VRCEMIG: A novel approach to power substation control

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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 requires a great deal of mental effort by the operators, during the controlling task. 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. 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 for training, since they have to send their operators to different electric substations, spread along their area of activity. Food, transport and accommodation must be provided for every technical visit.

Challenges

• To replace SLD diagrams by a Virtual Reality environment in order to reduce mental efforts when dealing with critical supervisory data of power system control
• To integrate 3D Substation environments with the SCADA (Supervisory Control and Data Acquisition) system.
• To provide a more natural and intuitive interface for simulation and training of electric substation procedures.

Our Objective

We propose a Virtual Reality based solution to provide a more natural and intuitive environment for control center operators. The novelty of this approach is the ability of operators to manipulate 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. Thus, there is no need to move from our widget to another when collecting different information.

Previous Work


• Development of a Virtual Reality environment of electric power substations for quality of service improvement. In: X Brazilian Conference of Power Quality, 2013, Brazil.

• A Strategy to Present 3D Information within a Virtual Reality Application. In XVI Symposium on Virtual and Augmented Reality (SVR 2014), Brazil.

Results and Future Work

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

Components Diagram

A Single-Line Diagram is replaced by a 3D representation of the electrical power substation. This approach provides a more faithful description of field reality. Also, a WebService is provided to allow real time reading and presentation of supervisory data within the virtual environment. Besides, interaction metaphors are implemented to support all necessary data for power system control and management through a single interface. With all these facilities is more natural and faster to program procedures for fixing or replacing electrical equipment in the substation pavement.

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