CHAVIR : A Virtual Reality Simulation Environment for Hazardous Working Sites

Laurent Chodorge, Christophe Montandon
CEA-LIST, BP6 – route du panorama, F-92265 Fontenay aux Roses, France

In the nuclear field, companies involved in the management and/or the design and performance of an intervention aim at preparing it by finding the most appropriate scenario(s) under several needs which are technical requirements (feasibility, kind of means to engage, operating modes, tasks scheduling), economical requirements (cost minimization) and environmental requirements (which means to take into account the individual and collective dose rate received by the human operators involved in the intervention(s)).

To this end and thanks to its expertise in virtual reality and interactive simulation, the Laboratory of Applied Research on Software-intensive Technologies of the French Nuclear Agency (CEA-LIST) started a few years ago a program called ***CHAVIR*** (for CHAntier VIRtuel in French, let's say "Virtual Site") in order to develop a software tool for the simulation of interventions in nuclear working sites. Our goal is to bring the user a complete software tool, taking into account all relevant components of the missions while using both interactivity and physically realistic simulation. This way, Chavir software tool will enable the operators to prepare and repeat the all the operations they will have to perform, in a safe virtual world, before achieving the real interventions within the hazardous facilities.

For interventions in nuclear field (design, control, repair, decommissioning, dismantling), radioactive sources inside the scene induce hostile conditions to deal with. According to the ALARA principle, one must find the best scenario(s) to prevent the operators from being too much exposed and from integrating too high dose rates. Besides, radiation conditions may lead to perform some of the tasks *remotely*, using robotic manipulators. Consequently, we distinguished for Chavir tool two main physical simulation areas : dosimetric evaluation (for humans involved in the mission), and simulation of mechanical aspects: check of accessibilities, robotic simulation, breaking of the installation (when dismantling). As most of installations are already designed with CAD tools (Catia, SolidWorks, ProE, …), such simulations have to work with industrial models in order to keep the connection with CAD world.

Interventions being carried out in radiating environments, we have integrated the calculation of the individual radiation doses received by the operators during their missions. This enables the user to preview the optimal intervention scenario and to guarantee with a relatively good precision the economic and environmental impact of the operations. Our project has the ambitious goal to bring dosimetry information on-line, in real time. CHAVIR makes all this possible by immediately taking into account all the evolutions in the geometrical scene (an object which moves can punctually "hide" a source, therefore protecting the operators from its radiations). It enables the user to change his strategy during the simulation (by knowing his actual dose rate on-line, the simulating operator has the opportunity to adapt his actions immediately).

Chavir software tool is also composed of a mechanical module, which makes possible the simulation of all robotic devices involved in the environment. Such an objective implies to simulate the dynamics of multi-body systems, and to compute

Tel: ++33 1 46 54 70 86 Fax: ++33 1 46 54 75 80 E-mail: christophe.montandon@cea.fr

real time collision detection. This typically allows us to perform simulations involving virtual robotic arms and to manage contacts with the environment. In order to warrant the interactivity with the operator, there is also a possibility to drive virtual objects/robots inside the simulation, either with passive peripherals (such as a SpaceMouse) or with active ones (such as force feedback devices).

Besides, we also achieved new developments to interactively take into account the changes in the virtual scene. The objective is to be able to help the user to design a dismantling scenario inside the software tool. That means that the simulation will allow the operator to move and break the objects in order to study his effective dismantling operations, while keeping on computing the other kind of simulations (dosimetric and robotic).

Today, Chavir is experiencing an intensive test phase for several pilot dismantling working sites, and for the study of maintenance operations in the Laser Mega Joule facility of CEA in France. Under the impulse of increasing collaborations with various industrial partners (EDF, AREVA...), CHAVIR is going to adapt rapidly to the complexity of real operations, including the coupling with field information data bases (3D models of environment, sources activity measurements...). CHAVIR has already started the industrialization process. It aims at shortly becoming a commercial software for dismantling site simulation, which is adapted to the professional needs in order to respect the ALARA principle. It should efficiently contribute to optimize any radiating working site, by means of a better preparation thanks to interactive simulation.

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