

Localization of Radioactive Sources with a Mobile Radiation Detection System using Profit Functions

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Abstract : The detection and localization of hidden radioactive sources are of significant importance in countering the illicit traffic of Special Nuclear Materials and other radioactive sources and materials. Radiation portal monitors are commonly used at airports, seaports, and international land borders for inspecting cargo and vehicles. However, these equipment can be expensive and are not available at all checkpoints. Consequently, the localization of SNM and other radioactive sources often relies on handheld equipment, which can be time-consuming. The current study presents the advantages of real-time analysis of gamma-ray count rate data from a mobile radiation detection system based on simulated data and field tests. The incorporation of profit functions and decision criteria to optimize the detection system's path significantly enhances the radiation field information and reduces survey time during cargo inspection. For source position estimation, a maximum likelihood estimation algorithm is employed, and confidence intervals are derived using the Fisher information. The study also explores the impact of uncertainties, baselines, and thresholds on the performance of the profit function. The proposed detection system, utilizing a plastic scintillator with silicon photomultiplier sensors, boasts several benefits, including cost-effectiveness, high geometric efficiency, compactness, and lightweight design. This versatility allows for seamless integration into any mobile platform, be it air, land, maritime, or hybrid, and it can also serve as a handheld device. Furthermore, integration of the detection system into drones, particularly multirotors, and its affordability enable the automation of source search and substantial reduction in survey time, particularly when deploying a fleet of drones. While the primary focus is on inspecting maritime container cargo, the methodologies explored in this research can be applied to the inspection of other infrastructures, such as nuclear facilities or vehicles.

Keywords : plastic scintillators, profit functions, path planning, gamma-ray detection, source localization, mobile radiation detection system, security scenario

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