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Statistical Approach for Detection of Low-Level Radioactivity

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Decommissioning involves activities such as the dismantling of power plants. Amongst the various technical challenges of decommissioning is to carry out accurate radioactivity measurements of a wide area of waste types. In this paper, we aim at measuring a low-activity uranium contamination on concrete surfaces, with varying enrichment encountered levels within a basic nuclear facility. In this context, we have developed an advanced method based on Bayesian inference. It allows to take a reasonable decision when using restricted and possibly conflicting information from various sources. The implementation of the Bayesian approach is based on a priori vectors constructed from the coupling of experimental data acquired within a basic nuclear facility using high-resolution gamma-ray spectrometry based on a high-purity germanium diode detector (HPGe), as well as simulated data with Monte Carlo N-Particles 6 transport code. The performance evaluation and characterization of Bayesian method were performed using classical receiver operating characteristic curves (ROC) with the study of the radiological background variations effect. The results clearly indicate that the proposed method allows to adjust the confidence degree in the stationarity of the radiological background. They also show that for a stable radiological background, our proposed approach provides a significantly higher tradeoff between specificity and sensitivity, close within 1 to the behavior of an ideal detection procedure with a little degradation in the case of the variability of the background radiation as expected under such constraints. Moreover, Bayesian inference proved their ability to ensure an acceptable tradeoff between the true detection rate (TDR), the false alarm rate (FAR) and the response time, in order to be compatible with the user's requirements.

Abstract Category

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