

A design of a flexible framework for cutting process simulation of a nuclear facility

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1. Introduction

The dismantling of nuclear facilities takes a very long time and is a dangerous procedure. Thus, it should go through a process optimization procedure based on the process simulation. The process simulation pre-evaluates the operation time and cost, and checks the possibility of danger of the dismantling procedures, thereby enhancing the safety of the dismantling [1].

Current methods for a process simulation cannot simulate the cutting operation flexibly. As is, to simulate a cutting operation, the user needs to prepare the resulting models of the cutting operation based on a pre-defined cutting path, depth, and thickness with respect to a dismantling scenario in advance. In addition, these preparations should be built again as the scenario changes.

To solve the problems, the user should be able to change the parameters and scenarios dynamically within the simulation configuration process such that the user saves time and effort to simulate the cutting operations.

This study presents the flexible simulation framework for the cutting operation, which can be applied to all procedures in the simulation of dismantling of nuclear facilities.

2. Proposed methodology

To simulate the cutting operations flexibly to scenario changes, we designed a framework to generate cutting volume automatically as the process modeling result.

In the process modeling procedure the user defines cutting path and the cutting profile. Using the information, our framework generate a cutting volume to cut the target model. And the cutting volume can be updated as the scenario changes so that the cut product of the target model can be updated.

In the process modeling procedure, the user needs to select the models of the cutting and carrier devices from the resource catalogue. The selected cutting device model has a pre-defined cutter profile and cutting depth. The cutter profile is a straight line composed of two points indicating the cutting position and depth, and the kerf width is defined in the model as a property with a real value. In addition, the selected carrier device has pre-defined kinematics information controlled by the user input. The user moves or operates the carrier device model using a GUI (Graphic User Interface) or

haptic device to create a device-moving path of the carrier device that has the cutter device.

In the process modeling procedure, the user creates the movement of the carrier device, which is carrying the cutter device to create the cutting path. The cutting path is recorded by a simulation system and is used to create the cutting volume during the cutting volume generation procedure.

Based on the created moving path and cutter profile, the cutting volume is created. In this step, at first, the cutter profile is swept along the user input moving path to create a surface of the cutting volume. In addition, we apply the kerf width property into the swept surface to create the cutting volume. In addition, the user selects the cut target product and the created cutting volume is copied into the selected product. Next, we transform its coordinate into the target product to align both models for cutting. We then conduct a Boolean remove operation on the target product as a blank model by the cutting volume as a tool model [1].

3. Implementation and Result

Implementation environments are shown in Table I.

Table I Implementation environments

	Environments
OS	Window 7 x64
Language	C++
Simulation-SW and Library	Delmia V5R21 and CAA
IDE	Visual Studio 2008 and RADE

Delmia is process simulation software developed by Dassault System which is widely used for process planning, process improvement and verification [2]. CAA (Component Application Architecture) is an API (Application Programming Interface) of the Delmia, and it provides the platform independent development environment. RADE (Rapid Application Development Environment) is CAA application programming tool for the Visual Studio [3].

An example of cutting operation is shown Fig. 1. The example shows how easily a user can change the scenario in our simulation framework. In Fig. 1, based

on the initial state of the simulation model, we apply Scenario#1 and obtain the cut result of the Scenario#1. And then rollback to initial state, we apply the Scenario#2 of which the cutting path is changed from the Scenario#1. In our software, a user can easily rollback to initial state by keyboard input control and z.

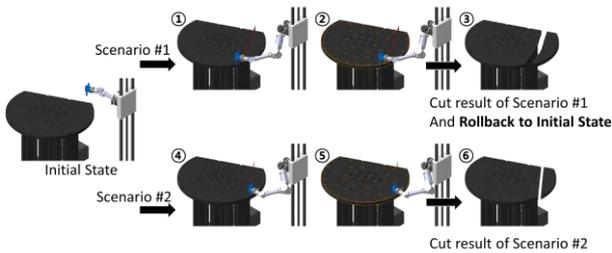


Fig. 1. An Example of the cutting simulation

3. Conclusions

In this study, we designed a flexible cutting simulation framework for the cutting operation in the dismantling of nuclear facilities. To do so, we proposed the automatic cut product generation procedure. The proposed methodology makes it so that the user does not need to create a result cut-model before the process modeling procedure. In addition, we implemented a cutting simulation framework based on the APIs of a commercial CAD system.

Acknowledgements

This work was supported by the nuclear research and development program through the national research foundation of Korea funded by the Ministry of Science, ICT & Future Planning.

REFERENCES

- [1] I. Kim, B. Choi, D. Hyun, J. Moon, J. Lee, K. Jeong, et al., A framework for a flexible cutting-process simulation of a nuclear facility decommission, *Annals of Nuclear Energy*, vol. 97, pp. 204-207, 2016.
- [2] G. Ryu, et al., Guidance weapon assembly simulation using the DELMIA. *KSAS Conference 2008*, Vol. 2, p. 1220-1223, 2008
- [3] I. Kim, et al., Cutting Method of the CAD model of the Nuclear facility for Dismantling Simulation, *Transactions of the Korean Nuclear Society Spring Meeting*, Jeju, Korea, May 7-8, 2015