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An exposure dose evaluation system based on virtual reality technology

The radiological protection of the workers in the nuclear industry is an important part of the safety culture. Optimizing the radiation exposure through the "As Low As Reasonably Achievable (ALARA)"principle is a very important procedure for assessing workers'safety and health.

A 3D ALARA planning tool is developed by China Institute for Radiation Protection (CIRP) to provide advanced, radiation exposure analysis technology to different users, who can benefit from an interactive 3D visual representation of radiation risks to support ALARA optimization.

By integrating radiological information with 3D models of radiological environments, this tool provides the possibility to plan the work in a 3D environment by taking into account the geometric shielding, material, and radioactive source specifications. This tool is supposed to facilitate risk-informed planning and work execution and to support the optimization of radiological protection for activities in nuclear environments and enhance safety in the nuclear industry.

The geometrical information, the material information, and the radiological information are imported from files or entered interactively through direct manipulation of 3D UI components. This information is integrated to define the radiological layouts and job scenarios.

This system supplies three simulators. The first simulator introduces the Point-Kernel technique with the infinite media buildup method to estimate the dose, isotopic contribution to dose, and shielding effects. The second is a simulator that contains several interpolation algorithms including Inverse Distance Weighted (IDW) algorithm and Kriging interpolation techniques. Hence the second simulator does not compute dose maps itself but uses data from imported dose maps to estimate the dose at any location within the dose mapped space. The third simulator provides a source inference technique to estimate the source strengths based on a dose mapping and the knowledge of the source positions and the isotopic composition of the sources.

The radiation visualization technique is also developed in this system. Given a set of sources and a shielding configuration, or a set of pre-calculated dose maps, the system enables the user to toggle a 3D visualization of the radiological conditions to support decision-making. The visualizations are color-coded by mapping radiation levels to colors and it provides user-configurable setting functions for changing the properties of visualization.

Based on the visualized 3D radiation field, it allows assessing the individual and collective dose uptake for a defined work scenario and enables the comparison of multiple scenarios for the optimization of efficient ALARA planning. Multiple data formats such as 2D charts, graphs, and plots of radiological conditions are provided to support the decision-making and evaluation of alternative scenarios.

This system also provides several digital management functions for assisting the person responsible for radiation protection on a nuclear facility. Users can add, access, and manipulate data in the database, and produce reports. These data include the geometrical information, measured radiological information, equipment information, radiation work permit (RWP) information, work scenarios, et al. This system is currently being used at the commercial nuclear reactor. It will contribute to improving safety in nuclear facilities by increasing stakeholders'comprehension of radiation risks.

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