Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.777631

DESIGN AND IMPLEMENTATION OF THE LIVING IN 3D VIRTUAL WORLD WITH MULTIAGENT SYSTEMS

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ABSTRACT: The application of virtual worlds through Internet for teaching allows that the student can submerge himself in friendly environments that make learning more pleasant. This article presents three educational applications developed in these worlds. The first, for virtual museum of history and culture, shows a set of virtual worlds are designed, and where the student interacts with different objects. When an object is selected, its name can be show and the student can listen to its history. In the following application, a virtual classroom, the created world can be shared simultaneously by several users. One such move is the incorporation of 3D virtual worlds in the learning environment. Another is the increasing development of multiagent systems that support the learner or the tutor. This is based on multiagent systems with 3D virtual worlds could provide a more engaging immersive learning environment. This analysis explores the feasibility of integrating a 3D virtual world with a pedagogical multiagent system named QuizMASter, an educational game for elearning that helps students learn their course material through friendly competition. The integration was developed by devising, implementing and testing an approach using open source technologies, namely, Open Wonderland and JADE. There are diverse materials available as in the traditional classrooms, for example a blackboard, laser pointer and a slide projector. Finally, the latest advances in the creation of virtual environments have been applied in the third application using a game server. This has made possible the design of a more realistic world where the student can interact with other users and share his experiences.

KEYWORDS: 3D,Multi-user Virtual Classroom, Virtual Museu, 3D Video Chat Room

I. INTRODUCTION

On one hand, for most of people, the idea of using the Internet as a learning environment has great appeal. The ability to attend class from the comfort of your own home can be both convenient and economical. Actually, many academic institutions around the world do offer many online courses to supplement their curriculums. While the number of online courses is vast, potential drawbacks with such courses include students feeling a lack of social presence and awareness. On another hand, modern service industries highly depend on new technologies and skills of service talent to carry out business in a flattened world, services skills are not like basic concept or knowledge of science and technology. They could not be very easily trained

in classroom without practice. Service skills are often consist of soft skills especially those skills that require a service staff to interact with relevant stakeholders, to be aware of the service environment, to respond to multiple groups' requests based on candidate solutions, priority of tasks, and all agreed final decisions [20].

A 3 dimensional (3D) virtual environment is created entirely from a computer database consisting of objects modeled by computer-aided design (CAD) software. These objects are programmed to behave in certain ways as the user interacts with them. A 3D virtual environment is special because the mixture of software and hardware gives the user an illusion of being immersed in a 3D space and the ability to interact with the 3D space. Where a 3D virtual technology is used to create an immersive and interactive environment to facilitate or aid learning, this is known as 3D virtual learning environment (3DVLE). Typically, 3DVLE is learning and teaching program that makes use of a MUVE (multi-user virtual environment) to immerse students in educational tasks.

Students move around the 3D space to virtual places and perform educational tasks. In the pursuance of these tasks, students are able to interact with digital artifacts and they can represent themselves through 'avatars' or virtual characters. In addition, the multi-user version of the 3DVLE is online and enables students to communicate with each other using real-time chat.

With advances in software and hardware technologies, 3D Virtual World (3D VW) technologies have been more and more adopted. 3D VW technologies are extremely helpful to build interactive 3D virtual environment that gives the users sense of being there. A number of institutions have begun to experiment with virtual worlds as a way to enhance online education. 3D VWs are highly interactive in that they provide dynamic feedback, learner experimentation, real-time personalized task selection, and exploration. Virtual worlds are also often purported to have other instructional benefits, such as allowing for creativity within a rich media environment, providing opportunities for social interaction and community creation, facilitating collaboration, increasing a sense of shared presence, dissolving social boundaries, lowering social anxiety, enhancing student motivation and engagement, and accommodating millennial generation learning preferences [6].

Among many 3D VW platforms, Second Life has become one of the most popular tools to facilitate collaborative online education. In Second Life players control an avatar on behalf of themselves to communicate and socially interact with others around the world; users can modify their avatars' appearance, build structures, and even purchase land. Hundreds of leading universities and school systems around the world use Second Life as a vibrant part of their educational programs. Universities such as Harvard, Texas State and Stanford are just a few of the many universities that have set up virtual campuses where students can meet, attend classes, and create content together.

