Digital Mock-up Update Based on 3D Scanned Environmental Information for Nuclear Facility Decommission

Ikjune Kim*, Dongjun Hyun, Jonghwan Lee, and Sungmoon Joo
Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea
* ikjunekim@kaeri.re.kr

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 [1].

And we are developing a system that performs cutting operations based on the scenarios created in the simulation system. However, existing CAD models and actual sites may differ, so that cutting activity in the scenario which is created based on the existing CAD models can be inapplicable for actual cutting operations.

So we need to acquire the actual site data and apply appropriate feedback to the simulation system to find out if there are changed parts of the existing CAD models from the real sites and then we update the models and dismantling scenarios [2].

As laser scanners become widely used in 3D data acquisition of industrial sites [3], we use a 3D laser scanner to acquire the real site data. The format of feedback data from the scanner is a 3D mesh model.

In this study, we developed the digital mock-up (CAD model) update methodology based on the dismantle simulation system, and tested the system with a sample 3d scan model on our test-bed.

2. Methodology

Fig. 1 is overall scheme of the digital mock-up update methodology which is applying transformation matrix to the CAD model calculated from the model alignment procedures.

The source point cloud is aligned to the target point cloud model. The scanned model is composed of point cloud, and the CAD model is defined by mathematical formulas. Therefore, to compare both models, we need to convert the CAD model into a point cloud model, because it's easier than vice versa.

We create a mesh model from the CAD model by tessellation. And sample the points from the tessellated model because tessellated model has boundary points only. So that we can get the point cloud of the CAD model. To enhance the alignment accuracy and shorten the processing time, we segment the scanned point cloud with the bounding box of the part of the CAD model as shown in Fig. 1.

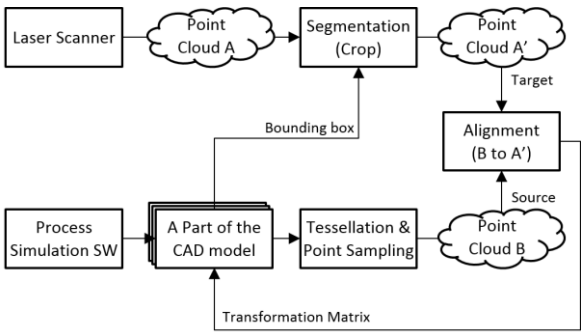

Fig. 1. CAD Model update methodology.

We align two models in two steps, first we perform initial alignment to get the initial condition of the Iterative Closest Point (ICP) alignment. And

then we align the model with the fine alignment method (ICP) ICP gives the very fine alignment result, but it's very sensitive to the initial condition of the input models. So we roughly calculate the initial alignment before ICP.

3. Test results

We tested the model update system between the laser scanned 3D mesh model and its original CAD model as shown in Fig. 2. In the figure, we confirm that it is possible to update the CAD model based on the alignment result between the scanned point cloud model and the point cloud which is sampled from the CAD model.

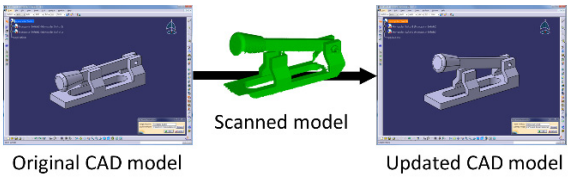

Fig. 2. Update result of sample model.

4. Conclusion

In this study, we developed the digital mock-up update system based on our process simulation software, and we tested the system on our test-bed. So far, we implemented the system for updating the location and orientation of the digital mock-up, In the future we plan to evaluate the CAD model update result numerically and develop the system that updates the shape of CAD model based on acquired point cloud model by the 3D laser scanning.

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