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COMPUTED BASED TRAINING FOR TEACHING INDUSTRIAL ROBOTICS

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Abstract. *This work consists on the development of didactic material, based on the educational possibilities that offer the multimedia techniques. The objective is to develop educational methodology based on the interactivity of multimedia that embraces hipertext, 2D and 3D graphics, visual animation, sound, digital picture and video of non-lineal edition.*

Keywords: *Education, Multimedia, Simulation, Robotics*

1. INTRODUCTION

This work is being developed inside the frame of the project: "Interactive Multimedia for Training in Industrial Manufacturing" that is carried out in the "Laboratorio de Multimedios Industriales" of the "Secretaría de Ciencia y Tecnología de la Universidad Tecnológica Nacional (UTN)". The developed didactic material will be part of a series of fascicles that will constitute an electronic library directed to learning several concurrent disciplines to Industrial Manufacturing Engineering. The "final product" is a transportable educational software in Compact Disc (CD) that can be run in a standard PC. The first work was developed on robotics and it will capitalize experiences achieved in investigations and developments carried out in "Universidad Tecnológica Nacional" in the disciplines of automatic control, electronics, computacional design CAD, simulation and robotics.

2. OVERVIEW

The origin of this work was the whole design and construction of a 5 DOF anthropomorphous robot, named RSA-1 inside the engineering college, see "Fig. 1" (Morán & Abate, 1993). Considering later the development of a D-H model proposed to solve the kinematics manipulator problem (Morán & Sánchez López & Apóstoli, 1996). Then, following with the direct and inverse manipulator kinematics solutions, and later linking altogheter with a virtual reality and 3D graphics facility for simulation tasks (Artola & Apóstoli & Kurbán, 1999).

For such studies, several softwares were used like: "Mathematica" used to manage symbolic mathematics in kinematics analysis; C++ programming language used for developing a 3D graphics engine utilized in simulation and virtual reality; "3D Studio Max"

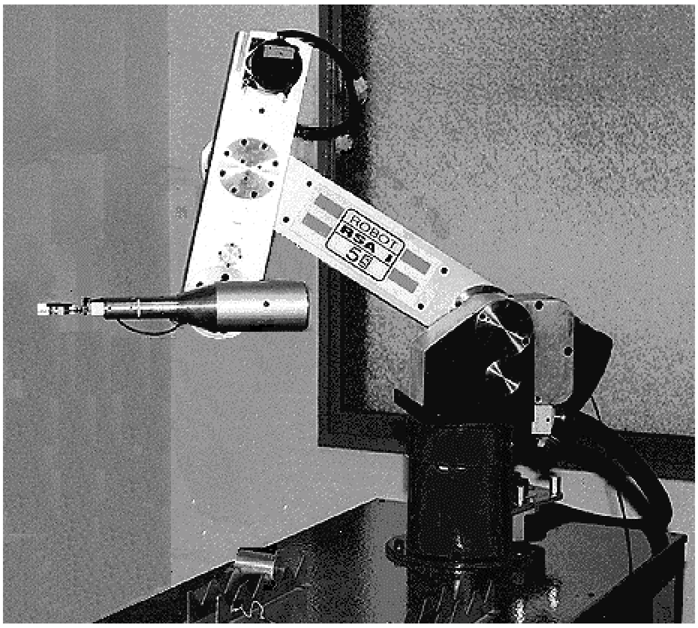


Figure 1- Robot RSA1

also used for implementation of robot's animation, starting from CAD files developed in mechanical design.; “Autocad 14” and “Mechanical Desktop 2” used in mechanical design (CAD); “Adobe Premier 4” used for non-linear editing; and others.

Named experiences and materials developed were “blended” in an authorware package (Asymetrix Toolbook 4) which will delivery the run-time prototype recorded in CD. In adittion, text, hipertext, 2D and 3D graphics, visual animation, sound, digital pictures taken with a Sony-Mavica’s Disquette Camera, and robot’s videos and sound footage captured with a Sony HI-8 camera and digitized with a Miro Mjpg conversion card, were integrated.

The possibility to carry out an educational software with multimedia techniques evolves, especially, from experiences obtained in simulation and animation. Subsequently we will decribe, briefly, the simulation procedures and the multimedia techniques used.

2.1 Simulation

Graphic simulation of a robot is very useful in the debugging process of control equations (Luciano & Apóstoli, 1997). For example, when solving the direct and inverse kinematics, it is convenient to visualize the results in three-dimensional graphics. These graphic tools used in debugging processes are easily transformed into didactic material.