Learning environments that provide an immersion into the content is a natural step towards creating learning environments for the new "digital native" group of learners. The current

generation of learners are used to multimedia applications that are immersive and highly interactive because many of them have been video-gaming since they were kids [5]. Multi User Virtual Environments (MUVE) have been created by many of the world's universities to provide such a learning environment in a 3D virtual world. A MUVE is best used by a synchronous but geographically separated group of learners. MUVEs are said to be perfect for "experiential" learning by providing concrete experience, reflective observation, abstract conceptualization, and active experimentation.

Two different approaches toward MUVE's are surfacing; the virtual classroom and the fantasy world. The virtual classroom has the look and feel of a regular classroom and is often made to look like a replica of the sponsoring university. Second Life (SL) is often the choice for building the 3D virtual classroom. Results are a mixed bag, with some reporting that SL has too many difficulties and is not game. Some learners reported that SL is not an environment where they would want to spend time. SL did not appeal to those who enjoy social software because of difficulties engaging with others, nor did it appeal to gamers because of the lack of any gaming scenarios.

Multiagent Systems that Support the Learning Environment Agents are encapsulated computer systems that are designed to behave flexibly and somewhat autonomously to achieve some goals. Agents are situated in some environment and have some autonomy and capabilities to observe that environment. They can communicate those observations to other agents. This makes them particularly suited to distributed environments. Within the distributed environment, the Multi-Agent System (MAS) can be designed using one or more architectures. The autonomous nature of agents implies that the architecture can even develop dynamically at run-time. A group of peer-to-peer agents can appoint one agent to be a central agent to whom the others report.

The application of multiagent technology to education has fallen into two groups of technologies, 1) Intelligent Tutoring Systems (ITS) and 2) Interactive Learning Environments (ILE). Some criticism of the current state of tutoring systems is the lack of sufficient intelligence in the tutoring system with a possible solution identified as the incorporation of pedagogical multiagent systems, such as a teacher agent and a student agent into the virtual classroom. Multiagent systems can also provide agents that act as guides, information retrieval assistants, and help systems in 3D virtual learning environments. The pedagogical benefits provided by the interactive MAS in learning environments are shown to be [1]: Interactive learning experience motivates students and helps to retain knowledge, instant feedback helps identify weakness in areas, interaction with other students introduces the competitive element which in turn makes the experience more engaging, interesting and fun, students collaborate with each other and students progress at their own place [2].

The use of the New Information And Communication Technologies (NICT) is already part of daily life for many people. The digital natives, the so-called Generation Z, have less difficulty to handle technological devices when compared to previous generations. When we propose to think of certain teaching materials currently used, has aware that some of these materials tend

to obsolescence, because for a range of students, use the blackboard and the projectors are no longer reference in its school context. They are used to presentations data show, the use of their computers or mobile devices like cell phones and tablets.

The incorporation of NICT to education is designed to enrich the teaching-learning process. These allow to present students learning situations beyond the classroom. In this context lies the remote laboratory experimentation, besides the possibility of being used as an alternative to schools that have no physical well-equipped laboratories, also allow students a more autonomous learning and without time restriction.

In the school context there is a constant search for resources that facilitate the construction and appropriation of knowledge. It is therefore necessary the development of Virtual Learning Environments (VLE) with attractive features and interactive for students, such as 3D Virtual Worlds. Understands the purpose of this paper present the use of remote experimentation and 3D virtual worlds as a complement to the teaching and learning process.

II. LITERATURE SURVEY

S. Bronack, et al [15] utilized a social constructivist framework analysizing 3D virtual world learning environment is unlike traditional classroom- or web-based learning environments in many important ways, students should be provided more choices within the 3-dimensional world, should be aided to construct individual paths through the virtual world .

A. De Lucia, et al.[8] presents a virtual campus created using Second Life which provides four distinct types of virtual space: common student campus, collaborative zones, lecture rooms and recreational areas, they argued that, in a 3D multi-user virtual environment, learning is strongly related to the user perception of belonging to a learning community, as well as to the perception of awareness, presence and communication. They conducted an experiment involving university students aiming at evaluating Second Life synchronous distance lectures in the proposed learning environment which results are very positive.

D.C. Cliburn and J.L. Gross et.al [9] described quasi-experimental pretest-posttest comparison groups design to compare the experience of a Second Life lecture to a real world lecture, found that those who attended the real world lecture performed significantly better on a posttest quiz than those who attended the same lecture in Second Life., commented that students encountered many difficulties, such as problems viewing the lecture material, and a lack of constraints on avatar behavior in the educational setting.

P. Dev, et al[14] reported a project of developing and evaluating a computer-based simulator (the Virtual Emergency Department) for distance training in emergency medicine residency programs teamwork and leadership in trauma management which aimed not only to manage trauma effectively but also not needing practice on live patients.

