VRCEMIG: a Virtual Reality System for Real Time Control of Electric Substations

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ABSTRACT

This research demonstration presents an integrated hardware and software platform developed for controlling electric substations, through a virtual environment. Each 3D substation is integrated with the supervision, data acquisition and control center of a real electric energy company. Today, this is pursued on a 2D diagram, lacking intuitiveness. VRCEMIG explores techniques to provide deeper immersion and intuitive interactions in order to support not only training for future employees, but also real time operation. During the demonstration visitors will be able to use different devices such as joystick, gamepad and VR glasses to navigate and operate an electric substation (for training purposes only). This substation belongs to the Brazilian company CEMIG, a research partner.

Keywords: virtual reality, electric power substations, operation control system.

1 VRCEMIG

The objective of the VRCEMIG system is to allow field events to update the reality of the control centre of the electric energy company. So is the opposite: changes in the components from the control centre will update electric component behaviour in the field. This strategy also allows the energy company to save time and money during learning phase. In fact, the apprentices can operate different substations from a specific point (company´s control centre), similar to a flight simulation system. Moreover, this virtual environment allows users to explore different possibilities without compromising their safety, in training mode.

1.1 The demonstration

In this demo, users will be able to navigate, explore the conditions of electrical components and to control a virtual electric substation. They will have the opportunity to evaluate the benefits brought by Virtual Reality when compared to traditional control procedure (through a 2D single line diagram). To do so, they will be provided with different input/output devices as shown in Figure 1, where a Director´s company is evaluating the system. Besides, different interaction metaphors can be tested for intuitiveness. Following CEMIG´s stakeholder's requests, the system allows an electric component behavior to change according to user inputs. The user will actually be able to change the electric component parameters and check the database updating, in real time. This is important since the energy company is responsible for more than 60 substations, from large hydroelectric plants to small ones.

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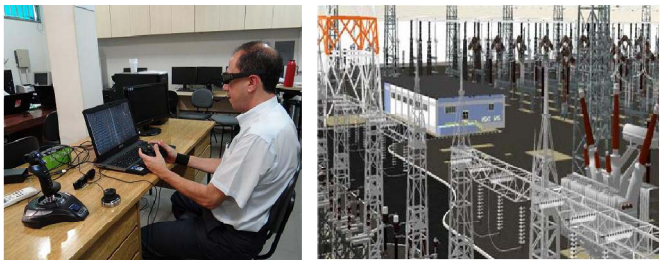

Figure 1: CEMIG´s Director evaluating the system (left) and one of the corresponding system´s view (right).

1.2 Demo layout

Figure 2 shows the layout for our demonstration. Visitors will have the opportunity to navigate in the virtual substation using a computer screen. Input commands can be sent by joystick and gamepad. Stereoscopic view is achieved through VR glasses. A testing database, collected from the field, will be provided so the user can perform changes in the electric components through the Internet, by a Web Service. In this sense, he/she can evaluate real time simulations.

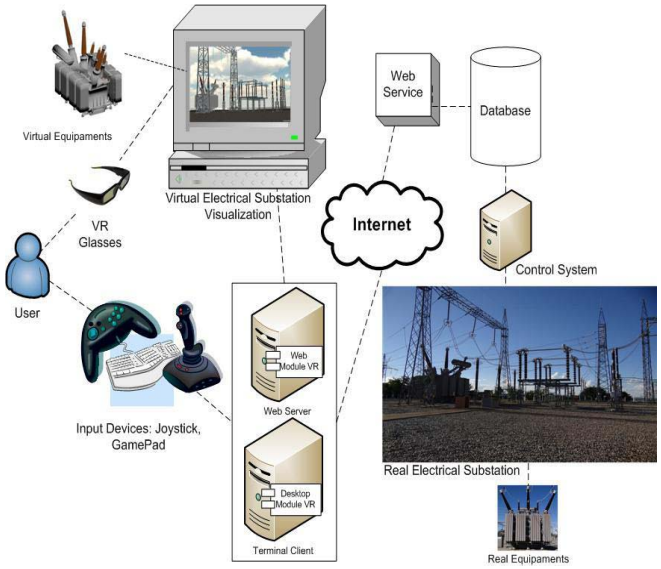

Figure 2: Schematic layout of the demonstration.

Demo video URL:
http://www.rv.eletrica.ufu.br/rvcemig/video/index.html.

