

EXTENDING VIRTUAL REALITY SIMULATION OF ITER MAINTENANCE OPERATIONS WITH DYNAMIC EFFECTS

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In ITER, maintenance operations will be largely performed by Remote Handling (RH). Virtual Reality (VR) simulation is used to study, improve and verify maintenance operations during preparation [1] and to improve the situational awareness of human operators during real operations. Until now, VR systems use geometric models of the environment and the objects being handled. Dynamic effects such as bending of beams under heavy loads, and sudden forces due to contact transitions are ignored. This paper discusses how simulation of dynamic effects adds realism to the simulation and improves maintenance operations for ITER in various stages of preparation and execution.

To investigate the effect of adding dynamic effects in Virtual Reality simulations, we developed a dynamics simulation module and introduced it as an add-on to the VR4Robots VR software and tested it in the context of realistic maintenance operations on the ECRH Upper Port Launcher Plug (UPL) [2]. We measured and analysed the impact on UPL maintenance operations at various levels of abstraction: at the level of handling individual parts, handling major components and handling the port plug as a whole.

The introduction of dynamic effects into Virtual Reality simulations was found to provide new insights during procedure development and improve the quality of operator training. Dynamic effect simulation can also form the basis for real-time guidance support to operators during the execution of maintenance tasks (augmented reality).

[1] A.G.A. Verhoeven et al., "A virtual environment for the simulation of the ITER ECRH Upper Port Plug maintenance in the hot cell", EC-15, Yosemite Park, USA, 2008

[2] B.S.Q. Elzendoorn et al., "Analysis of the ITER ECH Upper Port Launcher remote maintenance using virtual reality", Fusion Engineering and Design, Volume 84, Issues 2-6, June 2009, Pages 733-735