L. Jarmon, et al [7] suggests that 3D virtual worlds can be well suited for experiential learning environments, they use mixed research methods of journal content analysis, surveys, focus

group, and virtual world snapshots and video, empirically examines the actual instructional effectiveness of Second Life as an experiential learning environment for interdisciplinary communication.

C. M.Itin, et.al [12] describes that experiential learning is the process of making meaning from direct experience, focuses on the learning process for the individual. It engages the learner at a more personal level by addressing the needs and wants of the individual. According to this definition, we design a story script for the learning service in Second Life.

Bellifemine, F. L., Caire, G., and Greenwood et.al.,[3] described integrate a multiagent system developed on the Java Agent Development framework (JADE) (jade.tilab.com) with Open Wonderland (OWL), an open source 3D virtual world developed by SUN (www.openwonderland.org). JADE is the best-known and most widely used platform that supports FIPA (the Foundation for Intelligent Physical Agents*)* messaging [22]. Open Wonderland is a 100% Java open source toolkit for creating collaborative 3D virtual worlds. JADE is also a 100% Java open source toolkit. Since both JADE and Open Wonderland are Java toolkits, integrating these two technologies would not suffer from problems of cross platform issues.

III. Design and Implementation of the Living in 3D Virtual world with Multiagent Systems

The first application has focused on virtual museum of history and culture. One of the most important challenges for teachers is the incorporation of a great number of foreign students who do not know the history and culture of the country. A virtual world has been built up to improve the historical knowledge of these students. The user can walk though this world selecting the objects in the scene (Figure 1). After selecting an object, its name is shown and its pronunciation can be heard. In this way, students obtain progressive learning based on the comprehension and knowledge of history and culture.

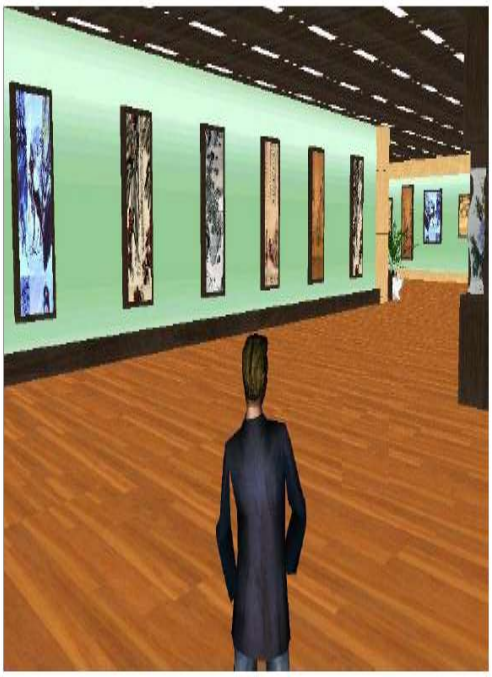

Fig.1: Snapshot of the virtual museum

The application has been developed using a database that identify basic objects(eg: poem, picture) and actions(eg: run, read). Each record in the database has the following fields: Name of the object.

- Sound
- URL of the 3D representation of the object.

Once the database has been defined, these different objects have been built up. If enter this world, system will include all objects of the database in the environments.

Multi-user Virtual Classroom is the 2nd application has focused on virtual classroom. Virtual classroom system is a multiuser application based on the standard VRML. It allows several users to share a virtual world and to interact with it as they would do in a mono-user world.

Open Wonderland is client/server architecture, whereas the JADE platform is used to create peer-to-peer systems. The link between these two separate architectures lies in the interface. The interface is actually a modified Open Wonderland module to which code has been added to start a JADE agent. The JADE agent is started via a runtime call, therefore the agent will be started on the local computer. However, the rest of the agents that make up the multiagent system (MAS) can be on other computers in the network. The agent started by the Open Wonderland module will communicate with the rest of the JADE agents using the FIPA specified protocol. One of the agents in the JADE/MAS communicates back to the Open Wonderland world by sending messages to a TCP port that has been activated on another Open Wonderland module, the Poster module.

System architecture of Virtual Classroom

The system has two parts clearly differentiated (Figure2):

· A server program that runs on a machine that acts as a Web server. The VRML and HTML files defining the world reside in this server.

·The client software is a Java applet which uses EAI (External Authoring Interface) to communicate with the VRML browser plug in that the client uses (Explorer, Netscape, etc).