In kinematics analysis, the developed software manages a virtual reality environment. We can appreciate in “Fig. 2” the user interface and in “Fig. 3” the virtual environment.

With this software it is possible to control the values of the joint variables or the position and orientation of the robot's Tool Center Point (TCP). The user can navigate in the 3D-virtual environment where it will be able to observe the location of the robot's links and the frames attached to them. This way, the understanding of the kinematics problem is more easily acquired. The development of this software was based on OpenGL routines. A Dinamic Linked Library (Dll) was implemented in C++ to provide an interface between low level graphic routines (OpenGL) and a high level programming language like Delphi 3. This Dll has a modular structure (Ferraro, 1995).

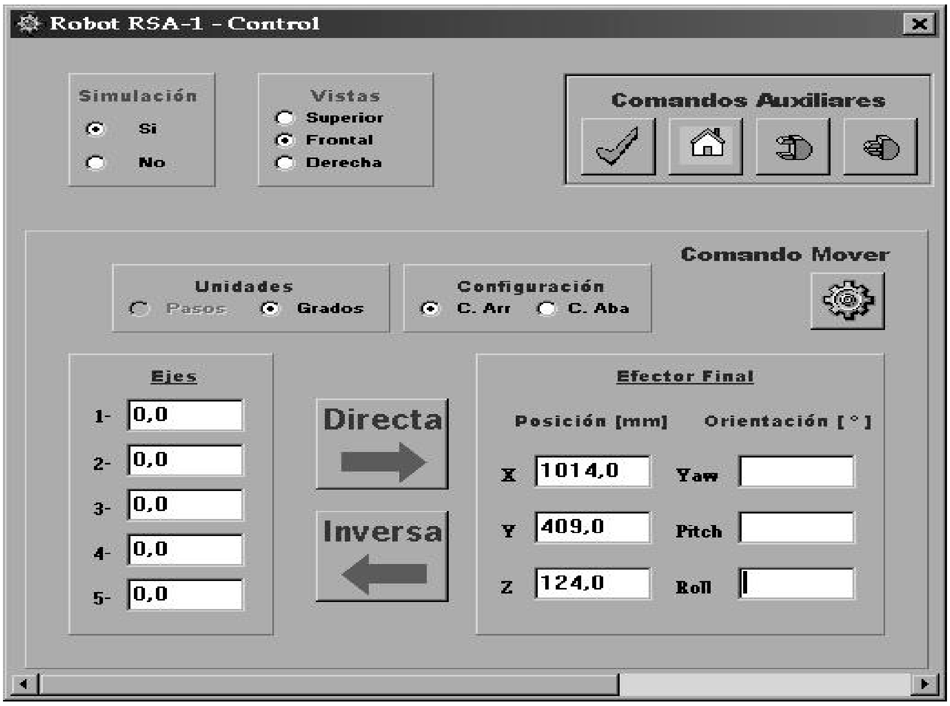


Figure 2- User Interface

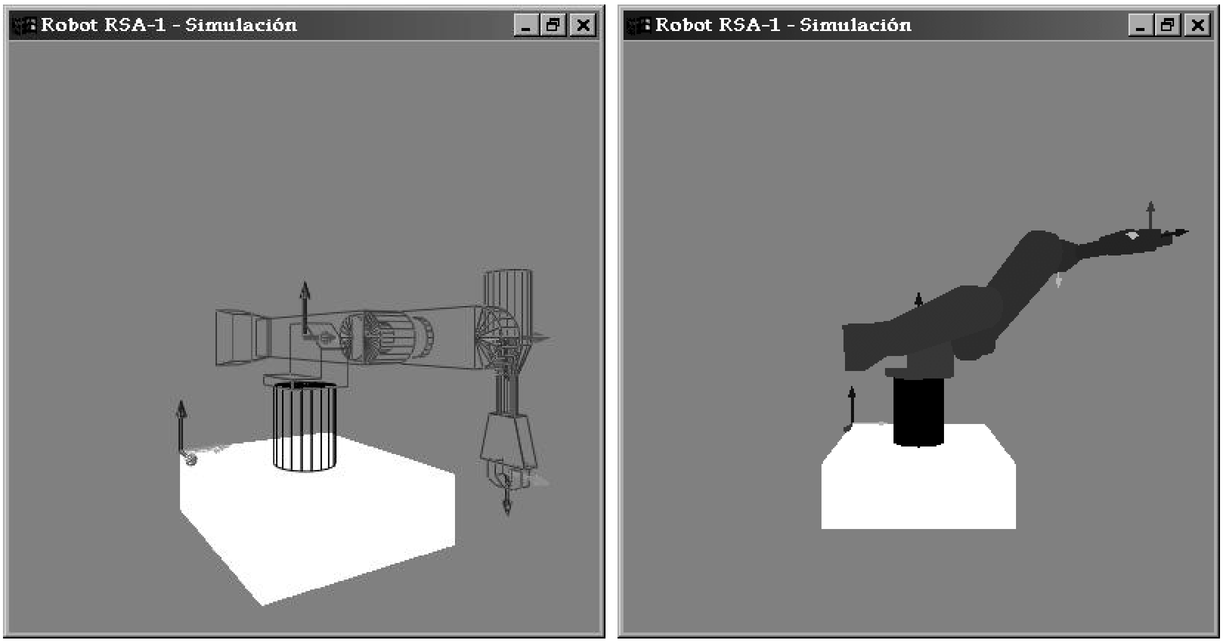


Figure 3- Virtual Reality Environment

This Dll is a graphic function engine that allow to control and handle computer resources. The general scheme is shown in “Fig. 4". The virtual environment consists in a set of 3d-scenes. This scenes can be created “off line", in a script file. Also, we can use CAD files to create scenes. See “Fig. 5". Moreover, with 3D CAD: Autocad 14, Mechanical Desktop 2 and 3D Studio Max 2, a more precise mechanical representation of the robot may be acquired and used in the virtual environment.

