FRAMEWORK FOR VIRTUAL CONTROL DESK PROJECTS

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ABSTRACT

Through the recent advances of the Brazilian nuclear program, the creation of virtual control desks allows an ergonomic evaluation and technique of the same, even before its physical implementation, reducing costs and time in addition to allow the virtual training of operators. This project intends to develop a "framework" where the components of a real control desk are available for creating a virtual desk, continuing the project control desk developed at the Laboratório de Interface Homem Sistema do IEN (LABHIS/IEN). Through the C++ programming language integrated with the OPENGL graphics library was possible to create the desk and its components, allowing a graphical modeling in 3D (stereo) of a virtual control desk where the operator, with the aid of GLUI user interface library, can choose what and where the components are positioned on the bench, and select the type of desk wanted from the pre-defined templates. Finally, with the control desk mounted and configured, enabling a virtual interaction with operators, making possible to reproduce its functionalities.
1. INTRODUCTION

Virtual Reality (VR), or virtual environment, can be applied in the most different areas of the human knowledge with great potential and applicability in diverse areas, since ergonomic training and studies to virtual simulation and experimentations (Mól et. al. 2007). This technology allows to recreate representations next to the reality for an individual, being made possible an interaction in real time.

According to the Comissão Nacional de Energia Nuclear (CNEN) recently Brazil decided to construct a new nuclear research reactor called Reator Multipropósito Brasileiro (RMB), with this increasing scientific development and technological, mainly in the nuclear sector. It is important to take care of the related demands on training projects of control desks and development of support systems for operation.

This work consists of the development a specific tool for the nuclear area using techniques of Virtual Reality. Through a tool developed in this work it is possible to create virtual control desks and its respective components, being able to be used for evaluation before its physical construction and for training of operators. More specifically, the work has the objective the creation of a “framework” for nuclear projects desks controls. Becoming possible to choose a desk from the types of predefined group of benches and to freely modify the position of its components, as: buttons, leds, meters and other types. With this allowing the user to use a virtual desk mounted and configured in accordance with the characteristics that he judge necessary, being able to be used for the operators in simulation.

2. METHODOLOGY

This project is based on the methodology presented for Mól et. al. (2008) and Aghina et. al. (2007, 2009), where a virtual control desk was developed with the objective to substitute the interface of synoptic screens used by the simulator of a PWR nuclear power plant (NPP) located in Laboratório de Interface Homem-Sistema - IEN (LABHIS/IEN). Aghina`s work components of a desk of real control are available for modeling 3D (stereo) of a control desk. These components are implemented in programming language C++ with the graphical package OpenGL, and the aid of library GLUI. Allowing a graphical modeling of the control desk, beyond the use of an user interface.

To follow the used tools for the development of this work, as well as creating and configuring a control desk and the procedure for its simulation will be described.

2.1. Tools

2.1.1. C++

C++ is a type of programming language, considered one of most used in the world. Being projected to serve as a improved version of the programming language C, meaning literally “C increased”. The language is guided objects and considered of high level. However, possessing the advantage to combine characteristics of languages low-level. (MIZRAHI, 2008).
According Mizrahi (2008), the main difference of C++ for language C is to be guides objects. The C++ allows that the programmers separate types of specific data of the program through the use of classes. Instances of these types of data are known as objects and can contain variable, constants, functions and operators defined by the programmer.

Making use of the C++ language, the components of a desk were able to be created using separate classes. With this, facilitating the repetition of some elements of one exactly type of component.

2.1.2. OpenGL

In accordance with Shreiner et. al. (2004), OpenGL is a software interface to graphics hardware. With OpenGL, you must build your desired model from a small set of geometric primitives - points, lines, and polygons.

A library of functions for this API is OpenGL utility library (GLUT), which provides many of the modeling features, such as quadric surfaces and curves, and surfaces NURBS (Non Uniform Rational Basis Spline). In addition to providing a simple interface for manipulating windows, mouse, keyboard and other input devices. (SHREINER et. al., 2004).

The OpenGL with the use of library GLUT allowed that the control desks and its respective components, as: buttons, mini buttons, leds, meters and pins, to be created virtually. Also making possible control over the functions of the mouse and keyboard, and allowing a 3D modeling (stereo).

