원자력시설 해체 작업자 보호 및 사고 예방을 위한 가상현실 기반의 훈련 시스템

The training system based on virtual environments to protect workers and to prevent incidents and accidents during decommissioning of nuclear facilities

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요 약

Decommissioning of nuclear facilities should be accomplished by assuring the safety of workers because decommissioning activities of nuclear facilities are under high radioactivity and work difficulty. It is necessary that before decommissioning, the radiation exposure dose of workers has to be evaluated and assessed under the principle of ALARA (as low as reasonably achievable). Furthermore, to improve the proficiency of decommissioning environments, method and system need to be developed.

The legacy methods of exposure dose measurement and assessment had the limitations to modify and simulate the exposure dose to workers prior to practical activities because those should be accomplished without changes of working routes under predetermined scenarios.

To simulate a lot of decommissioning scenarios, decommissioning environments were designed in virtual reality. To simulate and assess the exposure dose to workers, human model also was designed in virtual environments. These virtual decommissioning environments made it possible to real-time simulate and assess the exposure dose to workers.

It can be concluded that this system is able to protect from accidents and enable workers to improve his familiarization about working environments. It is expected that this system can reduce human errors because workers are able to improve the proficiency of hazardous working environments due to virtual training like real decommissioning situations. In the end, the safety during decommissioning of nuclear facilities will be guaranteed under the principle of ALARA.

keywords : *Decommissioning, Nuclear Facilities, Safety Assessment, Virtual Environments*

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1. INTRODUCTION

Decommissioning workers need familiarization with working environments because working environment is under high radioactivity 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.

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

2. DEVELOPMENT OF THE TRAINING SYSTEM FOR DECOMMISSIONING

2.1. Configuration of the training system for decommissioning workers

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 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.

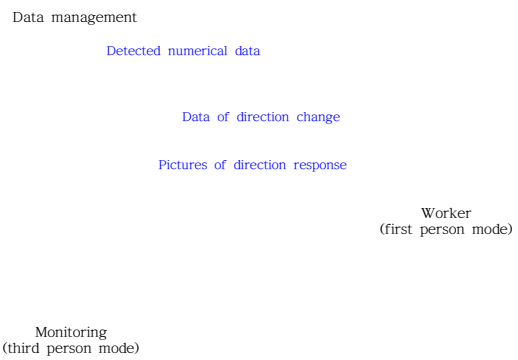

Fig. 1 Conceptual design for the training system

2.2. Development of the training system

The training system for decommissioning worker was developed as shown in Fig. 1. When worker puts the HMD on his head, the graphic server of virtual training system is being operated. The graphic

server receives data of worker's direction changing. The graphic server exchanges data management unit with the detected numerical data. The graphic server provides the HMD with pictures of direction response and the monitoring device with pictures of worker's location and behavior. In this situation, worker is in first person mode and recognizes decommissioning scenarios with HMD as ones of working in place. On the other hand, Manager is in third person mode and could keep up with location of worker and situation of working.

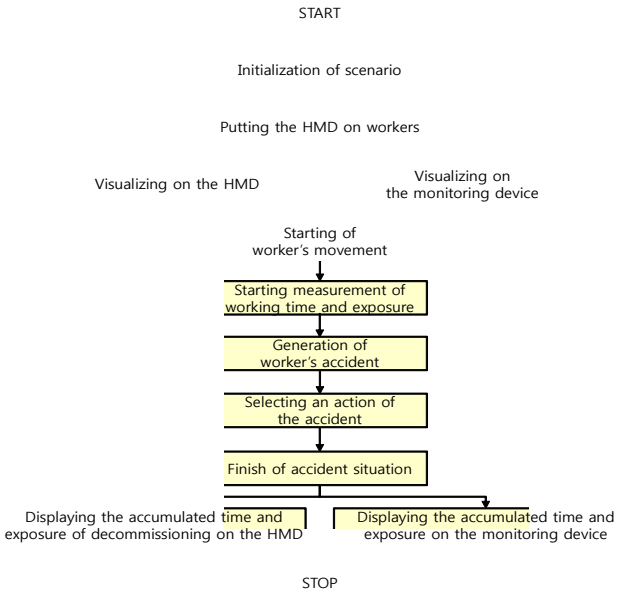

Fig. 2 Flow of the training system

2.3. Development of the training system

Fig. 2 presents how to operate the training system. As presented in Fig. 2, the training system is started by initializing the scenario of decommissioning. The subject of the training system then put the HMD on his head. The visualization of a decommissioning scenario is displayed for the subject through HMD and for the supervisor through the monitoring device of the subject. If the subject starts to move in virtual environment, the working time and radiation exposure of the subject start to be measured. Also, if an accident takes place, alternatives of counter-actions of the accident are provided and choice of the alternatives is made. After finish of the accidental situation, the accumulated working time and radiation exposure are displayed on the subject's HMD and on the monitoring device of supervisor.

2.4. Performance test of the training system

The assumption on testing of the training system is that the worker's falling accident rises during installation of cavity pool seal. The performance test of the training system is shown in Fig. 3. Once the subject puts the HMD on his head, he can look at the cavity pool seal lifted by a crane. The one subject starts to go down from the upper floor to the below cavity pool, the other subject supports the

moving of the one subject. The other subject plays a role in supporting the one fallen subject in case of an accident. At this time the working time and radiation exposure of the subject are for the first time measured. During installing and checking of the cavity lines around the cavity pool seal, an accident of the one worker's falling takes place. The other subject observing the moving of the one subject goes down to the accident spot on a ladder and both of them gets to the upper floor. In the end, the accumulated working time and radiation exposure of the subjects are measured and displayed on the HMD in first mode and on the monitoring device in third mode.

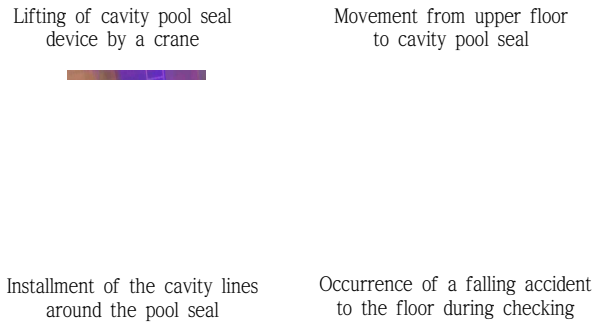

Fig. 3 The performance test of the training system

3. CONCLUSIONS

This system has extraordinary features. One feature is to real-time change direction of workers in a virtual decommissioning scenario. Another feature is to real-time measure and assess the personal exposure dose and the collective exposure in a virtual decommissioning scenario. It can be come to conclusion that this system can be protected from accidents and enable workers to improve his familiarization about working environments. In the end, the safety during decommissioning of nuclear facilities will be guaranteed under the principle of ALARA and this system can be utilized as a training tool for operating & maintenance phases as well as decommissioning phase in life-cycle of nuclear facilities.

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