Computer Supported Collaborative Social Environment for Education, Training and Work

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Abstract – **The increasing employment of collaborated and blended learning techniques in educational institutes indicate that this kind of solution maximizes investments whether the growth of students demands more resources and teachers. Collaboration is working together towards a common goal at different times (time flexibility), in different locations (spatial flexibility), at different companies and educational/training institutes (inter company/institutions relationship) in different functions (multi disciplinary work). Principles are: support collaboration within the entire team: sharing ideas, minimizing collocation, making jobs easier; and helping knowledge building. Internet accessible virtual computer environments allow social interaction as well as medium for education, training and work as soon as the environment supports this kind of interactions. Therefore an environment that supports these interactions is envisioned by the authors and currently under research for future development.**

Index Terms – **Computer Supported Collaborative Learning, Computer Supported Collaborative Work, Mixed Reality, Virtual Social Environments, Blended Learning.**

I. Introduction

Collaboration is a wide term related mostly to the active participation between two or more people to achieve a common goal. The new trend of collaboration between distant or physical dispersed personal employs computer or network infrastructure of computers as common medium. This medium is mostly called Computer Supported Collaborative Environment (CSCE). Virtual environments are designed to offer tools for several different types of interactions between the users, among them: social, education, training and work. Social environments are developed to strengthen social relations between its user/participants. Despite this specific goal, social relations are a generic broad term that is present in all types of interactions between people. A social environment is mostly employed in education and work for recreative scope, despite the "serious game" [1] interface or non-entertainment purposes of education and work. Education when combined to entertainment is called edutainment.

In its broadest sense, an instructional system (educational tool) is an arrangement of resources and procedures to promote learning. In this sense, MMORPGs (Massively Multiplayer Online Role-Playing Games) are clearly instructional systems. So, analogous to social environments, MMORPGs offer or can be designed to serve learning purposes [25].

Collaborative environments are based on distributed technologies in order to facilitate the work of a group geographically dispersed. More concretely, the design of a good distributed architecture can be the ground of any kind of distributed application. How to perform interoperability among heterogeneous tools and platforms in distributed systems is the key question addressed to the collaborative community. Interoperability must be carried out in order to provide new services to end users with total integration with the platform. Hence, users should not be conscious of different technologies which underlie in the new integrated platform. This study focuses on computer supported social collaborative environments (CSSCE) applied to engineering education, training and work.

The following sections describe the research results of this work. In section 2 the motivation is presented followed by the work objectives. Section 4 describes some ongoing results and finally in section 5 future works are listed and commented.

II. Motivation

Several misconceptions arise when using the acronym CSCW and his two interpretations. One refers to computer supported collaborative work and the other computer supported cooperative work. Even though the significance is closely related, cooperation is not the same as collaboration. According to [2], cooperation and collaboration do not differ in terms of whether or not the task is distributed, but by virtue of the way in which it is divided; in cooperation the task is split (hierarchically) into independent subtasks; in collaboration cognitive processes may be (heterarchically) divided into intertwined layers. In cooperation, coordination is only required when assembling partial results, while collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem.

The term computer supported cooperative work was first coined by in 1984, at a workshop attended by individuals interested in using technology to support people in their work [3]. At about this same time, in 1987, Charles Findley presented the concept of collaborative learning-work. According to [4], CSCW addresses "how collaborative activities and their coordination can be supported by means of computer systems." On the one hand, many authors consider that CSCW and groupware are synonyms. On the other hand, different authors claim that while groupware refers to real computer-based systems, CSCW focuses on the study of tools and techniques of groupware as well as their psychological, social, and organizational effects. In [5] the difference between these two concepts is related as: "CSCW is a generic term, which combines the understanding of the way people work in groups with the enabling technologies of computer networking, and associated hardware, software, services and techniques."

In these new environments, centred communication becomes a key factor. Users must be able to customize presence and operation to suit individual needs represent themselves as unique individuals and select and control the medium and manner in which they access and participate in the environment.

Very little has changed in the last one hundred years in the way that educators instruct students [7]. The system still holds fast to the age-old delivery method of the solitary scholar. This representation of teaching has been the most dominantly used option for the past several decades with universities and colleges as one section of schooling in which this traditional education method has been applied and adhered too studiously. Many of the newer methods of education that are emerging differ from conventional methods by the inclusion of online learning and Web based instruction, which is attracting the attention of many universities.

The online learning is tight related to other common topics like: CSCL and CBT (Computer Based Training). All these topics are used in distance education and employ concepts of active learning [8, 9], distributed learning [10] and team learning [11]. Active learning can be also classified as "learning by doing", "self learning" and, when related to experiments (or laboratories), "hands-on learning". Distributed learning is obviously related to the space flexibility that the distance education offers. The last, team learning, when users are synchronously learning together, is called collaborative learning.

Figure 1. Example of a 3D social virtual environment used in the education and training.

