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A DIGITAL ENVIRONMENT DEDICATED TO DISTRIBUTED AND COOPERATIVE PRACTICAL ACTIVITIES

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ABSTRACT

This paper deals with a project that aims at improving students engineering skills especially when the actors of the project, the tasks to be achieved and the knowledge, are distributed between several different countries. The goal is to obtain a digital environment that is capable of hosting distributed and cooperative practical activities for groups of students from different universities and different countries working together on the same activities. In the following sections we lay out our implementation of the virtual classroom metaphor and we describe how we distributed our virtual worlds (X3D/VRML, JavaScript and AJAX). Further in the article we explain how we coped with the constant need for change and extensions in the context of distributed virtual environments: new objects to fill the ever-growing 3D world, and in the context of pedagogical activities: new activities, new topics, new methods, etc, by the means of a plug-in-like concept.

KEY WORDS

Distributed and Cooperative Practical Activities, Virtual Classroom, X3D/VRML world, JavaScript and Ajax3D.

1. INTRODUCTION

1.1 Context

The aspects that make the subject of this paper are the design and implementation of the EMULACTION (Environnement MULTimodal pour Activités Coopératives Transnationales de formatION / Multimodal

Environment for Cooperative and Transnational Training Activities) project.

Most of higher educational establishments are developing their international relations in order to make students' mobility easier. But on a world-wide scale, which is often synonymous with international manpower or knowledge transfers, few establishments point out the real stakes enhancing the links between people and their activities to students.

This project aims to improve the students' practical skills through a distributed learning environment, with support for collaborative tasks and knowledge, which can be accessed by users from different countries.

Our target is to develop a Digital Environment (Web-Based Portal) in order to enable distributed and cooperative practical activities: groups of students from different universities and different countries working together on the same activities.

Practical activities are designed using concept maps and therefore are translated into domain ontology [1].

SCORM (Sharable Content Object Reference Model) is used as a reference model for pedagogical material storage [2].

The first experiments that we will perform with EMULACTION implement practical activities in the following fields: Electronics, Digital Image Processing, Numerical Analysis, Computer Science and Signal Processing. Students from partner Universities are

involved in these experiments. Some of them are also involved into the design of the Digital Environment.

1.2 Digital Environment Architecture

According to the work to be carried out by students, a teacher configures one (or several) virtual room(s) where a group of students will have to work. To configure virtual rooms (Figure 1) means:

1. To define a teaching scenario: number of virtual rooms, assignment of activities to the rooms, order of the rooms according to activities, requirements to access the rooms (pre-requisite);
2. To select communication tools that will be useful for students (chat, forum, blog, voice, video, whiteboard, etc.);
3. To choose software tools to be used by the students according to the nature of the practical activities to carry out.

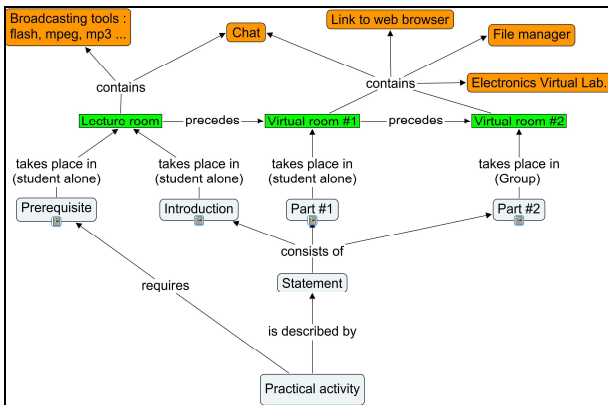


Figure 1. Example of Concept Map

In order to monitor their activities, teachers are able to interact with students in the virtual rooms. Students provide reports from their practical activities. Teachers have access to these documents in order to assess students' work (Figure 2).

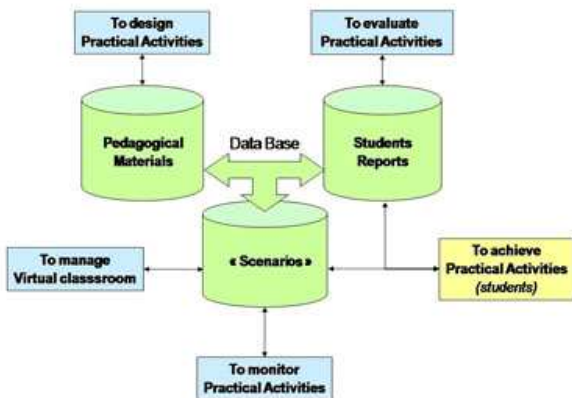


Figure 2. Digital Environment Architecture.

The virtual room is a digital infrastructure that enables a cooperative learning process [3]. Our virtual rooms are developed in X3D (Extensible 3D). Users' interactions are managed through JavaScript and AJAX. On the server side we have a LAMP (Linux, Apache, MySQL, PHP) architecture.

