

REAL ENVIRONMENTS MANAGEMENT THROUGH VIRTUAL CAMPUS

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Abstract — Usually, researches about three-dimensional virtual campus present three-dimensional environments as a way to provide to users a sense of location in real campus and offer access to educational tools. A university can offer information for students beyond administrative activities and services for the general society. Then, this work presents the development of a virtual environment that integrates navigation and access to several services (educational, administrative and social) of a real campus. Some services allow changing the real environment since connected to servers and use electronic circuits, sensors and actuators. Thus, the control of the real environment through a Virtual Campus provides the remote access to the physical environment allowing tasks such as connect or disconnect equipments as air-conditioning, computers, projectors and lamps, among others.

Index Terms — Virtual Campus, Collaboration, Environments Management, Virtual Reality.

INTRODUCTION

Until the 70's the access to several services was dependent of the physical presence of individuals into specific places. With the advent of the Internet, some of these services became remotely accessible. Additionally, the development of technologies such as virtual reality allows the creation of three-dimensional spaces composed by realistic graphics and able to be explored by several interaction modes. Nowadays, people can know places never visited before, explore inaccessible structures and interact with the displayed environment [13].

Virtual Reality (VR) systems with focus in the development of Virtual Campus (VC) have been approached in all world [6,10], including Brazil [9]. These researches usually have a specific goal. They can be used for architectural recovery, spatial location or educational purposes. However, a university includes also administrative activities and offers services for the general society. Therefore, integrate activities of these three areas (academic,

administrative and social) in a single system could allow the offer of a greater diversity of services and could give support to students, professors and staff, beyond anyone remotely located. Additionally, several services could be carried out in a collaborative approach, where two or more users collaborate to develop a common task. The main objective in such approach is to enrich academic activities, making possible to teachers and students work together in laboratory experiments.

This work is related to the research of virtual reality environments to support access to information of a university. A case study was applied to the development of a virtual campus of the Federal University of Paraíba (UFPB) and integrated the modeling and development of a three-dimensional interface of its campus to support access institutional services. The innovation is related to the integration of supervision and control activities related to administrative tasks.

VIRTUAL CAMPUS

Generally, a Virtual Campus is a Virtual Environment (VE) which focus is related to university activities. However, the expression “virtual environment” is mentioned into a context that must be analyzed, once it is used to define several types of environments that present some virtual component as Internet sites with hypermedia contents and conventional application [7]. Sometimes, the term is applied to assign virtual learning environments as: Moodle, TelEduc, AulaNet and WebCT, among others [11]. Another form to define the term “virtual environment” refers to an interactive three-dimensional scene stored into a computer and processed in real-time through VR techniques and computer graphics [8]. Therefore, Virtual Campus is a VE of a specific area and can be interpreted in several forms. The commonest use of VR for Virtual Campus refers to two-dimensional places, as Internet sites of educational institutions. These sites provide general information about the institution, extension activities and content for distance learning. In these cases, the Virtual Campi are composed by resources as texts, videos, chats,

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among other functionalities, and have access restrictions for security reasons [1].

With the diffusion of VR techniques, three-dimensional components were integrated to virtual campi and 3D Virtual Campi have been developed. These environments provide stimulus for navigation, better space orientation and can increase the presence sense to their users. Mostly, these Campi offer:

- First person visualization, becoming more natural the navigation process.
- Active exploration, real-time interaction.

There are campi that have as goal the three-dimensional reconstruction of their physical structures, emphasizing architecture details and promoting to users the opportunity to know and/or to explore them from a virtual representation [9,10]. Others campi add education functionalities to the virtual environment. Thus, students can extract or improve their knowledge through videos, chat rooms or educational tools, among others [3,6].

One way to extend the set of tasks and services offered by a three-dimensional Virtual Campus is interconnect the virtual mockups to the real environment and allow the actuation and teleoperation of real devices and equipments. This way, a Virtual Campus could be used for academic activities as such as to supervision, control and maintenance of administrative activities.

TELEOPERATED REAL ENVIRONMENTS

Components of a real environment can be manipulated through remote commands getting an interconnection between a real environment and a computer application [14][15]. With this interconnection, the users can either verify the current real environment characteristics or modify and manage it. A computer representation of the real environment can be obtained by a three-dimensional modeling that reconstruct the visual form of the real space [3]. The communication between virtual and real environments can be performed through the manipulation of graphics components. By this communication, people can access real devices through the Internet, without the necessity of their physical presence [15].

