

A Study of Functional Simulation for reliability of the device design

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1. Introduction

Pyroprocessing, which can separate nuclear materials from spent fuel by means of electrochemical methods, is a technology to recover nuclear materials such as U, and TRU elements through electrolytic reduction, electro-refining, and electro-winning after decladding of the fuel assembly. The head-end process plays an important role in providing feed materials to electrolytic reduction after fabrication of the fuel fragments (crushed pellets) and the porous pellets feed materials. The head-end process is composed of various devices such as disassembling/rod extraction/rod cutting devices of the nuclear fuel assembly, oxidative decladding device, compaction, and pre-treatment device. The head-end process project currently has no hotcell. In addition, there are no tools validate core devices designed or manufactured. This paper introduces a head-end process fDMU (Functional DMU) being developed to solve this problem.

2. Methods and Results

2.1 Functional DMU

A previous DMU technology has been mainly used as a visual tool for 3-dimensional configuration information, confirmation of the mate condition of the assembly, interference inspection etc. However, the head-end process requires a connection of the integrated management, a design verification considering the continuity between devices, and a characterization of each device. To satisfy these requirements, an advanced new technology is required. Namely, there is a need to manage an integrated database management, functional and behavioral simulation of mechatronics, extraction of design sensitivity optimum design, implementation of the process simulation and line based on events [1][2]. Based on these technical elements, this paper proposes an applied fDMU technology such as collision detection, visualization interaction, and distance measuring of the head-end process.

2.1 fDMU design of Head-end proces

The fDMU of the head-end process was designed to be composed of 4 modules. In the 3D modeling module, the 3D configuration and mockup facilities of the main devices of the head-end process are being produced. A simulation for improving the design requirements and a performance evaluation of main devices are conducted in the simulation module. In the co-simulation module, a simulation related to remote operation and maintenance in a virtual hotcell will be carried out. The database module will be taken to save and manage all data that have been created in the 3 modules during the integration. A conceptual diagram of fDMU for the head-end processes is represented in Fig. 1.

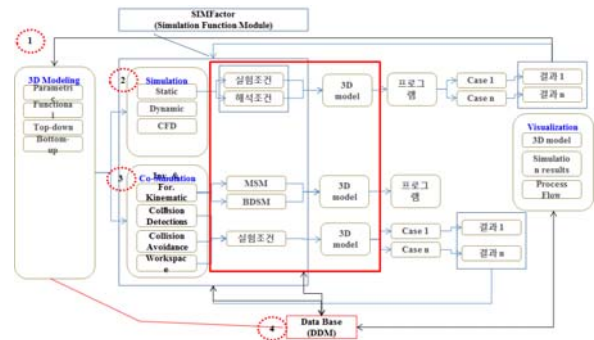


Fig. 1. Schematic diagram of fDMU for Head-end process

2.2 Functional User Interface

A head-end process fDMU begins with devices that have a specification similar to real devices in the 3D modeling module. When a user wants to simulate with a device made using a 3-dimensional object, he/she will start the simulation according to the experiment and analysis conditions. The results will be made through a case study and prototyping. If the user wants to improve the object devices based on the result of the simulation, they have to amend a specification of the corresponding devices in the 3D modeling module. After that, users run a program and repeat it until they find the optimal solution. A co-simulation will be carried out to make an optimal remote environment related to remote operation and maintenance process as in the above procedure. The main window of fDMU for the head-end process is shown in Fig. 2.



Fig. 2. Initial screen of functional user interface

2.3 3D modeling module

VRML97 (also called as VRML2) was set as a standard import and export file type in a simulator. These files can be imported as two types (MEC and FAC) of file.

- MEC files are mechanism files that keep the data for every individual model.
- DMU FAC files are layout facility files that contain all of the models (MEC).

To add models to the FAC file, click on the (+) symbol and select the MEC file of the model. Then, to locate the model inside the facility file, enter the position and rotation information when prompted. Multiple models can be added to a facility file. Fig.3 explains a method on how to import models and files.

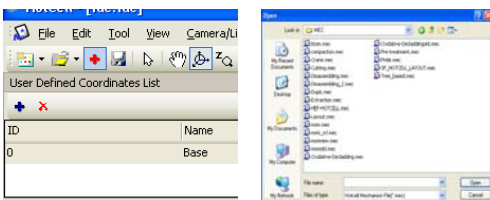


Fig. 3. Adding models to fDMU FAC files

2.4 Distance Measuring

The distance measuring technology measures the distance between two points (vertices). To use this feature follow this procedure:

- Change the cursor to the selection cursor.
- Click and select the first point (when you click the point, it is captured by the system).
- Hold the "Shift" key on the keyboard and repeat the selection process (i.e., click on the second point).
- At this point you will see both points are highlighted (selected and captured).
- Move to the Menu Edit → Measure Distance → Vertex to Vertex.
- The Distance dialog box will show the results.

The following demonstrations show the above procedure.

	<p>Select the first point</p> <p>Move to the Menu Edit → Measure Distance → Vertex to Vertex</p>
	<p>Click model 1, hold SHIFT key Click model 2.</p>
	<p>User confirm the calculated result between 2 objects.</p>

3. Conclusions

To establish the efficiency and reliability of core devices based on a previous DMU environment, an advanced fDMU for the head-end process was designed. It was concluded that fDMU has great features such as a functional integration and validation of virtual mechatronic systems, couple the functional and geometry models within the total system model, and combine the functional simulation and interactive 3D visualization.

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