2 VIRTUAL AND AUGMENTED REALITY GROUP

The Virtual and Augmented Reality Group at UFU´s Faculty of Electrical Engineering (www.rv.eletrica.ufu.br) is a research team developing and transferring techniques and technology related to Virtual and Augmented Reality applications. The lab is led by Professor Alexandre Cardoso, an Associated Professor at UFU. Professor Cardoso was the President of the Brazilian Virtual Reality Special Interest Group from 2005 to 2007. He is considered as a VR and AR pioneer in Brazil. During the past years, the lab has contributed in different areas of applications. Two of them are presented in the following sections.

2.1 Engineering

Since 2000, the group has been developing research in the control and simulation of myoelectric prosthesis with the Biomedical Engineering researchers at UFU. At the beginning, Virtual Reality was used to control an avatar´s arm, according to EMG signals (muscle activity) read from real patients [1]. Later, to provide a more natural and intuitive interface, Augmented Reality was explored to simulate a virtual prosthesis, when EMG signal are read from an electronic device, in real time [2], as illustrated in Figure 3. Other VR and AR applications in human rehabilitation include the works in [3] and [4].

Figure 3: Augmented Reality applied to real time prosthesis simulation and control. EMG signals are collected from user´s remaining muscles.

In Electrical Engineering, the group has also developed several applications for simulation and teaching of the electrical energy phenomena, including the one that will be presented in this demo. Figure 4 shows one application where a motor-fan engine is realistically tested (with engineering parameters in energetic efficiency), using Virtual Reality. Besides safety, details of the electric components can be explored. Note, for example, the fan´s transparency and the electric motor disassembly. These features can only be achieved within a virtual environment.

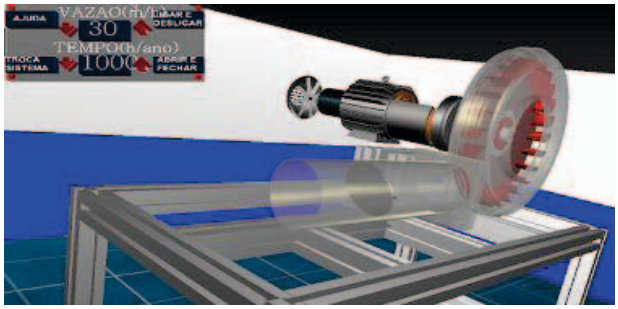

Figure 4: A VR application for electric energetic efficiency.

2.2 Natural User Interfaces (NUI)

To provide natural and effective interaction between humans and computers is not an easy task. On other hand, human beings naturally communicate themselves by means of gestures, expressions and movements. Thus, the term NUI is used to a user interface that is (1) effectively invisible, or becomes invisible with successive learned interactions, to its users, and (2) is based on natural elements. Recently, our research team has also focused on NUI applications that are achieved by means of Virtual and Augmented Reality techniques. Figure 5 shows some of the applications as related in [5] and [6].

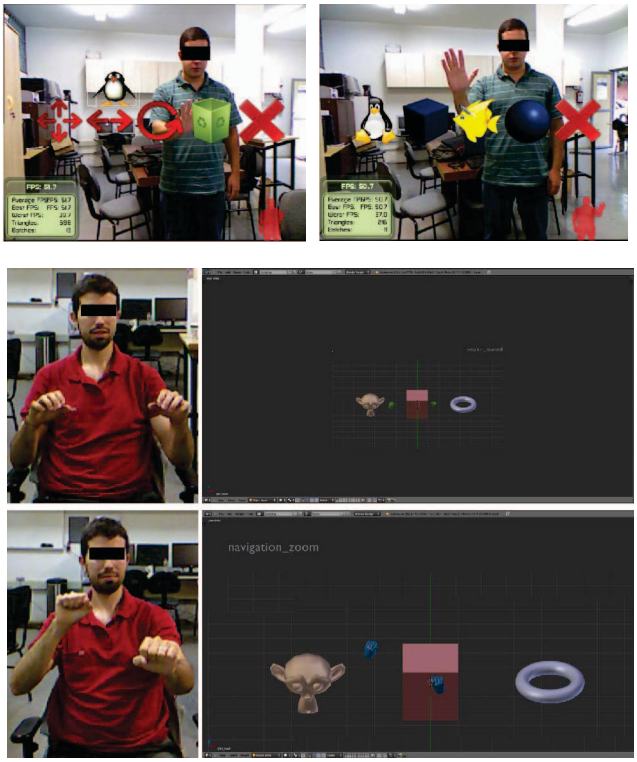

Figure 5: NUI applications at UFU´s research group.

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