that influence its effectiveness; notably social presence and immediacy, explaining how technology may enhance or detract from these. In particular we noted that whereas most research questions of the last century regarding educational implications of immediacy and social presence focused on the instructor as the person of interest, social networking software that connects hundreds of millions of users online demands the traditional focus be broadened to all members of learning communities. From our work it is evident that virtual reality-based avatars challenge early paradigms for research on social presence and immediacy in two ways: the source of communication control and the dominant instructor as source of immediacy. The Networked Minds paradigm exemplifies new lines of inquiry that emerged in the 1990's that extend beyond immediacy behaviors to measure emotional and cognitive states, and collaborative dispositions. With these new perspectives and new instrumentation, researchers will better be prepared to investigate complex communication modalities and media that integrate and filter sensorimotor, cognitive, and affective cues of communicators which will all need to be accounted for in mixed reality AmI social spaces, such as online learning.

Clearly venturing into virtual environments will expose many new challenges for AmI systems and whilst this work is at an early stage, we hope the insight provided in this paper will be helpful to those considering working in this area of AmI systems.

References

[1] Shen, R. M., Wang, M. J., Gao, W. P., Novak, D., & Tang, L. (2009). Mobile Learning in a large blended computer science classroom: System function, pedagogies, and their impact on learning. IEEE Transactions on Education, 52(4), 538-546

[2] Gartner, Inc. (2007). Press Release, April 24, 2007. Retrieved December 14, 2007, from http://www.gartner.com/it/page.jsp?id=503861

[3] Lenhart, A., Kahne, J., Middaugh, E., Macgill, A., Evans, C., & Vitak, J. (2008). *Teens, video games, and civics.* Pew Internet and American Life Project. Washington, DC. Retrieved September 19, 2008, from http://www.pewinternet.org/pdfs/PIP_Teens_Games_and_Civics_Report_FINAL.pdf

[4] M. Davies, V. Callaghan, and M. Gardner, Towards a mixed reality intelligent campus, *Proceedings of the 2008 international conference on Intelligent Environments (IE '08)*, Seattle, USA.

[5] Meadows, M. S. (2008). *I, Avatar. The culture and consequences of having a second life.* Berkeley: New Riders

[6] RealXtend, realXtend – Open source platform for interconnected virtual worlds, *http://www.realxtend.org*, Retrieved: 1st March 2010.

[7] OpenSim, Main Page – OpenSim, *http://opensimulator.org*, Retrieved: 22nd February 2010

[8] Linden Lab., Second Life, *http://secondlife.com/*, Retrieved: 15th February 2010.

[9] Google, 3D Warehouse, *http://sketchup.google.com/3dwarehouse*, Retrieved: 22nd February 2010.

[10] Callaghan V, Gardner M, Horan B , Scott J , Shen L and Wang MJ "*A Mixed Reality Teaching and Learning Environment*", in Book Hybrid Learning and Education, published by Springer Berlin / Heidelberg in Series Lecture Notes in Computer Science, Volume 5169/2008, Pages 54-65 , ISBN 978-3-540-85169-1, Nov 2008

[11] Bower, J., & Christensen, C. (1995). Disruptive Technologies: Catching the Wave. *Harvard Business Review* (ed. March 3, 2009. HBR OnPoint Enhanced Edition). Retrieved February 8, 2010, from http://www.amazon.com/Disruptive-Technologies-Catching-OnPoint-Enhanced/dp/B00005REGO

[12] Kosma, R. (1994). Will media influence learning? Reframing the debate. *Educational Technology, Research & Development, 42*(2), 7-19.

[13] Moore, M. (1993). Theory of transaction distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 22-29). New York: Routledge.

[14] Mehrabian, A. (1966). Immediacy: An indicator of attitudes in linguistic communication. *Journal of Personality, 34,* 26-34.

[15] Andersen, J. (1979). Teacher immediacy as a predictor of teaching effectiveness. In D. Nimmo (Ed.), *Communication yearbook 3* (pp. 543-559). New Brunswick, NJ: Transaction Books.

[16] Hastings, N., & Tracey, M. (2004). Does Media Affect Learning: Where Are We Now? *TechTrends 49*(2), 28-30.

[17] Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications.* London: John Wiley & Sons.

[18] Schroeder, R. (2002). *The social life of avatars.* London: Springer

[19] Mehrabian, A. (1968). Inference of attitudes from the posture, orientation, and distance of a communicator. *Journal of Consulting and Clinical Psychology, 32,* 296-308.

[20] Mehrabian, A. (1971). *Silent messages.* Belmont, CA: Wadsworth.

[21] Gorham, J. (1988). The relationship between verbal teaching immediacy behaviors and student learning. *Communication Education, 37*(1), 40-53.

[22] Richmond, V., Gorham, J., & McCroskey, J. (1987). The relationship between selected immediacy behaviors and cognitive learning. In M. McLaughlin (Ed.), *Communication yearbook 10* (pp. 574-590). Beverly Hills, CA: Sage