Suggestions on Application of Wide-Range 3D Laser Scanner to the Decommissioning Process of Nuclear Facilities

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1. Introduction

The structural materials, equipment, and pipe lines to be decommissioned in the nuclear facility have various levels of contamination, and/or different shapes and structures. For the safe decommissioning, it is essential to accurately define the geometry information such as size and volume in advance of determining the decommissioning method and establishing the detailed work plan to ensure worker safety.

Even though the basic information such as design data is primarily reviewed to do this, it is usually insufficient and/or inaccurate in most of nuclear facilities constructed a long while ago. In these cases, it may be able to use data for the reference facility or to directly measure dimensions with tools such as tapeline or laser ranger. However, acquirable data through these methods is very limited in case that target to be identified is very different from that of the reference facility or has a complex geometry.

In this paper, we suggest how to apply wide-range 3D laser scanner to the decommissioning process of nuclear facilities as a solution to overcome the limitation as above.

2. Application of Wide-range 3D Laser Scanner

In this section, a brief description of wide-range 3D laser scanner is presented, and applications of the device to the decommissioning process are suggested.

2.1 Features of Wide-range 3D Laser Scanner

Main advantages of the wide-range 3D laser scanner are its portability and long-distance measurability. While there are many types of 3D laser scanner, generic characteristics of these devices are very similar. Table I exemplifies main features for the FARO Focus^s 70 scanner, which is the device our company has. [1]

With this scanner, compared with other products, it is possible to acquire the clearer and more detailed visualization data through compositing the point data obtained by measurement and high-resolution color photo actually taken. [2]

2.2 Application of the Device

Considering generic features, the wide-range 3D laser scanner can be applicable to the process shown in Fig. 1 in the decommissioning of nuclear facilities.

Table I: Specifications of the FARO Focus^S 70 Laser Scanner

Range Focus	0.6~70m
Measurement Speed	Up to 976,000 Point/sec
Laser Class	Class 1
Integrated Color Camera	Up to 165 Million Pixels
Observating Range (Vertical/Horizontal Angles)	300°/360°
Ranging Error	± 1mm
Angular Accuracy (Vertical/Horizontal Angles)	19 arcsec
3D Location Accuracy	10m : 2 mm 25m : 3.5 mm
Weight	4.2kg
Size	230 x 183 x 103 mm

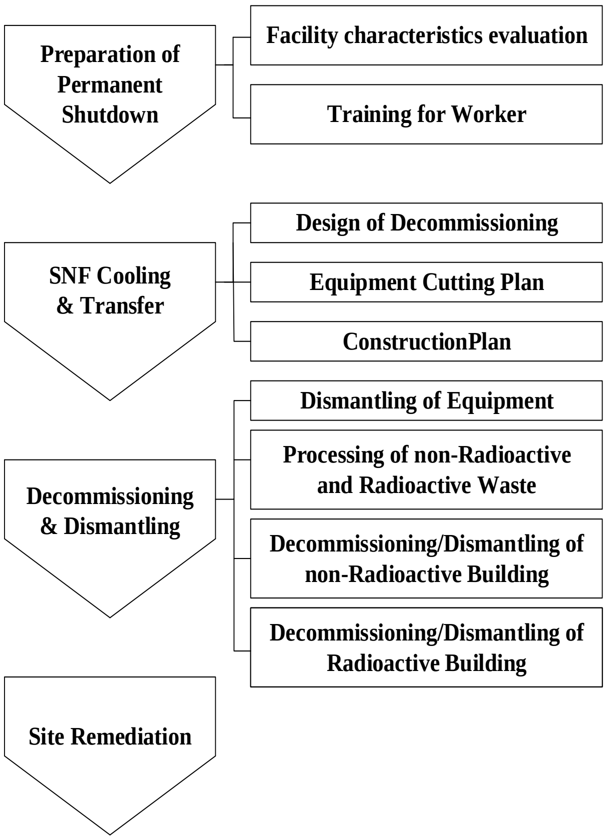

Fig. 1. Applicable Processes of the Wide-range 3D Laser Scanner in the Decommissioning of Nuclear Facilities

More detailed description for application of this device to the decommissioning process is as follows.