Although there are many implementations that support CSCLEs, there is none equivalent to face-to-face education. There are a number of experimental studies and implemented systems available in the literature to emphasise the effectiveness of collaboration. An experiment on Constructive Interaction by [15] confirms that in the learning process the bulk of Constructive Criticisms occur while learning in collaboration. The experiment showed that about 80% of self-critiquing (reflection) took place during collaborative learning compared to 20% which took place when students were learning alone. Self-critiquing is one of the major contributors to the effectiveness of collaborative learning. This experiment showed that the learners might have missed the opportunity for better understanding if they had not collaborated. Misconceptions in peers could be put to effective use when an appropriate peer is found to handle the misconceptions.

The increasing audience of game or socialware implementations, like Active Worlds [20] and Second Life [19], point out to a more game-like solution applied to virtual education with more interactive contents (see Fig. 1). This alternative captive more attention from students while focus on collaboration for education.

III. OBJECTIVES

This work proposes the development and research of a system or CSCE implementation that comprises the following desired characteristics:

- distribution – distributed, modular interactions using the Internet infrastructure;
- social "game-like" interface;
- 3D virtual world representation;
- displaying and managing educational contents;
- teleoperation through employment of hyper-bonds [33] and Web-based technologies;
- autonomous (automatic) tutoring through employment of awareness and monitoring agents;
- interoperability among services and tools from CSCEs.

Each of the above mentioned characteristics aim to increase usability, stability and flexibility. The envisioned environment uses the Internet infrastructure and connectivity to reach a greater audience (globally dispersed). This infrastructure also allows distribution of environment modules. This modularization, each module is responsible for specific functionalities, is the key to achieve flexibility.

Including a social game-like interface together with the 3D world representation gives the environment a "skin" or "metaverse" [17]. Compared to other electronic tools for distance communication (Computer Mediated Communication – CMC), this metaverse improve the sense of being "there" (in a classroom) [18], rather than of being a disembodied observer. This representation employs state of art technologies that support collaboration, creativity and sharing over the Web. Network collaboration technology is commonly linked to Web 2.0 or tools for collaborative sharing [22], an trend called second generation of Web-based communities and hosted services.

An ideal CSCE for engineering should incorporate learning and also training functionalities allowing shared workspaces as well as video conferencing tools. For educational purposes the environment must also incorporate support for educational contents (didactic material) and practical/didactical experiments to confront theory. Collaboratories are a well known association of collaborative tools with remote laboratories (experiments). A basic implementation of collaboratories is the integration of VLEs with remote experiments in a single environment [12].

The appliance of mixed reality techniques joins real and virtual spaces for collaborative work. In this manner, mixed reality applied to experiments and shared workspaces enhance virtual-to-real collaboration increasing the reach of the CSCEs. This also allows the dynamic interchange of simulated/real parts in remote experiments, possible by the interchangeable components architecture previously developed in [12]. The hyper-bonds concept offers besides teleoperation, an energy interface, *i. e.*, the energy is transported through the Internet from one side to the other and vice-versa. This makes possible remote true feeling of force, vibrations and motion, *i. e.*, haptic [35]. Shared workspaces (distributed collaboration) that allow/require handling of instruments is even more realistic when haptic interfaces are used. The application of this theory to social Web 3D worlds is not yet been developed, leaving this field open to technical innovations that will bring more "reality" to virtual environments.

Educational tools to enhance system awareness of student's learning status, as proposed by [13], near CSCEs to automatic learning systems capable of autonomous or automatic tutoring. Environment's collaboration awareness, as proposed by [14], also demonstrates automatic capabilities associated to CMC. Awareness agents developed in Java (JADE - Java Agent Development Environment) that monitor and capture students (avatars) interactions with the MOODLE can be employed in the CSCE. This "monitoring" is extended to interactions with the metaverse. The agents "personifications" are tutor's avatars representations. The tutor guides and responses to direct (with the tutor avatar) and indirect (with the course metaverse) interactions, generating a feedback response to the other avatars (suggestion of didactical material and remote experiments).

Maintaining known and widely employed standard technology for communication allow interoperability with other modules. Common programming languages like Java, PHP, possibly also Flash, and MySQL as standard database managing system serve as basis to the system framework. Standard XML files describe communication protocol so that modules commands/interactions will be easily/humanly understood.

IV. Ongoing Results

The current work is at early stages at development. Most of the results are in the research field. So that selected standards and technologies were studied.

A. Tutoring Agents

JADE framework for developing/programming agents was selected due to its portability (Java) and adaptability with known implementations and association with VLEs, like MOODLE [24]. The work presented by [21] presents an implemented solution to "pre-select" or "pre-evaluate" student interaction with MOODLE using JADE implemented Multi Agent Systems (MAS). Although [23] only report a small and simple implementation "on demand" agent response, these implementation leads to new trends and developments of awareness agents. The work of [16], relate some advantages when shifting from cooperation services to cooperation (collaboration) aware environments. This scenario requires a shift from application oriented towards the design of collaborative-aware work environments that support collaboration and interaction in terms of activities instead of technical functions.

The JADE framework complies with the FIPA (Foundation for Intelligent Physical Agents) Standard and the FIPA-ACL (Agent Communication Language).

