Technical Note

The scenario-based system of workers training to prevent accidents during decommissioning of nuclear facilities

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ARTICLE INFO

ABSTRACT

This paper is meant to develop the training system to prevent accidents during decommissioning of nuclear facilities. Requirements of the system were suggested. Data management modules of the system were designed. The system was developed on virtual reality environment. The performance test of the system was proved to be appropriate to decommissioning of nuclear facilities.

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1. Introduction

Decommissioning workers need familiarization with working environments because working environment is under high radio-activity and work difficulty during decommissioning of nuclear facilities. On-the-job training of decommissioning works could effectively train decommissioning workers but this training approach could consume much costs and poor modifications of scenarios. The efficiency of virtual training system could be much better than that of physical training system (Freitas et al., 2014; Mol et al., 2009).

This paper was intended to develop the training system to prevent accidents for decommissioning of nuclear facilities. The requirements for the training system were drawn. The data management modules for the training system were designed. The training system of decommissioning workers was developed on the basis of virtual reality which is flexibly modified.

2. Requirements of the training system for decommissioning workers

Table 1 presents requirements of the virtual reality training system for decommissioning workers. Items to be required are data handling of structures and equipments, real-time visualization of

worker moving route, real-time detection of worker moving route, and real-time monitoring of worker moving route.

Data handling of structures and equipments means that modifications of structures and equipments have to be flexible according as decommissioning scenarios change. Real-time visualization of worker moving route is that worker could see changes of structures and equipments during changes of decommissioning scenarios. Real-time detection of worker moving route is that the system could detect exposure of worker, duration time of worker, error of worker because working situations also change as decommissioning scenarios change. Real-time monitoring of worker moving route shows that the system could monitor worker because the location of worker also changes as decommissioning scenarios change.

3. Configuration of the training system for decommissioning workers

3.1. Configuration of the training system

Based on requirements of the system as suggested in Table 1, design tools were selected as shown in Table 2. The hardwares are a head mounted display (whereafter 'HMD'), a monitoring device, and a graphic server. The software is Unity3D and (Monte Carlo N-Particle transport).

The HMD is a device that taken on the head of worker and enable worker experience decommissioning scenario under virtual

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Table 1
Requirements of the reality system.

Items	Descriptions
Data handling of structures and equipments	Flexible modifications of structures and equipments according to changes of decommissioning scenarios
Real-time visualization of worker moving route	Real-time visualization of structures and equipments according to changes of decommissioning scenarios in view of first-person mode
Real-time detection of worker moving route	Real-time detection of data according to working routes of decommissioning scenarios
Real-time monitoring of worker moving route	Real-time visualization of structures and equipments according to changes of decommissioning scenarios in view of third-person mode

Table 2
Configuration of the virtual reality training system.

Items	Descriptions
Hardware	• HMD (head mounted display) • Monitoring device • Graphic server
Software	• Unity3D • MCNP

environment. It visualizes real-timely the same structure and equipment as working place. The monitoring device is to check the changes of structures and equipment and track the worker's location in view of third person according to changes of decommissioning scenarios. The graphic server is hardware that structures and equipment of nuclear facilities are databased on and serve to provide HMD and monitoring device with the changed data as routes of worker change. The handling directions of the HMD are yaw, pitch and roll as seen in Fig. 1.

The Unity3D is a development tool and graphically programmable language that enables decommissioning scenarios simulated and evaluated. The MCNP is a calculation tool of space dose distribution estimation.

3.2. Configuration of data management for the training system

To efficiently handle and manage transaction data of the virtual reality training system, data handling was modulized as seen in Table 3. Module of data management is to manage all data of the virtual reality training system. Module of graphic handling is to provide worker (first person mode) with 3D data and to supply manager (third person mode) with 3D data. Module of first person mode is to suggest worker put on HMD with changes of decommissioning scenarios. Module of third person mode is to provide monitoring person with location of worker and situations of decommissioning scenarios. Module of radiation exposure estimation is to estimate the radiation exposure of worker's route by the time.

Fig. 1. The HMD as a hardware tool of the training system.

Table 3
Data management modules of the training system.

Modules	Descriptions
Module of data management	• Database of structure and equipments • Detection data of working route as worker moves
Module of graphic handling	• Real-time linking to module of data management • Providing worker and manager with 3D data
Module of first person mode	• Real-time visualization of scenarios through HMD (first person mode)
Module of third person mode	• Real-time visualization of scenarios through monitoring device (third person mode)
Module of radiation exposure estimation	• Real-time visualization of radiation exposure during decommissioning