3D Virtual Laboratory for Learning Environments: A New Learning Object

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Abstract: Over the years, teaching methods have not achieved significant changes to accompany advances in audiovisual media. Technologies could be implemented in order to create interactive platforms that would improve in quality of teaching, especially in practical disciplines offered in technical and Engineering Courses, with the purpose of enhance the learning process. In addition, many institutions do not have sufficient resources or quality technologies to meet the demand of students and teachers. This work presents a new resource for virtual learning object and virtual laboratory prototype with remote access to improve the quality of classes, in which students can get an immersive experience close to reality, and actually interact and test the knowledge acquired. The objective was to provide remote access to the control
and automation laboratory and optimize practical experiments more safely. As pilot experiment, an environment consisting of a 3D model of the ARM-7220-4 arm robot was developed, presenting the majority of the robot movement functions, as well as mechanical accuracy, geometric and kinematic model of the Robot, and provided access in Moodle for the students of CEFET-MG, Campus Leopoldina. A real robot ARM-7220-4, connected to the virtual tool, responds to commands of manipulation by the environment and can also be monitored in real time through a camera installed in the physical laboratory. The teaching method is established through movement tasks in order to validate the knowledge acquired through bibliographic didactic resources, addressing theoretical aspects. Results of usage analyzes demonstrate that the new resource provides a motivation for participation, interaction and collaboration among the students who have tested the system and presents itself as a promising resource for distance learning. We would like to thank CEFET-MG, CNPq and FNDE for their support in this project.

**Keywords:** Virtual Learning Environment, Virtual Learning Objects, Virtual Lab, Remote Access.
Chapter 32. 3D Virtual Laboratory...

32.1 Introduction

The technologies of audiovisual communication are increasingly present in our daily life, however, they are still insufficient explored in educational institutions.

Because students are already familiar with receiving interactive information across multiple platforms in their homes, these same technologies could be very useful for performing practical activities required to complement the theoretical content offered by the teacher.

The use of new educational tools such as projectors and touch-sensitive frames has brought more interactivity to classrooms, but they still do not offer an immersive experience in which the student can actually interact and test the acquired knowledge.

Many institutions, mainly Engineering courses, also lack of physical and financial resources to match to all students’ needs, and many of them do not even have labs to carry out specific activities.

A virtual learning environment becomes an interesting approach to contribute to new experiences, such as to provide students with a greater involvement with practical activities, inserting virtual objects, similar to real laboratories that arouse the sensation of being physically performing practical and collaborative activities\(^1\). Thus, institutions that do not have sufficient
resources to meet the demand of students and teachers can use more modern and interactive methods for teaching and learning with a low investment.

### 32.2 Purpose

This paper presents a virtual learning object for use in Engineering courses, with a proposal to create a 3D virtual laboratory in which students and teachers interact in an immersive environment.

The virtual environment is an alternative both to teaching theory and teaching in practice, with the possibility of visualizing the interaction of a real robot through the control of a virtual robot.

By accessing the virtual object, the student can develop his laboratory activities provided by the Moodle platform\(^2\), and also control real equipment without the need of physical presence, besides making available to the institution a new technological resource to improve the practical quality in teaching of Engineering.

### 32.3 Design

For the development of the laboratory a virtual learning object was implemented using the Unity 3D software tool\(^3\), consisting of a model of the robotic arm ARM-7220-4\(^4\) and with basic functions of driving the 6 motors of
the robotic joints for manipulation of the arm robot. The virtual object and a camera were embedded in the Moodle through an application server for remote access, as shown in figure 32.1.

![Figure 32.1 – Virtual Teaching Environment Scheme.](image)

The learning tool was implemented with basic activities to motivate student interaction. The tasks were associated to the rotation parameters of the robotic arm motors, according to figure 32.2. For each task, the parameters were released one by one as the students succeeded in the previous tasks.

At the end of each task, the student can confirm and visualize the execution of the real robot through the camera. With this, it was possible to provide an immersive and more pleasant environment for students.

### 32.4 Results

For the evaluation of the laboratory, a questionnaire was applied to each student who participated in the experiment. The tasks were applied to the
students of the Control and Automation Engineering course at CEFET-MG campus Leopoldina. Only 23% of the students had participated in distance learning courses or had contact with other types of virtual learning object, but most (75%) showed great interest in the object. In relation to knowledge of robotics the level of contribution of the object in the course was evaluated. The student’s level of knowledge in robotics was considered reasonable, but
93% showed great interest in learning through the virtual environment. All students approved the use of the new teaching object and confirmed that it can be essential to encourage and help learning.

32.5 Conclusions

The implementation of a virtual laboratory with remote access gives students a great immersion and interactivity with learning objects, as well as facilitate the accomplishment of practical activities in the disciplines of the Engineering course. This paper presents a proposal for a 3D virtual laboratory integrated into Moodle that can be replicated in remote simulation of laboratory experiments, making institutions that do not have such equipment can use them, requiring or not supervision for the activities, since it reduces the risk of damaging the equipment or hurting students. In addition, creating mechanisms for the interaction between virtual and real equipment.

The virtual environment was offered to control and automation Engineering students who positively evaluated the learning resource, indicating a new opportunity for the construction of increasingly interactive educational tools.
Bibliography