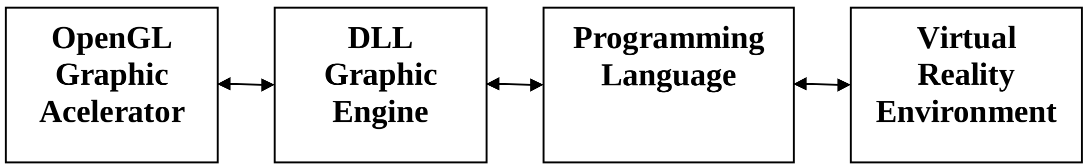


Figure 4

Obviously, these scenes can be created at run-time, improving the speed in the program initialization, since it doesn't look for files in disk.

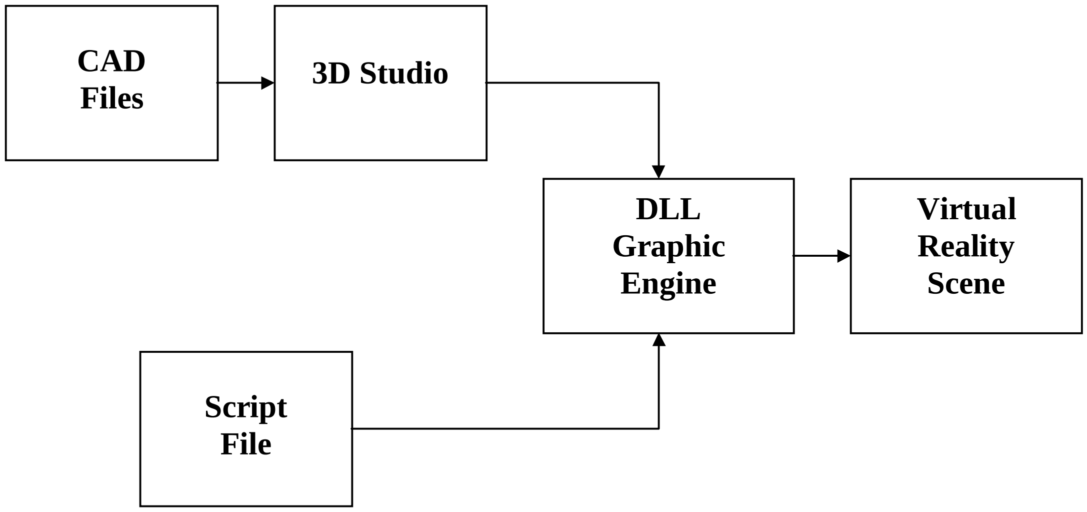


Figure 5- Creation of a Virtual Scene

2.2 Multimedia

Figure 6 shows the main "top cover" book window of the "Introducción a la Robótica" multimedia presentation developed on Asymetrix Toolbook 4. On top there is a digital photo captured in Jpeg format presenting the robot RSA-1 and the tutorial CNC 3 axes mill (Apóstoli & Morán & Tromboto, 1993).
Under the photo there are two transparent pushbuttons: one with label "atrás" for searching the previous pages and the other "adelante" for the following ones. At the botton place the user can find several head chapter names, some of them with "hot word" actions: in this case the mouse arrow change to the classical little hand and simultaneosly appears a pop window called "viewer". Inside the viewer the author can show a photo, (Fig. 7), or a video in avi format (Fig. 8) on a "stage" with some options. At the stage the user can press three pushbuttons: one for starting the video, one for pausing "pausa" and finally the stop button "detener".