In related works there is an approach called virtual laboratory. These laboratories are virtual environments that allow users to perform remote experiences [16]. There are three types of communication used for virtual laboratories: real to virtual, real to real and virtual to real. The last one is the most important to this work and deals with the manipulation of real objects through components completely virtual.

The remote laboratories emerged as a derivation from virtual laboratories. They are spaces that enable collaborative tasks to enrich users knowledge and promote experimental activities. However, to communicate real and

virtual environments there is a necessity of something that forwards the information from computer to devices. Circuits, sensors and actuators can intermediate such communication and make it possible.

VIRTUAL CAMPUS AND REAL ENVIRONMENTS

The communication between real and virtual environments creates several possibilities of services to be used in the context of a Virtual Campus. One of these possibilities is the remote supervision of administrative resources that exist in the institution. This brings more flexibility to staff and can offer more speed in the solution of problems. As example, employees can, through the virtual environment, remotely turn off electronic devices that are not in use.

The inclusion of management functions in the Campus could open new possibilities of remote services. Among the benefits, could be cited:

- Know the real buildings and spaces of the institution;
- Production of a 24-hour active;
- Maintenance of geographical location aspects and distribution of knowledge according to the real organization;
- Availability of resources for distance learning through educational tools, learning objects, educational games and video classes.
- Incentive to the communication during the learning process, through collaborative tasks that promote arguments and debates among students.
- Possibility to access operational information about courses, lectures and dates of university entrance exam.
- Real environment management by the three-dimensional virtual environment, as energy monitoring.

DEVELOPMENT

The system development of a three-dimensional campus with the mentioned benefits demands many steps, from the construction of the three-dimensional environment to the set up of the communication with real devices. This session intends to present the development process of a collaborative campus. It includes the presentation of the system architecture model used for services integration with the virtual environment; and the three-dimensional environment modeling, that exhibits the virtual campus construct process. The case study is based on the campus of the federal University of Paraíba.

System Architecture

The proposed system is based on a client/server model. In this communication design, the client requests are sent to a central server that is responsible to answer the requests. In the present work, the client receives the requested portion of the virtual environment. When client make changes in the environment, a request is sent to the server. The server

receives client actions and changes the real environment. A set of sensors will change the status of the equipment stored in a database and the server will resend the changes to others clients connected to the same environment immediately after the database update. Figure 1 presents the server model.

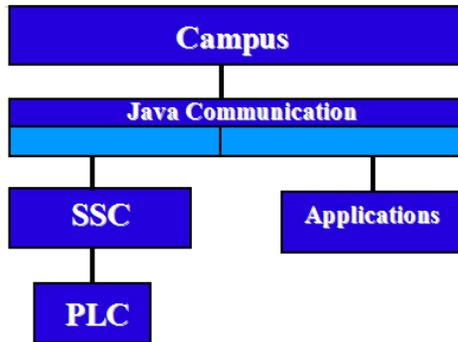


FIGURE 1
GENERAL SYSTEM ARCHITECTURE.

The Campus presented in Figure 1 represents the three-dimensional environment model. The communication level in Java make possible the association of the model with the services applications and with supervising and control systems (SSC). In some cases, a logic controller (PLC) can execute the action over the real equipments. Additionally, services offered by this communication can demand a simple interface for access to teacher’s homepages, department information, registration control, exam scores, educational tools and collaborative laboratory experiments. However, there are several applications developed in the past that need to be adapted to run in a network.

Initially, in a collaborative activity is analyzed the exchange of information among users. A communication layer present in the server and in the client performs this. The implementation of the layer consists on the interconnection of the virtual worlds through a Java socket application. The integration of this layer guarantees consistency among the virtual worlds, i.e., everything that is changed by user in his environment is also changed in others environments.

A data storage system is added to the communication layer and is responsible to store all changeable scene configurations. This module is integrated to the server application and concentrates information about all environments. The storage is done when the server is notified about any change in components of real world. It means that, when one of the clients modify something, a message is sent to the server that send a request to the embedded system. When the real device is modified, the embedded system updates the server database. Thus, the server retransmits it to other clients connected to the same environment.

Environment Modeling

The modeling of the environment demanded specific tools such as Blender [4] to create basic entities and the eXtensible 3D (X3D) [2] to produce and organize the graphic scene. The way used to organize the entities of the campus was the hierarchical model. In this model the entities are arranged in tree structures. This feature makes easier to understand how isolated structures are used to compound the environment. The hierarchy also allows a full entity or part of it to be derived for other entities. For example, to model one of corridors of a building (Figure 3) was built a heterogeneous tree where the corridor is the root. This root is linked to others sub-trees, as rooms, laboratories, bathrooms and secretary. The same method was recursively used for the sub-trees until reach the basic entities as wall, door, floor, chair, window, etc.