Since previous works with MOODLE and basic tutoring systems based on on-demand responses [12] received positive feedbacks from students, an enhanced version of tutoring systems with agents is in development. These agents monitor student interactions with MOODLE analysing in-time student logs (database inputs). Each student that interacts with the VLE is "tutored" by an instance of the tutor agent. This methodology assures that each student receives full attention online while interacting with learning materials, simulations and remote practices. Each user login generates an agent creation that searches/monitors user's interactions. The agent (tutor) response (feedback) is displayed within the VLE. The responses are implemented/programmed based on predefined specifications for the knowledge construction.

B. 3D World "Social" CSCEs

While software may be designed to achieve closer social ties or specific deliverables, it is hard to support collaboration without also enabling relationships to form, and to support a social interaction without some kind of shared co-authored works. Analogously, the differentiation between social and collaborative software can be compared as that between "play" and "work". Some theorists hold that a play ethic should apply, and that work must become more game-like or play-like in order to make the activity of using computers a more comfortable experience.

The 3D representation aims to display more realistic (virtual) "worlds" to its users. Commonly this representation is more often in the entertainment field and specifically in games.

Known social "game-like" examples of CSCEs implementations are: Active Worlds – with the more especial designed Educational Universe (AWEDU) [26]; Second Life (SL) [27]; Cyber Town [28]; Worlds.com [29]; and closely related to this work the SLOODLE project [30, 31].

SLOODLE offers a possibility to merge the 3D world Second Life with the MOODLE open source system to mirror web-based classrooms with in-world learning spaces and interactive objects [24]. SL is used like a "metaverse" skin on the Learning Management System MOODLE. The SLOODLE project created a virtual "world" in the Second Life server called VirtuAlba were MOODLE contents can be displayed (see Fig. 1). This way, lessons and courses are available at the Internet in virtual worlds with traditional LMS advantages. In SL, each student is personalized in 3D virtual characters (body) called "avatars".

Although, all the cited examples of virtual worlds are mostly commercial software implementations, one SL alike parallel project called OpenSim [32] is freely available as open-source code. The available OpenSim client implementation is also compatible to SL server, *i. e.*, the free client software can connect to the commercial server of SL. This increases the possibilities to create automated clients or "simulated" 3D avatars (commonly called "bots") that can represent tutors. These envisioned tutors are virtual representations of software agents that help/guide students in the CSCE. The tutors can also collect and monitor other avatars activities in the world of interest.

C. *Remote Handling (Haptics)*

CSCEs address also collaborative projects and workspaces designs within many levels of human interactions. Virtual collaborative workspaces are developed within CSCE to achieve common collaborative goals in physically distributed systems. These workspaces applied to education are employed mostly to integrate physically dispersed personal into a simple environment used as training/learning grounds.

The appliance of mixed reality techniques to collaborative work environments was demonstrated first by [35]. Also [36] demonstrated techniques of mixed reality as a way of joining real and virtual spaces for collaborative work. In this manner, mixed reality applied to experiments and shared workspaces enhance virtual-to-real collaboration increasing the reach of the CSCEs.

Hyper-bonds, as proposed by [6], offer tight bidirectional coupling of virtual-to-real applications. Hyper-bonds follow the theory of Bond graphs that provides a unified view on different systems using the notion of effort and flow. This technology allows virtually every computer mediated hardware or software application to interact locally or remotely with each other. This concept can also incorporate haptic to allow remote handling (teleoperation) with real/virtual response (force-feedback).

Hyper-bonds have been proven to be efficient when employed in collaborative workspaces (see Fig. 2), as in [33, 37], and force/energy coupling (haptic) (see Fig. 3), as in [34].

Although remote handling has not been yet tested in virtual 3D worlds, his implementations should not be very difficult, since avatars already interact with many types of virtual objects and these objects return a virtual response. Assuming that metaverse objects can be linked to remote real or simulated equipments and experiments, these objects can return experiment responses directly to the avatar in the metaverse. This way, virtual interaction can be sensed by the avatar when handling equipments or running experiments.

Figure 2. Workspace using CAVEs with the real workbench (center), the virtual one in front and the remote counterparts (left and right pane)

V. FUTURE WORKS

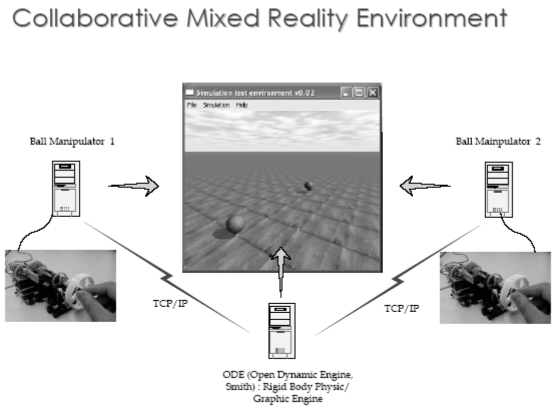

Figure 3. Interaction of real ball manipulators in virtual world over computer network, an haptics of collaborative mixed reality environment.

Following the goals, the future work should implement and test each of the ongoing results and incorporate these results in a single CSCE.

Further research in non-commercial solutions for online 3D worlds representations should be addressed.

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