2.1.3. GLUI

GLUI is a GLUT-based C++ user interface library which provides controls such as buttons, checkboxes, radio buttons, spinners, and listboxes to OpenGL applications. (RADEMACHER, 1999).

This library has as main objective to provide user interface elements of pattern, not present in OpenGL and GLUT. As was written based on GLUT, not dependent on the operating system so that applications can be platform independent. (RADEMACHER, 1999).

Library GLUI made possible to develop an interface for the user, thus making possible to create menus containing controls simplifying the manipulation of the table. And providing a more intuitive environment for developing graphical applications.
3. APPLICATION

The following shows how to build and edit a desk using the virtual control program developed. And for comparison purposes will be created one with the same characteristics of the project of control desk from Aghina et. al. (2007, 2009) and Mól et. al. (2008).

3.1. Creation of Control Desk

This program possess four types of predefined desks of control, Fig. 1. Therefore, it is necessary to choose between the model types available. To do this you must click with the left mouse button on the desired template in the “Type of Desk”. After it is necessary to add the components that will be present in the control desk, in the section “Objects” are present all the available components. With the object selected is necessary to press the button “Add Components”, thus making with that when click with the right button of mouse on the bench this object is added to the position where the mouse is present. If there is a need to remove objects, a click in the section “Remove Components” enable this function. The result is that when you press the right mouse button on the component to be removed, it will be deleted.

Finally, with the control desk in accordance with the user is possible to save it. For this in the section “Save Desks” it is necessary that a name is attributed for it and pressured the button “Save”, Fig. 1. When you start the program is allowed to load a safe desk previously. In the section “Load Desks” displays a list of all saved in the system. Then, one must be chosen and pressuring the button “Load”, the desk will be shown for the user.

Figure 1. Creation of control desk with its components.
3.2. Edition of Control Desk

To facilitate the edition of the desk another menu of options was developed. For it to be displayed is necessary a click in the button “Edit Objects”, present in the Fig. 1. With this, a click with the right button of mouse in the component will show its information in this panel, Fig. 2, thus being able to be edited in accordance with the user. Certain elements of the control desk possess exclusive characteristics, these will only be enabled case the selected object are the correspondent to this section. The sections “Object” and “Server” are present for all the components, the first being responsible for editing the position where the object is and the second for the communication of this with the server, making the simulation next to the reality for the operators.

These alterations will only occur after pressing the button “Edit Object”. After that, in case that it is desired to finish the edition must be pressured the button “Close Edit”, bringing back the initial menu. Being necessary to repeat the process of saving for the desk be stored.

Figure 2. Components control desk edition.
3.3. Procedure for the Simulation

At first, it is necessary to use a control desk created and configured. In the section “Execute” it is present two buttons, by pressing one of them will start the simulation. The first button called “Offline” will go to reproduce the program without the use of the communication with the server, thus allowing the evaluation of the construction of the desk before its physical implementation. The second called “Online” will reproduce the program communicating with the server, making it possible to simulate situations for operators of a nuclear plant or simply for training.

With the program running the simulation, the added components will reproduce its respective functionalities, as a button will exert a function when clicked with the mouse. In addition, certain commands of the keyboard possess programmed actions. The keyboard keys of arrows and the keyboard keys <a>, <w>, <s> e <d> respectively are responsible for the movement and camera view on the computer screen. The keyboard keys <+> e <-> correspond to the approach of the camera in the control desk. And the keyboard keys <1>, <2> e <3> are used to focus the camera on different benches present.

4. RESULTS

With the use of framework it was possible to develop a desk of similar control to the project of Aghina et. al. (2007, 2009) and Mól et. al. (2008). The tool made possible the construction of this with efficient form and providing a bigger interaction with the user. Also, allowing edit it at any time if needed.

The figure below shows the program executing this control desk, previously mounted and configured.

![Figure 3. Virtual control desk.](image)
5. CONCLUSIONS

This work showed the possibility of the use of the Virtual Reality for the development of a tool for creation of virtual control desks. Since the performance of operators depends on a number of factors, including the structuring of the room and of the control desk, with this framework we can model control desks, and can even choose what and where the components are positioned on the bench. Being able to be used for training of operators and simulation, and provide an ergonomic evaluation and technique of the same ones. Future improvements, such as the inclusion of new components and other types of group of benches models can make this tool more efficient.

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