Real-Time Radiological Source Term Estimation for Multiple Sources in Cluttered Environments

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Abstract:

A particle filter algorithm is presented to estimate the position, strength, and cardinality of an unknown number of radioactive point sources in an obstacle-rich environment using count measurements. The algorithm addresses gaps in the prior literature by incorporating two novel elements. The first is a precomputation step in which local terrain and obstacle data is processed to compute attenuation kernels throughout the search area. This enables rapid estimation performance in obstacle-rich environments as measurements are gathered. The second novel feature is a dynamic particle allocation technique in which the number of particles is adjusted in real time to meet convergence goals. This feature allows the algorithm to scale more efficiently to scenarios with a larger number of sources. A series of computational experiments using simulated data demonstrates the algorithm's performance in a cluttered environment with up to eight sources. A preliminary small-scale hardware experiment validating the algorithm with real sources and sensors is also presented. Finally, future directions including full scale hardware experiments and incorporating spectra into the measurement model are discussed.