Reduction of Equipment Access Time through Cyber Plant Navigation

Jang-soo Suh*, Ja-sung Goo, Yong-yi Kim
Nuclear Power Education Institute. KHNP
*Corresponding author: sjssjs@khnp.co.kr

1. Introduction

Safe and effective on-the-job training at a nuclear power plant has been gaining its importance in South Korea and in the UAE. As a solution to this, a cyber plant has been developed based on 3D model design data. It allows its users to access equipment and components in a virtual reality without risks or danger of potential radiation exposure and also increases their familiarity with NPP structures. Equipped with navigation functions similar to those of the applications installed in automobiles and smart phones, this application displays the shortest route to reach the target equipment and predicts estimated access time and radiation exposure dose.

This application has contributed to the reduction of equipment access time, and therefore has facilitated early response to abnormal conditions, reduced radiation exposure dose, and maximized the effects of OJT at nuclear power plants. This paper will look at the realization of the cyber plant, the operations of the cyber plant, and how cyber plant applications can be applied further.

2. Realization of Cyber Plant

2.1 Selection of Cyber Plant Viewer

WalkInside 6.0 has been selected for this project as a virtual reality viewer. It is highly recognized for its route storage function and avatars with excellent movements, including the ability to move up and down stairs and ladders.

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2.*2 Development of Cyber Plant Navigation Application*

Consisting of high-density steel-concrete structures, the GPS (Global Position System) is of no use inside a nuclear power plant. Therefore, the LBS (Location Based Services), which is used in automobiles and smart phones, cannot be used at nuclear power plants. The cyber plant, however, has been designed with the essential function of allowing the avatar to search equipment from the point where the avatar is positioned and identify the shortest access route by setting the places in which to stop and the destination.

When setting the destination, this application allows you to add a multiple number of places in which to stop. This helps the user figure out the shortest route to access several components located at different places, the access time, and the total integrated dose (TID).

2.3 Mapping of Simulated Dose Rate per Section

With an avatar’s speed set at 2m/sec, the estimated exposure dose and estimated cumulative time can be calculated based on the avatar’s speed and the dose rate per section. Simulation is also available.

The current dose rate per section is simulated data. A new data base will be established using the actual data once the target power plant starts its operation.

2.4 Hardware and Software

The cyber plant uses VRContext WalkInside 6.0, Dell T5500 (Xeon X5550 2.66Ghz/8MB LC Cache, windows7 Pro 32bit, 12GB DDR3 SDRAM (1,066MHz), and 4G GDDR3 nVidea Quadro (FX5800).

3. Operations of Cyber Plant

3.1 Application Areas

The cyber plant can be used as an effective tool in plant familiarization programs, setting up work plans at the local site, and mentoring programs. In addition, it is currently under review whether the cyber plant application may be of good use in developing simulator scenarios based on the emergency manuals for earthquakes, tsunami, or terrorist attacks against nuclear power plants, and in executing simulator training.

3.2 Viewer Distribution and License Policy

The viewer currently runs in a standalone version, but a new type of viewer and models via a server system will be distributed once it is extended to the network system. The viewer will be operated under a floating license. If needed, remote access services, in which users request a license from a central license server, run the application, and return the license when they finish using the application, will be available at a reasonable cost.

3.3 Network Version and Device Interlock Operation

Once the application is extended to the network system, remote users can enter the cyber plant using their own avatar and work at the local site as a team via the multiparty voice-over-IP system. This function will be of good use for the mentoring system between users located at different places.

Once the interlock process with the interactive virtual reality device is complete, the application can provide viewpoints which interlock with the actual location and direction of the user wearing an HMD (Head Mounted Display) in a space where the location and the direction are traceable. This allows the user to move their head, walk through the cyber plant, and transfer between spaces using the 6DOF wand (six degrees of freedom controller) if the user has to leave the space.

4. Results

4.1 Navigation

Outdoor navigation applications such as the GPS have entered into general use while indoor navigation applications such as WiFi AP and the RFID have become partially commercialized. However, there is a limit to applying this GPS navigation technology and wireless communications system to a nuclear power plant due to security reasons and a NPP's steel-concrete structures.

This project has been developed to help the application's user identify the shortest route using the route search function of the application before they are dispatched to the local site. Personnel who are already at the local site can access the cyber plant by logging into the Cyber Plant Access System installed at major points in the NPP. In addition, route information can be provided from the above access system onto mobile devices via a local area network such as Bluetooth. With the installation of passive RFIDs throughout the plant, information on current locations can also be transmitted to mobile devices.

Using the route and location information transferred to their mobile devices, personnel can easily access the destination. This information can be effectively utilized during emergency evacuation or life rescue activities in case of an emergency at a nuclear power plant, but in-depth technical review should be carried out.

4.2 Interlock with Contents

The cyber plant should not simply remain as a basic application which contains configuration and property information of equipment, components, piping and structures, but must transform into an integrated portal which monitors related data and plant operating conditions as a whole.

The added values of the cyber plant are expected to multiply with the real-time interlock of plant procedures, drawings, design data and operating parameters and the combination of the NPP-related contents (disassembly, assembly, and actuation principle models of component internal structures, system/component contents, 3D drawings, and panoramic photographs).

4.3 Interlock with Interactive Devices

As the cyber plant lacks reality in comparison to the actual nuclear power plant, it has tried to demonstrate a real plant as closely as possible using tags, instructions, colors and texture similar to those of a NPP. However, the sense of reality still seems to be restricted.

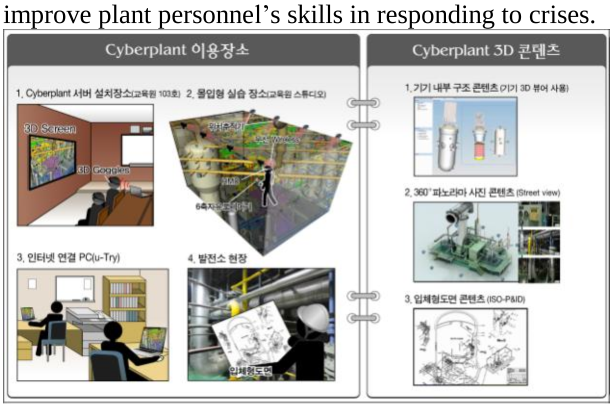
To supplement this, this application uses immersive devices such as HMD, location/direction trackers, and 3D display & sound systems. The cyber plant will be used more widely when it is equipped with augmented/mixed reality, interlocked with immersive reality, and available on mobile devices.

5. Conclusions

Three-dimensional models are created at the NPP design stage, and these models are used in the design intervention and review and the construction and process management processes. By using panoramic photographs of the actual power plant along with verified 3D models and interlocking data with the SAP (Systems Applications and Products) and SCADA (Supervisory Control and Data Acquisition) systems, the cyber plant should be able to achieve a higher level of reality.

The cyber plant navigation and mentoring system under development can be used by plant personnel as a plant familiarization tool. In particular, its function to construct visuals for abnormal operation, emergency training, and major disasters at a NPP will strengthen personnel's ability to react effectively.

With growing concerns about nuclear power after the recent Fukushima accidents, the cyber plant is expected to enhance the safety of a nuclear power plant and improve plant personnel's skills in responding to crises.



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