In this paper we will focus on the design and the implementation of these virtual rooms as classrooms.

2 VIRTUAL CLASSROOM METAPHOR

The learning environment we propose is a place where users can draw upon resources to make sense out of things and solve problems; here the learning may be fostered and supported [4].

A predominant metaphor is the "virtual classroom". According to [5], a virtual classroom is a location where students and teachers can communicate and collaborate on the basis of a "room metaphor" [6].

In such a classroom, it is considered that organizing the learners in teams may reduce most of the gaps between the individual knowledge by increasing communication and competition (in this order) [7].

In this way competition becomes cooperation and increases the level of motivation. Hence, the complexity that may arise in "natural" ways even in the most "simple" subjects is a non-declared motivational factor when introduced gradually. Doing so, in the learning context, if the learners' needs are satisfied and their expectations are met, they will strive to develop their professional competences. Indirectly they are contributing to the development of the learning context (see Figure 3).



Figure 3-a. Sample of a shared virtual classroom.



Figure 3-b. Sample of a shared virtual classroom.

The potential of the proposed learning environment is significant because it gives its users space to explore, determine goals and learning activities as attractive concepts.

Students can share the virtual environment in the same way they share the real one, and they naturally start to form small work teams in the virtual setup, based on the real environment configuration. Later, these teams evolve based on the complementary knowledge that the team members possess, in order to assure high-level of team performance. At this point, learning communities emerge [8]. Shared experiences, based on common projects and learning curricula, provide different but complementary perspectives to the subject of the lesson, depending on each individual.

3. DISTRIBUTING VIRTUAL WORLDS

In this section we try to explain why we used the online 3D content paradigm in the educational context, what software solutions we chose to achieve a viable system, and how we made the system extensible.

3.1 Using web3d technologies in education

Very often we were asked a simple but hard to answer question: “*Why are you using 3D for education instead of classical or multimedia approaches?*” In a discussion about Perkins’ point of view about learning environment, expressed in [9], Wilson points out that if we simplify and pack instruction for consumption, the fullness of the subject can be bleached away, and so learning outside the context of its natural setting can also have the same affect [4]. Using 3D virtual environments (VEs) can thus be a very attractive approach in education process by reconstructing, as much as possible, the real environment and context of traditional education.

For example, Chittaro showed in [10] the different components to use in a VE in order to reach such effectiveness:

- Using three dimensional graphics;
- Interacting with another human being;
- Involving more senses in the acquisition process;

- Using collaborative VEs;
- Using virtual teachers, or animated pedagogical agents.

Concerning the domains in which 3D VEs can be used for education purpose one can mention: teaching and learning optics, anatomy, manufacturing and maintenance, robotics, etc. [11]

Relying on the previous arguments and references, we decided to adopt the web3D technology in the realization of the EMULACTION project to preserve the richness of the subject.

3.2 Software architecture of EMULACTION

Most interactive game-like 3D web applications use commercial-ware means such as Adobe Flash¹ or Shockwave² or open-source but cumbersome Java applets which communicate through dully configurable sockets to display content.

One of the main features of EMULACTION is that it uses open-source technology to create a viable distributed learning environment using communication between JavaScript (with AJAX) and the X3D/VRML world. Like any complex web application, it uses a PHP and MySQL backbone for user and interface management, JQuery³ for interface enhancement, and FluxPlayer⁴ for X3D rendering.

Having a means of communication with the 3D world, one now needs to add dynamism to the equation. A virtual world is made of objects that have properties; position, rotation, size, colour, logical variables, input, output and even URL addresses must be stored to properly generate an environment for practical activities. Distribution means multi-user, thus the world must contain avatars to impersonate the users who are present in it. Decorative aspects must also be taken into account to add a realistic touch to the virtual experience. Just storing the objects in the database is not enough though; dynamism means movement and movement means spatial and logical coordinates.

To deal with these musts, EMULACTION benefits from a detailed database enabling the storage of information from the level of classrooms to the one of properties. But this information has to be used to dynamically generate the world, so AJAX was used to retrieve XML documents generated with PHP that contain the current state of the room. To simulate a direct connection with the server, a periodic request is made to update the world.

¹ http://en.wikipedia.org/wiki/Flash_animation

² <http://en.wikipedia.org/wiki/SWF>

³ <http://jquery.com>

⁴ <http://www.vivaty.com>

User interaction is handled through JavaScript object listeners that tap into the X3D embedded file and changes are sent to the server. Avatars are also treated as objects, but the personal avatar is bound to the movements of the user; in this way each user can be aware of other users' location. User's interface is nonetheless important; window space must be used to its fullest to embed all functionalities of the application without the need to scroll down. JQuery is a JavaScript framework that makes working with draggable windows and collapsing tabs easy, and makes the choice for EMULACTION's user interface.