The user generates two types of events through the interaction with the virtual classroom: local events, these only concern to our local world, and remote events, that are transmitted through the network to the Web server which distributes them to all the clients. These remote events offer information on the actions that other users are making in the classroom.

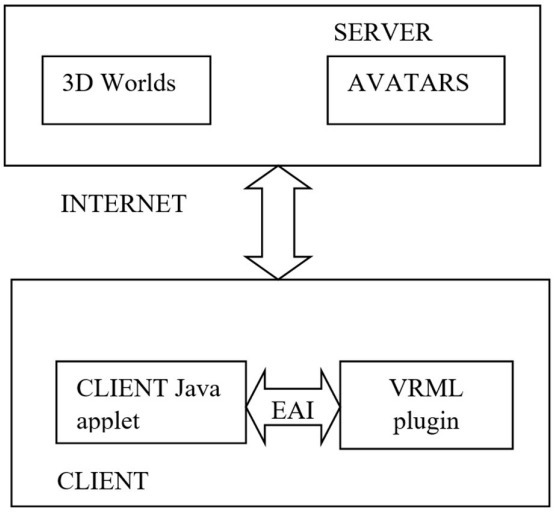

Fig.2: System Architecture Of Virtual Classroom

Implementation of Virtual Classroom:

The world built up in this application simulates a multi-user classroom. The virtual classroom was designed as accurately as possible to emulate a real one, and the users are represented as avatars. Each avatar can interact with the others and share its experiences (Figure 3).

Specific objects have been added to the classroom, with which the user can interact: a blackboard, a laser Pointer and a slide projector.

The blackboard: It is possible to write and draw on it with some basic primitives such as: lines, circles, rectangles and ellipses. The colour of these primitives can be chosen by the user.

Fig.3: Snapshot of the virtual classroom

The blackboard: It is possible to write and draw on it with some basic primitives such as: lines, circles, rectangles and ellipses. The colour of these primitives can be chosen by the user.
· The slide projector: It works on a list of predefined images that the user can visualize in a sequential way.
· The laser pointer: It allows the users to point either in the slides or in the blackboard.

In this way, it is possible to focus the other users on this point of the classroom. This application has been developed using VRML 2.0 and the node extensions and the multi-user functionality provided by the system.

The last developed applications create a 3D virtual world where a user group can communicate by a video chat service. In that environment, each user has an own 3D representation or avatar. The application allows the user to walk through the world and to communicate with the different avatars using a video chat service.

System architecture of 3D Video Chat Room: The system has client-server architecture. The user executes a Client application that is fundamentally in charge of the visualization and the communication with two server applications. One of these servers holds the positions of all the avatars (Avatar Location Server), and the other manages the video chat service (Chat server). The system architecture is in Figure 4.

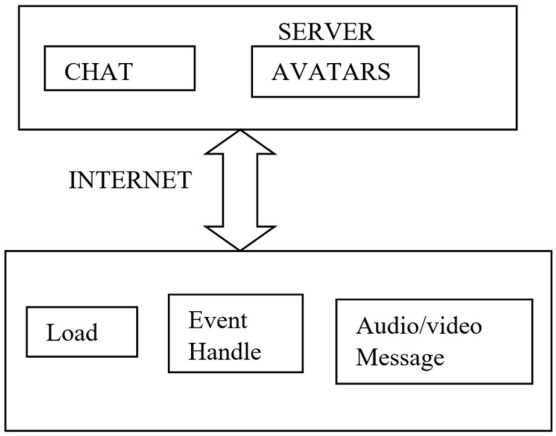

Fig.4: System Architecture Of 3D Video Chat Room

- Chat Server. We use a telnet video chat service.
- Avatar Location Server.

The server monitors the state of each client (nickname, position, orientation, time) and communicates this information to the other clients. The pseudocode of this server is shown in Figure 5.

```
do {
       Socket localSocket = this.server.accept();
       Log.log("bDone=" + this.bDone);
       if (!(this.bDone))
        {Vector localVector;
         monitorenter;
         try {
            if (this.clients.size() >= maxUsers)
             {Log.log("too many clients connected, connection from " +
localSocket.getInetAddress().getHostAddress() + " dropped");
              localSocket.close();
              localSocket = null;
              monitorexit;
              break;}
             }
         finally { monitorexit; }
         Object localObject1 = new Client(this, localSocket, getUniqID(), this.bDebug);
         Log.log(((Client)localObject1).getIP() + " connected to the server.");
         monitorenter;
         try { this.clients.addElement(localObject1); }
         finally {monitorexit; }
         Log.log((Client)localObject1).start();
        }
    }
while (!(this.bDone));
```

Fig.5: Avatar Server Algorithm

- Client application.

