Virtual Decommissioning Simulator for Optimization of the Nuclear Facility Decommissioning

Byung-Seon Choi*, Dongjun Hyun, Ikjune Kim, Jonghwan Lee, Kwanseong Jung, and Jeikwon Moon
KAERI, 989-111 Daedeuk-daero, Yuseong-gu Daejeon 305-353, Republic of Korea
*bschoi@kaeri.re.kr

1. Introduction

The decommissioning market is expected to grow rapidly in a few decades owing to the change of nuclear policy in several major countries and the increase of decrepit nuclear power plants. Decommissioning of nuclear facilities demand a large scale of budget and high level of safety, and therefore the preliminary verification of dismantling scenarios is very important.

In recent years, the manufacturing industry has aggressively adopted the virtual manufacturing technology to verify the facilities and processes with high efficiency. P.G. Maropoulos and D. Ceglarek reviewed the standard definitions of verification and validation in the context of engineering design and progresses, and presented industrial requirements and research trends related to the technology [1].

The virtual manufacturing technology was beginning to be adopted in the area of the nuclear facility decommissioning. Engineers of San Onofre Nuclear Generating Station (SONGS) are the first to apply the technology to the nuclear industry in order to replace the steam generators on time and on budget [2].

The virtual decommissioning simulator in this paper is developed to verify various dismantling scenarios over nuclear facilities with low cost and high efficiency. Existing virtual manufacturing technologies are inadequate for verification of dismantling scenarios since the object segmenting function absolutely required for graphical simulations over dismantling scenarios is unavailable. The virtual decommissioning simulator can handle the whole dismantling scenarios using both the newly developed object segmenting function and various existing functions available in the existing virtual manufacturing technologies.

2. Description of the Actual Work

The virtual decommissioning simulator capable of an object segmenting in the course of a process simulation is proposed for the flexible planning of the nuclear facility decommissioning. At the planning phase of the decommissioning, the visualization and verification using the virtual decommissioning simulator can be powerful tools for the flexible planning of the dismantling process over a highly radioactive, heavy and complex nuclear facility. The virtual decommissioning simulator can flexibly handle various dismantling scenarios including repetitive object segmentations over heavy and complex structures using the embedded CAD kernel.

2.1 Methodology of Object Segmentation

The topology, which represents objects by boundaries and the connections between different parts, is used as the geometric representation in this paper while the methodology based on the mesh is more popular with the machining simulation [3-4] and surgical cutting simulation [5]. The reason using topology is compatibility with the CAD kernel which may offer even better stability and reliability at the repetitive cutting situations over various sizes and complicated shapes occurring frequently in the dismantlement of the nuclear facility.

The CAD kernel supports a couple of segmenting methodologies such as the split operation and the Boolean removal operation. The segmenting operation requires an object part and a cutter part. The split operation adopts a surface or a plane as a cutter part, and the Boolean removal operation adopts a solid or a volume as a cutter part. The split operation is not suitable for the segmenting methodology because situations occurring in the physical segmenting operation such as the cutting thickness and the incomplete cutting cannot be

processed, as shown in Fig. 1 In this study, the Boolean removal operation is selected as the segmenting methodology owing to the capability of expressing various characteristics of the physical cutting operation, and a solid is selected as the cutter part between the volume and the solid since most of object parts are already represented with the solid supporting more advanced features than the volume.

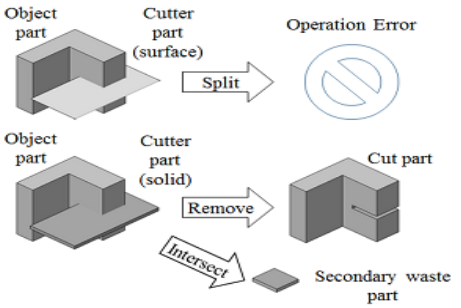

Fig. 1. Object segmentation using CAD kernel.

2.2 Implementation of Virtual Decommissioning Simulator

The virtual decommissioning simulator consists of a front main display, a side supplementary display, a haptic hand controller, an operator's chair, and a graphic workstation operating virtual decommissioning software (see Fig. 2).

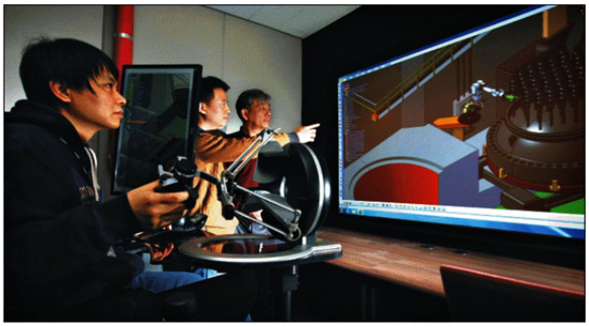

Fig. 2. Virtual 3D decommissioning simulator.

The nuclear power plant demonstrating the virtual decommissioning simulator over various dismantling scenarios which is segmenting of a large cylindrical component is shown on Fig. 3.

3. Results

The implementation result demonstrates that the developed virtual decommissioning simulator can verify various decommissioning scenarios over nuclear facilities with low cost and high efficiency. The proposed simulator is expected to contribute the flexible planning and optimization of the nuclear facility decommissioning.

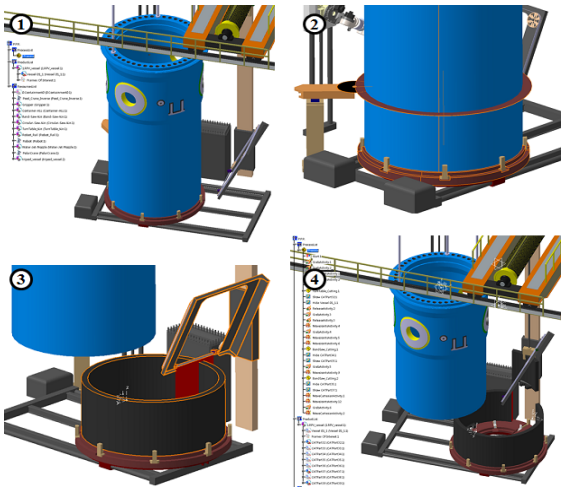

Fig. 3. Segmenting scenario of the reactor vessel.

4. Acknowledgements

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5. REFERENCES

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