A window-oriented interface is used to exhibit the room a user is present in, along with additional tools, such as text/voice/video chat allowing communication between online users, as well as other tools such text/code editor, workspace file manager, etc. for a smooth functionality.

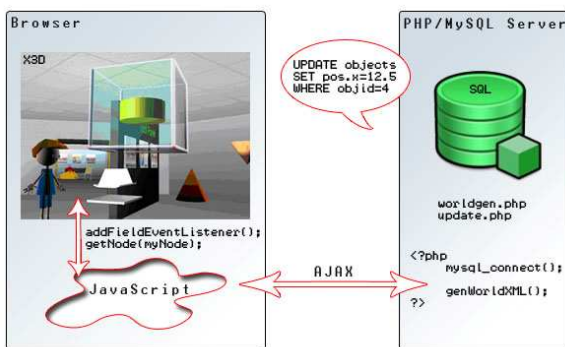


Figure 4. Architecture and working principle diagram of EMULACTION

Figure 4 describes the communication that takes place between the components of the application. A robust object-oriented JavaScript engine solves client-side management issues, while an AJAX module is used to query for the world's current state and to update the server with information. The update rate can be set down to 100 milliseconds without crashing the browser and resembles a real-time connection, making it possible for users to visualize the actions of fellow classmates and to interact.

3.3. Plug-in concept

When developing an application, regardless of the field in which it will be used, one needs stable software architecture, code flexibility, but most importantly a means to extend the life of the application. Moreover, according to Wilson, an environment good for learning cannot be fully pre-packaged and defined [6]. This is the reason why we implemented a mechanism of plug-ins.

The concept of plug-ins is a widely-known and efficient solution for enabling an application to be extended after its development has ended. A plug-in is a piece of code

that can be developed by a third party and inserted into an application for usage. In the context of distributed virtual environments there is constant need for change: new objects to fill the ever-growing 3D world.

Many successful web applications and software use the plug-in paradigm to enhance user's interactivity, security or performance (e.g.: Mozilla Firefox⁵, Joomla⁶, etc.).

To set grounds for plug-in support, a developer should separate the software logics from the visual content. The project EMULACTION makes use of a MySQL database to store the configurations of the virtual classrooms that are later used to create instances in which the users can practice. The main principle on which the web application was based is to provide a flexible framework for classroom creation; a plug-in installation form is available that enables the teacher to use new educational entities such as sonar scanners, electronic circuit boards, graph simulators, etc. As simple as it may sound, a single object may use quite a lot of files to provide its functionality, thus we decided to set a standard for zip-archived object packages.

An object package for EMULACTION consists of a main VRML file that may use other *.wrl files or textures inside the archive, and an XML file that instructs the installer module about the properties of that specific object: a property can be any attribute ranging from position to colour or Internet link. The real purpose of the properties is to enable the JavaScript engine to tap into the virtual world and dynamically generate the scene with every stored aspect of it.

The plug-in package was developed with the idea of making its installation as simple as possible in order to increase user's friendship; it consists of a GUI browsing option that allows the user to select the zip archive containing the object package, and an install button (Figure 5.1). Once installed, an object is accessible through the classroom generation module, in which the teacher can choose and place the content of a room (Figure 5.2).

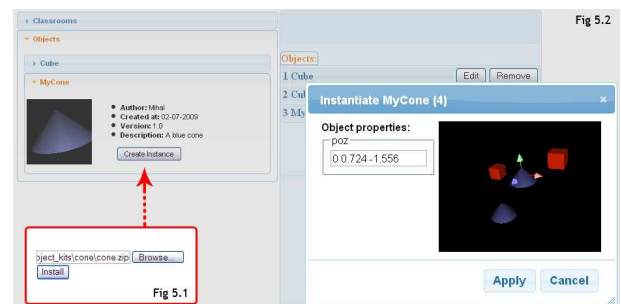


Figure 5. Object installation and classroom configuration interface

⁵ <http://www.mozilla.com>

⁶ <http://www.joomla.org>

Through the concept of plug-ins we can develop the application without the need to create all possible object types (infinite possibilities) from the beginning. This way, third parties can create their own custom virtual gadgets to use inside this educational environment and effectively adapt the system to new educational contexts.

4. CONCLUSIONS AND FUTURE WORK

In this paper we have presented a Digital Environment dedicated for pedagogical purposes. This environment is optimized for Mozilla Firefox and compatible with Microsoft Internet Explorer and Google Chrome. It uses Flux Player as X3D viewer and relies solely on Javascript for object management.

The EMULACTION environment will be tested by the end of this year with students from six countries: Canada, France, Lebanon, Moldova, Romania and Vietnam, complementary to traditional practical activities.

The purpose is not to replace traditional practical activities but to enhance the students' ability to practice. This way, we hope to increase students' performance as much as possible during face-to-face activities, by preserving the richness and the complexity of the learning environment, and providing tools and support for them to "learn their way around" [4].

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