The client is in charge fundamentally of the world visualization. It manages the communication with the servers in order to show the success of the video chat. It draws the avatars in their positions. Figure 6 shows the algorithm executed by the client application.

```
public Client(Server paramServer, Socket paramSocket, String paramString, boolean paramBoolean)
 {
   this.bReady = "";
   this.me = null;
   this.nZoneID = -2;
   this.stopWatch = Calendar.getInstance();
   this.ignoreList = new Hashtable();
   this.bDebug = false;
   this.theServer = paramServer;
   this.socket = paramSocket;
   this.remoteIP = paramSocket.getInetAddress().getHostAddress();
   this.bDebug = paramBoolean;
   this.me = new Person();
   this.me.uniqID = paramString;
   this.me.privID = Integer.toHexString((int)(Math.random() * 2147483648.0));
   int i = Integer.parseInt(Server.TIMEOUT);
   Log.log("Server.heartBeatMSec=" + i);
   this.bIsRunning = true;
   try {paramSocket.setSoTimeout(i);
       this.in = new BufferedReader(new InputStreamReader(paramSocket.getInputStream()));
       this.out = new BufferedWriter(new OutputStreamWriter(paramSocket.getOutputStream()));
      }
   catch (IOException localIOException)
      {Log.log("[" + this.me.uniqID + "] Client IP: " + this.remoteIP + " could not be " +
"initialized and has been disconnected.");
       stopClient();
      }
 }
```

Fig. 6: Client application Algorithm

The client always maintains two states for each avatar: the state at the moment and the new state. When the avatars are drawn in the world, they are placed in a position that interpolates both states in order to obtain a continuous visualization.

Communication management is handled without using blocking communication calls. In this way, the application is simplified because it is not necessary to use threads.

The avatars have two types of animations, the movement animation and the animation that happens when the avatar is quiet. The transition from one animation to another depends only on the speed of the avatar and is solely managed by the client.

Implementation of 3D Video Chat Room: In order to construct the application, a game engine has been used. This type of software incorporates the recent advances developed in the field of real-time rendering. In this way, it is possible to design more realistic environments with a great number of visual effects. BS Collaborate Server has been chosen from among the available game servers for the following reasons:

·It is a public domain server (GNU Library General Public License).
· Open source.
·Multi-platform: MacOS Classic, MacOS X, UNIX,
Windows, Linux, Irix, FreeBSD, NetBSD, and Solaris among others.
· Good rendering quality either in software or in hardware mode.
· OpenGL and DirectX support.
· In continuous development and maintenance.

The world used in our application is one of the example worlds in the BS Collaborate Server. The avatars have been imported from the user's "avaters" files. The application environment is shown in Figure 7.

Fig. 7: A Scene Where Two Users Appear While They Are Video Chating.

In addtion, it is not necessary to have graphic acceleration in the computer to run this application, although it is recommended. But if everyone wants have a video chat, you need install a microphone and usb-camera.

IV. CONCLUSION

Using virtual worlds for teaching through Internet allows the students to immerse himself in friendly environments that make the learning process more pleasant. The students can interact with the world in a realistic way. For that reason if the advantages of these worlds are added to the advantage to connect by Internet, this produce that the learning process is easier. In the virtual worlds, the students learn in an individual way interacting with the computer. However, the users can interact with each other in the multi-user virtual worlds. This allows that learning process to be more complete, because students can share experiences and have a teacher who guides them.

The worlds created with VRML have all these advantages, but if a game server is used to design these worlds, more realistic environments can be obtained. Some game server is public domain opencode and they allow us to incorporate all the desired technologies. This is not possible using VRML alone. The game servers incorporate the advantage of modularity and the applications developed can be executed in a great number of platforms. However, these servers are not properly documented and they still present difficulties at the time of generating contents for the environments.

One of the current lines of work we are working on is the improvement and extension of the educational applications presented in this analysis. When the students start using them, their necessities will be monitored and the applications adjusted to meet these necessities. For example, the next step in the virtual classroom application is to specialize it in Computer Graphics teaching.

In order to make these possible, 3D objects will be included in the environment to teach some concepts of Computer Graphics. The 3D video chat application has been designed with an open system for the inclusion of the new technology in the field of the real-time rendering. This application will incorporate in the future a similar system to the virtual classroom with the last techniques of virtual realism.

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