VRCEMIG: A novel approach to power substation control

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(a) (b) (c) (d)

Figure 1: (a) Single Line Diagram, (b) Corresponding (ellipse) virtual representation, (c) Real time data reading, (d) User with VR Oculus.

Abstract

In this work, we propose a Virtual Reality based solution to provide a more natural and intuitive environment for controlling electrical operation centers. The research is being carried out with the collaboration of one electric company called Cemig. The novelty of this approach is the ability operators will have to manage the electric system and its electric components by being immersed within a 3D world, reflecting the very true arrangement found in the real electrical substation. Besides, the solution has been designed in a way to provide the operator with all supervisory data in the same virtual environment.
We have conducted experiments with the electric company operators Mental efforts to understand the reality of the field have been reduced, according to Cemig's employees. They also claim that a unique environment with all data integrated is very important for taking engineering decisions.

Keywords: Virtual Reality, Power Electrical Substation, Real time operation.

Concepts: **• Computing methodologies~Virtual reality;**
• Hardware~Power and energy

1 introduction

Providing electric energy is crucial for the development of countries and nations. However, it is a high complexity activity that must be performed by control center operators of electric companies. Moreover, a national (or federal state) power system is currently represented by SLDs (*Single-Line Diagrams*), which is a 2D representation of a real electric substation. Such representation, during the controlling task, requires a great deal of mental effort by the operators. As a matter of fact, a single SLD line corresponds to a 3-phase transmission line in an electrical substation. In turn, each phase is composed by a sequence of electric components (Figures 1a and 1b). When an interference occurs in real life, the operator can hardly say in which phase or electric component the problem is taking place. The only solution is to make voice calls to other operators in the field, hundreds of kilometers away from the control center.
Furthermore, several parameters (such as the oil level within an electric transformer, *on/off* status of a circuit breaker etc.) have to be read and managed at real time. These parameters are provided by a SCADA (*Supervisory Control and Data Acquisition*) system. However, traditional computational solutions do not support the handling of all this information in a unique environment. The operator has to switch from one computer screen to another to manage all strategic data. This approach is time-consuming and hinders efficiency when dealing with critical situations.
Finally, electrical companies spend millions of dollars in training, since they have to send their operators to different electric substations, spread along their area of actuation. Food, transport and accommodation must be provided for every technical visit.
In this work, we propose a Virtual Reality based solution to provide a more natural and intuitive environment for controlling operation centers. The research is being carried out with the collaboration of one electric company called Cemig. The novelty of this approach is the ability operators will have to manage the electric system and its electric components by being immersed within a 3D world, reflecting the very true arrangement found in the real electrical substation. Besides, the solution has been designed in a way to provide the operator with all supervisory data in the same virtual environment (Figure 1c). Thus, there is no need to move from one widget to another when collecting different information.

2 Our Approach

A key finding of our approach was to design interaction metaphors that allow the operator to manage the electric system

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SIGGRAPH 2016 Posters, July 24-28, 2016, Anaheim, CA
ISBN: 978-1-4503-4371-8/16/07
DOI: http://dx.doi.org/10.1145/2945078.2945081

without the need for leaving the virtual environment. Indeed, in order to support online reading of supervisory data, a WebService interface has been implemented. This service supports communication between the virtual environment and the control center database information. When navigating in a virtual substation, the user can, by proximity rules, read all parameters of a specific electric component, in real time. Thus, he can identify what phase/electric component is presenting difficulties or disorders during system operation. Figure 2 presents a layout of the proposed solution.

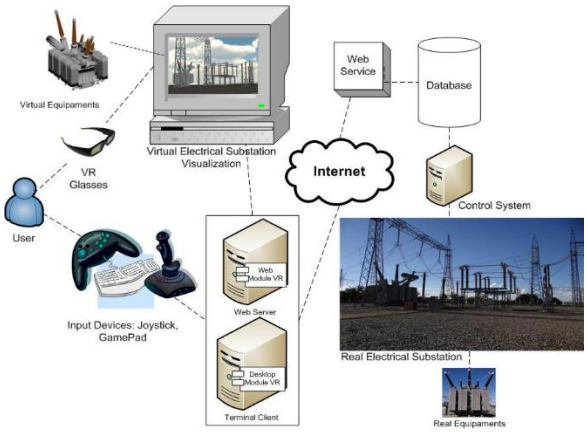

Figure 2: RVCEMIG – Component diagram.

We have conducted experiments with the electric company operators as shown in Figure 1d. First results demonstrate the feasibility of the proposed solution. Mental efforts to understand the reality of the field have been reduced, according to Cemig's employees. They also claim that a unique environment with all data integrated is very important for taking engineering decisions.

Acknowledgements

To CEMIG, and National Electrical Agency (Aneel) for all support.

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