3D As-built Management System Supporting On-site Work Style Reform

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In recent years, while efforts for work style reform are being called for, remote work is becoming common in addition to improvements in work efficiency and workload reductions. For scheduled inspections at nuclear power plants, we have developed a "3D as-built management system" that can also contribute to work style reform, because it reduces the number of preliminary visits to the worksite before actual inspection/maintenance work takes place by visualizing the layout and arrangement of plant facilities using a 3D laser scanner. This report presents the system and the resulting effects and describes its applications to improve the efficiency of maintenance work.

1. Introduction

Conventionally, when planning a construction project for the maintenance of nuclear power plants or facility remodeling to comply with regulations, we visit the worksite in a preliminary inspection of each of the facilities including the equipment, piping and cables in the work area, before the feasibility study is performed. To enable a nuclear power plant in operation to continue to operate safely, there are work restrictions and restricted areas on the premises. Therefore, a large number of human resources are usually brought in to perform preliminary site inspection within a limited time frame during a scheduled inspection. As such preliminary site inspection is necessary for individual construction work and as-built management is required after construction, there have been calls to develop a system by which the latest site conditions can be effectively shown for streamlined design/construction planning.

2. Improved system efficiency for checking the latest site conditions

Conventionally, preliminary site inspection involves photographing and size measurement, both of which are labor-intensive. In this way, however, every time the need for an additional inspection arises, workers must enter the site. To avoid this, spatial information covering much of the site needs to be obtained beforehand in a short time and in a reliable manner. We have therefore decided to use a 3D laser scanner. The 3D laser scanner can measure in all 360-degree directions around the point of the installation and the coordinates of any object found within a radius of several meters in several minutes. During measurement, the surrounding images can be captured, enabling the simultaneous execution of laser irradiation and imaging. The low output laser used has no adverse effects on the human body. **Figure 1** illustrates improvements in system efficiency for obtaining information about the latest site conditions.

By measuring the whole construction area with the use of 3D laser scanner at the time of construction completion, it has become possible to efficiently obtain information about the latest site conditions through the accumulated measurement results. Consequently, fewer personnel are required and they visit the site less frequently for preliminary inspection, which also reduces worker exposure to radiation at the same time.

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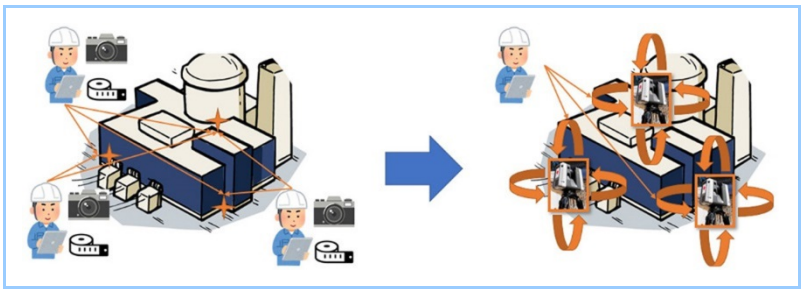

Figure 1 Illustration of improved system for obtaining information about latest site conditions

3. Visualization of the latest site conditions

The information obtained by the 3D laser scanner is “point cloud data” with x,y,z “coordinates” and still images captured in six directions of up, down, front, back, right and left. Regarding the still images, a “360-degree spherical panoramic image” is produced by combining them, allowing views in all directions around the point of shooting. If this “360-degree spherical panoramic image” is properly aligned on the building layout drawing of a nuclear power plant, the whole area of interest can be seen in any direction, making it possible to use for “walk-through” purposes. **Figure 2** shows an image and data obtained by the 3D laser scanner.

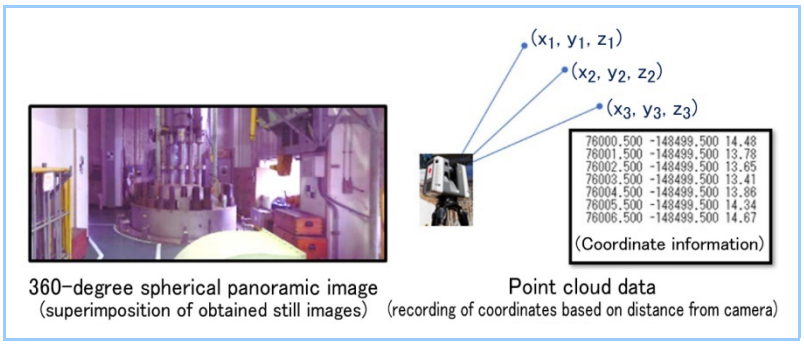

Figure 2 Image and data obtained by 3D laser scanner

Superimposition of point cloud data on the “360-degree spherical panoramic image” can produce “point cloud panoramic data” with each point of the image having a coordinate, thus realizing a simple measurement function that can measure the distance between two given points in the image using dedicated software. **Figure 3** gives an overview of the system. The 360-degree spherical panoramic image “walk-through” and the simple measurement function enabled by point cloud panoramic data have made it possible to perform preliminary inspection from a desk in terms of the installation/removal route of construction equipment, etc.

As a basic function of the “3D as-built management system,” we have also developed a system to organize these datasets according to the plant, store them on a secure server and browse them at the time of construction planning.