2.2.1 Acquisition of detailed geometry information

In case that information on the structural materials, equipment, and pipe lines to be decommissioned is limited, it is possible to acquire the detailed geometry information through 3D laser scanning.

By performing the scanning operation at different angles with a high-accuracy 3D scanner, dimensions of target such as length and diameter can be identified, and thereby the total volume can be calculated through the further post-processing for measurement results. These data can be applied to estimating quantity and costs to be decommissioned.

In addition, through the reverse engineering, the computerized data for targets (e.g. structural materials, equipment, and pipe lines) could be acquired since the 3D geometry information can be exported to various formats of files such as IGES and STEP that can be utilized in the AutoCAD program. These data will be applied as the reference for future processes.

Fig. 2 shows the comparison result of a photo actually taken, a scanning screen, and a converted drawing for a certain area.

Fig. 2. Comparison of a Photo actually taken (Top), Scanning Screen (Middle), and Converted Drawing (Bottom)

2.2.2 Work Planning

Even if the radioactive contamination is significantly removed by sufficient decontamination operations, it is expected that work in the high radiation zone would not be avoided. Especially, decommissioning for large equipment such as steam generator highly contaminated with radioactive materials require a significant amount of work (i.e. cutting, transport, decontamination, etc.) and time.

Prior to a certain process for equipment with high radioactivity level, detailed work plan (e.g. movement, distribution, and etc.) can be established and optimized based on 3D geometry information on the subject acquired through laser scanning. This enables workers to efficiently perform the operation and to minimize the occupational exposure dose.

2.2.3 Training using Virtual Reality (VR)

The 3D laser scanning operation provides data for the nearby surroundings (e.g. floor, wall, ceiling, lamp, switch, instrument panel) as well as information on targets to be scanned. All of visual information such as color and height saved as point-cloud, and a specific data is obtained for every scanning point. For a certain area, 3D data can be generated by merging 2D point-cloud data acquired in various points, and accuracy of 3D data is increased with the number of scanning points.

Through integrating these 3D data, it is possible to create VR components divided by building, elevation, area and compartment as per user needs.

Fig. 3 exemplifies a VR display converted from the point-cloud data.

Fig. 3. Sample of VR Display converted from Point-Cloud

By connecting with the VR device, workers can check and/or confirm the moving path (from entrance to the target) and the working space for performing a certain process. This VR function could be used as visual aids in the pre-operation training, and it enables to ensure and improve the safety of workers.

3. Conclusions

In most of nuclear facilities constructed a long while ago, basic information for decommissioning is usually insufficient and/or inaccurate. In this paper, we suggest how to apply wide-range 3D laser scanner to the decommissioning process of nuclear facilities as a solution to overcome the limitation. Considering generic features, the 3D laser scanner can be applicable to various processes in the decommissioning of nuclear facilities.

First, in case that information on targets to be decommissioned is limited, the detailed geometry data can be acquired by 3D laser scanning at different angles. These data can be applied to estimating quantity and costs to be decommissioned, and to securing the computerized data through the reverse engineering.

Next, prior to a certain process for equipment with high radioactivity level, detailed work plan can be established and optimized based on 3D geometry information on the subject acquired through laser scanning. This enables workers to efficiently perform the operation and to minimize the occupational exposure dose.

Finally, 3D data for a certain area can be generated by merging 2D point-cloud data acquired in various points. Through integrating these 3D data, it is possible to create VR components divided by building, elevation, area and compartment as per user needs.

It is clear that advantages of the 3D laser scanning enable to ensure and improve the safety of workers.

REFERENCES

[1] Faro Focus Laser Scanner S Series Tech sheet, SPDF_04MKT-476 Revised: 01/09/2019
[2] https://www.faro.com/products/construction-bim-cim/faro- focus/