

In scenarios when no significant neutron sources or changes are expected, the ability to characterize a neutron field and identify possible anomalies could be crucial for verifying compliance to safeguards or arms control agreements. We are focusing our efforts on demonstrating a unified approach using the N-SpecDir Bot, a Neutron-detecting Spectrally and Directionally Sensitive Robot, for localization of an anomalous source, absence confirmation, and template matching. Starting from a simplified particle filter, we introduce several improvements which are applicable to nonproliferation and arms control applications. The particle filtering framework is selected for its ability to perform source localization while incorporating information from successive measurements as the N-SpecDir Bot explores its search environment. We generalize the particle filter to account for unknown background radiation and the possibility of zero sources so that it can simultaneously verify the absence of sources or localize an anomalous source. We also propose a method for adapting the particle filter to template matching with prior measurements by redefining the particles to represent the location and magnitude of deviation from the template. For all variants of the particle filtering approach, we can also simplify the distribution of particles by incorporating physical limitations on the placement of potential sources. These improvements help to mature particle filtering with the N-SpecDir Bot from a canonical source localization approach to an application-relevant tool.