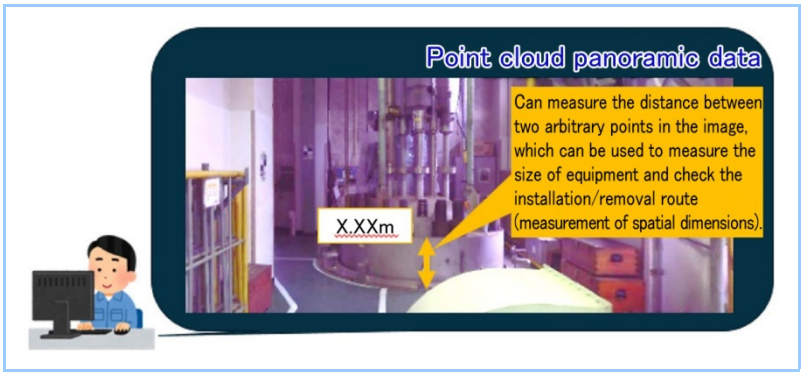

Figure 3 Application of point cloud panoramic data

4. Expansion of function

As an aid to plan construction projects, we have added another function that is useful to assess possible interference with existing facilities by displaying 3D-CAD data of the project superimposed on the point cloud panoramic data. **Figure 4** is a graphic representation of such superimposed data. Where the interference occurs between the 3D-CAD data and point cloud panoramic data is highlighted, making it possible to efficiently examine the presence/absence of interference.

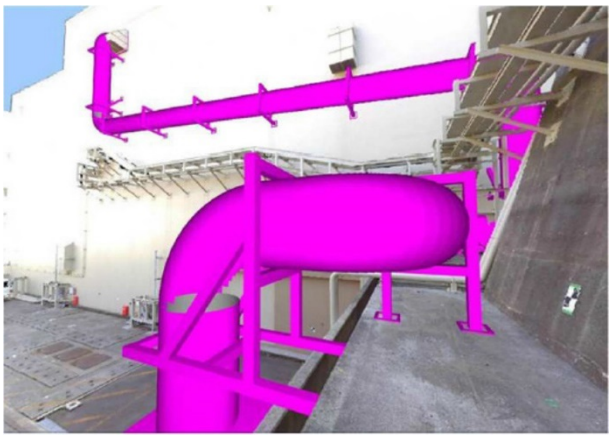

Figure 4 Graphic representation of 3D-CAD data superimposed on point cloud panoramic data

Two other new functions have also been developed: the "attribute information addition function" by which maintenance information such as the equipment model numbers and history of replacement can be added to the image and the "URL link generation function" by which data located at a specific address can be directly retrieved through a browser. These functions have enabled coordinated operation with other on-premises systems. **Figure 5** presents examples of such operation.

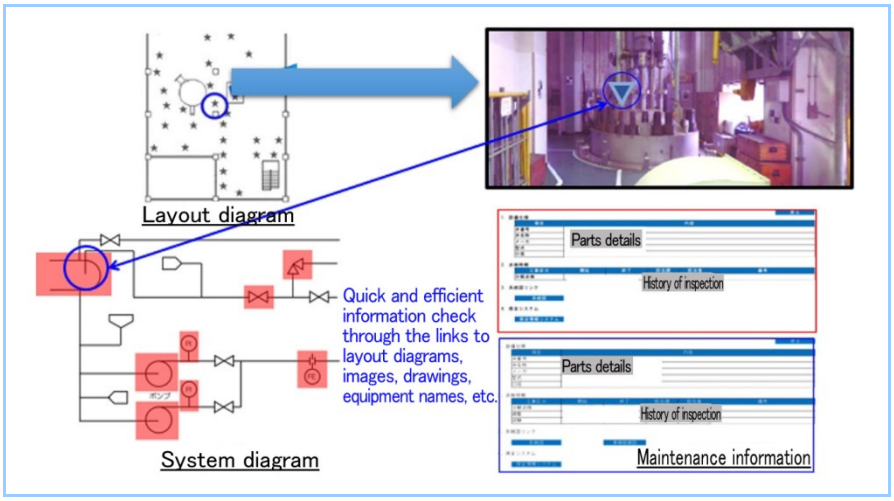

Figure 5 Example of coordinated operation with other systems

5. Effects

Using the "3D as-built management system," we have achieved work rationalization and the reduction of exposure to radiation by shortening the work time required for planning construction projects. It has also been made possible to respond in a timely manner to changes in the project plan. After the Great East Japan Earthquake in 2011, a portable "stand-alone version of the 3D as-built management system" was introduced to nuclear power plants. It is highly rated by electric power companies, because it serves as a precautionary tool for business continuity planning (BCP) as a means of obtaining information about the site to which the occurrence of a severe incident has made entry impossible. Moreover, during "remote work," which is becoming common as part of

recent work style reforms, the "3D as-built management system" can be shared using the screen sharing function of online meeting tools. This offers the advantage that involved parties can share the same understanding of the situation of the site without actually meeting.

6. Future prospects

A new inspection system that was fully implemented in April 2020 emphasizes the importance of the systematic maintenance of plant facilities based on the concept of "configuration management." Configuration management attempts to implement consistency between the three elements of design requirements, facility configuration information and physical structure. In addition to panoramic image of the facility and point cloud data, the "3D as-built management system" has functions for attribute information and URL link generation. Therefore, if operated with other systems for existing plants, it will also become applicable to implement configuration management.

7. Conclusion

After going through the system concept presented in this report, supplementary development for requirements that arose in the operational process and actual operation, we have established a system to perform preliminary site inspection that is not just based on drawings. This system is fast-acting and effective in simultaneously achieving the improved efficiency of some types of work and work style reform from the perspective of not only nuclear power plants, but also aftersales services for facilities. We think that the system can further contribute to work rationalization and on-site work style reform by applying it to not only the aftersales services of nuclear power plants, but also other fields through appropriately allocated resources and the streamlining of redundant work processes.