This multimedia environment can help students to interact with the tutorial course, regulating the knowledge rithm and going forth and back inside the lessons acccording with each personal preference.

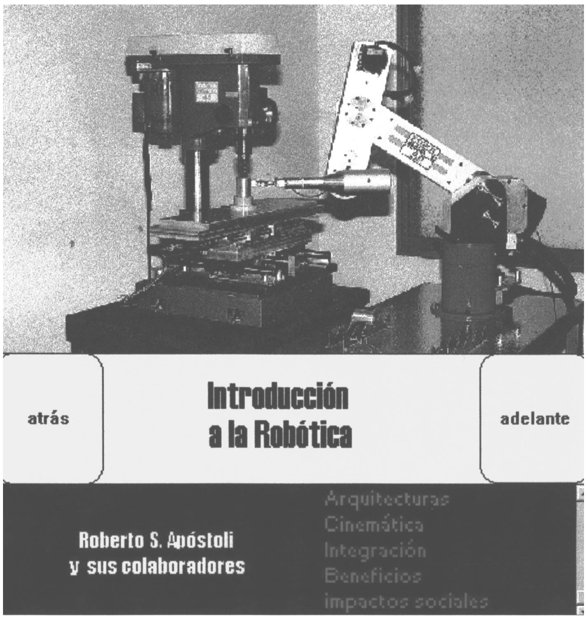
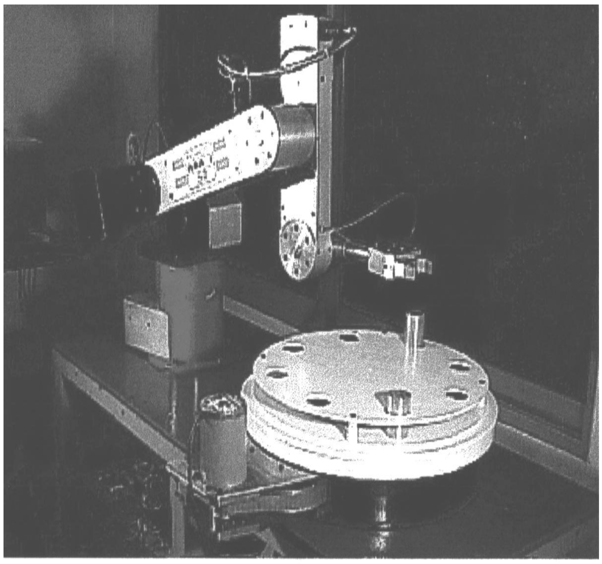


Figure 6



Robot RSA 1 de 5 ejes articulados

Figure 7

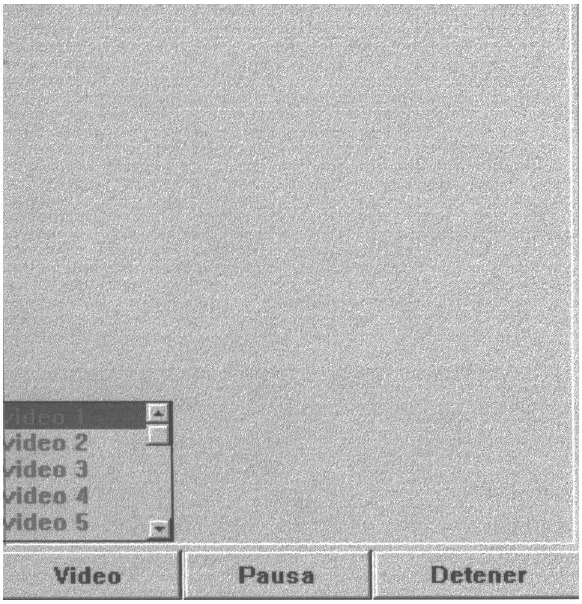


Figure 8

3. CONCLUSIONS

Teaching of robotics through multimedia material supposes an appreciable improvement to those given by the classic bibliography. Specially, experimentation in a simulated robot, allows to achieve a clearer understanding of treated problems in robotics. The easiness, flexibility, and economicity, for installing and using a multimedia software opens the doors of multimedia education; with the final objective of transferring the knowledge from reserching environment to academic environment. A beta version program is actually under consideration. Students and Professors are evaluating the samples, which is a real technology transference from R&D to college classrooms.

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