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A radiation field reconstruction method based on the combination of Empirical Bayesian Kriging algorithm and Least-squares Fitting algorithm

During the operation, maintenance, decommissioning of nuclear facilities, workers often need to work directly in the radiation environment. Considering the personal dose limit principle in the radiation protection, specific planning is usually carried out prior to the implementation of the work, which requires the radiation protection personnel to obtain the radiation field data of the entire work area. However, due to the number of detectors is limited, the radiation data can only be obtained at a few locations in the radiation area. Hence, it is necessary to select appropriate algorithm to reconstruct the complete radiation field based on these limited radiation data.
After studying the accuracy and principle of commonly used reconstruction algorithms, the combination of Empirical Bayesian Kriging algorithm and Least-squares Fitting algorithm is introduced to reconstruct nuclear radiation field based on the sparse measurement data. And after many attempts, the semivariogram type of the Empirical Bayesian Kriging algorithm adopts the whittle detrended, while the model of the Least-squares Fitting algorithm is exponential function. In this method, the two algorithms are responsible for calculating different regions, the radiation field of the region surrounded by the measuring points is interpolated using Empirical Bayesian Kriging algorithm. Then the extrapolation is performed to obtain the radiation field of the outside region with Least-squares Fitting algorithm based on the results obtained in the previous step. To demonstrate the feasibility of this method, the simulation experiment with scattered and sparse measuring data is performed based on a large gradient virtual radiation field, and the average relative error of the reconstructed results is 20.7%. Considering more realistic application, another experiment with sparse data along a certain path is simulated. It shows that the average relative error is 25.1%. The results in this study indicate that the combined method is effective for the reconstruction of large gradient radiation field with sparse measurement data, which is helpful for radiation protection in practical engineering.

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