Cutting Simulation Method Based on the 3D Scanned Environmental Information for Nuclear Facility Dismantlement

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1. Introduction

We are developing a system that performs cutting operations with the scenarios created based on the digital mockup of the nuclear facility. However, the digital mockup and actual sites may differ, so that cutting activity in the scenario which is created based on the digital mockup might be inapplicable for actual physical cutting operations [1].

So, we used the 3D scanning method to acquire the actual site data to which the digital mockup is aligned. And by the result of the alignment we update the digital mockup and the dismantling scenarios. Before deploying the updated scenario to the physical cutting system, it is simulated in the digital environment to check the cutting path of the equipment and the cutting result.

Existing cutting process simulation method [2] creates the cutting result model in the process modeling procedure, which is done before the digital mockup update process of the actual physical cutting operations. And at the simulation stage, it hides the cut target model and shows the cut result model to animate the cutting action. Hence, it produces the inaccurate geometry of the cutting result model with respect to the updated cutting motion and geometry of target model, despite it is very important to evaluate the cost of the cutting operations.

In this study, we propose the method to simulate the cutting result model with the updated digital mockup in the physical cutting operations.

2. Methodology

The concept of the dismantling control system is shown in Fig. 1. The concept system has two main parts, simulation system and physical system. In the simulation system, the user defines the cutting scenario and deploy the scenario to physical system which is composed of actual cutting device such as robot manipulator and laser cutter.

In the operational loop, at the end of each activity of physical system, simulation system updates the digital mockup and the next cutting scenario based on the environmental information. Using the updated scenario and the model, the user simulates and checks the activities and send it to physical system to proceed the cutting operation.

The focus of this study is how the simulation system creates the cutting result more exactly base on the environmental information. Hence, we do not create the cutting result model in the cutting scenario definition phase because the cutting result model cannot be updated with the transformation matrix that is calculated from digital mockup to environmental information alignment. Rather, we create the cutting result model on the fly inside the simulation stage.

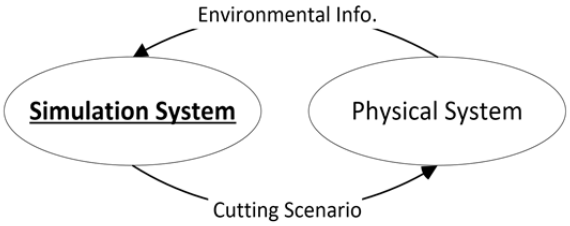

Fig. 1. Concept of the dismantling control system.

To do so, we have implemented the device model observer in the simulation system. When the cut activity is simulated, the observer is also activated. The observer observes all the resources regarding the cut activity simulation, and creates the cutting volume based on the shape and motion of the cut device at every time step with which cut the target model.

At the end of each time step, observer performs the Boolean remove operation, subtracting the cutting volume from the target model. Therefore the cut result model is created in the simulation stage based on the updated scenario and the digital mockup.

By the proposed methodology, even if the digital mockup model is updated in the cutting operation, simulation system still creates the exact cut result model. Hence the user can exactly evaluate the cost of the cut activity and the mechanical properties of the cut result model.

3. Conclusion

In this study, we have developed a simulation system which creates the exact cut result model based on the updated digital mock-up by the 3D scanned environmental information. This is a core component of our concept of dismantling control system. We expect that the proposed dismantling concept enables the cutting operation more accurate and fast. So far we couldn't deploy entire methodology to our testbed, in the future we have to test the methodology with real cutting operation.

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