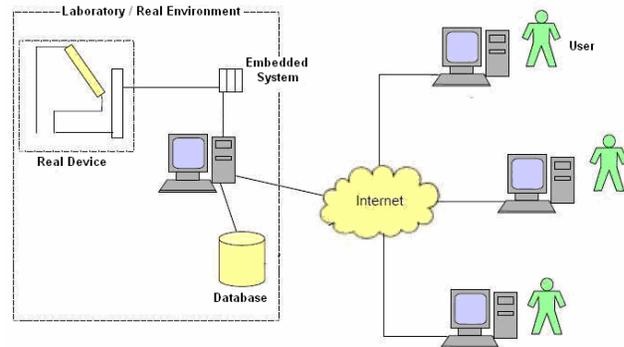


FIGURE 2
DEMONSTRAÇÃO DOS MÓDULOS DO SISTEMA UNIDOS.

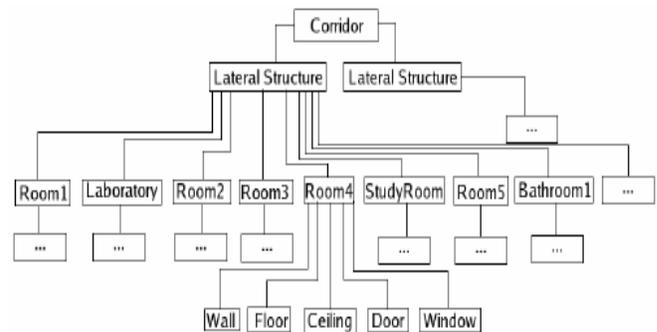


FIGURE 3
GENERAL MODEL OF THE HIERARCHY OF THE CORRIDOR OF THE CCEN.

The basic entities contain several attributes to describe their geometry, appearance and transformations. The geometry description of these entities of the CCEN is composed for the space definition of points and polygons. For the description of the appearance, the material or texture

is specified and associated to an entity. The positioning, orientation and size of the entities in the graphical scene use geometric transformations as scale, rotation and translation.

In the scene tree, it is necessary to define the space position of basic entities and label them. Thus, basic entities can be instanced several times in the 3D model.

RESULTS

The model of the Virtual Campus already contains buildings, departments, connective structures, green areas and land. The land modeling consists on areas demarcation. It improves the localization of structures and preserves distance proportions.

The Virtual Campus offers navigation, access to homepages, access to others 3D environments and access to learning tools, as the Calculadora Estatística [5]. Figure 5 presents entities programmed to start applications in the Virtual Campus.



FIGURE 4

SIDE SIGHT OF ONE UNIT OF THE VIRTUAL CAMPUS AND IS CORRESPONDING IMAGE.

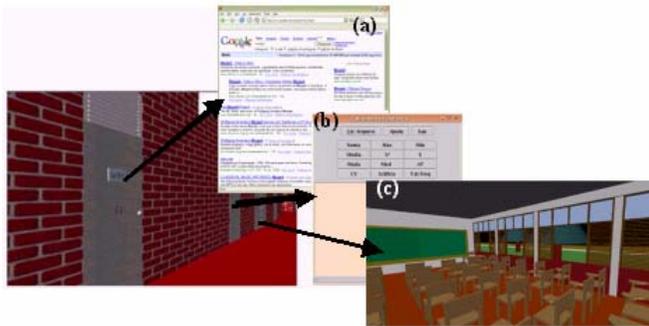


FIGURE 5

EXAMPLE OF THE AVAILABLE APPLICATIONS FROM THE VIRTUAL CAMPUS: WEB PAGES (A), EDUCATIONAL APPLICATIONS (B), AND 3D ENVIRONMENTS (C).

CONCLUSIONS

This research presented a Virtual Campus that intends to integrate to a virtual model several types of application, including collaboration processes and real environments management. As advantage of this system, can be mentioned

the remote access to a set of services (academic, administrative and social) through a model that favors their localization and preserves the administrative organization of the university.

In this sense, it was presented the results of modeling, incorporation of services and design of the integration of collaborative applications and management subsystems. Currently, the VC allows users to explore its structures and access services offered by the model.

Currently, the 3D campus model is being integrated to the collaboration layer and storage database to allow remote modification and supervision of real equipments of the campus. Thus, the system could be extended to get essential information to the monitoring and management of the real environment. In order to reach that, embedded systems have been connected to real equipments and computer systems.

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