Both immediate response and mitigation of a nuclear incident would greatly benefit from rapid, remote radionuclide identification and spatial mapping, readily performable by an autonomous unmanned aerial vehicle (UAV) platform. This project has as its goals the optimization of algorithms governing the holistic exploration strategy of a small UAV. Simultaneous localization and mapping (SLAM) is a popular problem in robotics with many insights to this dilemma. Much previous research into source localization is focused upon greedily reconstructing and seeking sources a posteriori. Such approaches largely rely on statistically significant sensor-to-source distances, and degenerate with increased source count, noise, and more complex terrain to be avoided. They directly seek out individual sources with no regard to the most efficient exploration strategy of the entire space. Prior work in this area treated it as an image-reconstruction problem, exploring non-linear regressions in addition to Bayesian filtering. While effective for localizing individual sources, to achieve optimal performance a more intelligent exploration strategy is required, rather than greedily seeking out the nearest source. Both probabilistic frontier-based and behavior-based exploration methods will be examined along with genetic algorithms.

Localization will be treated as an objective function governing exploration, beneficial as each objective can be made modular and generalized. Additional directives can be provided that may be useful in response scenarios, such as: search and rescue, ecological and industrial inspection; and general SLAM. Experiments involving non-ionizing radiation sources, such as WiFi from a router, are planned to measure each algorithm's efficacy. Consideration will be given to extrapolation to ionizing radiation detectors based upon the experimental results. The experiments will be focused on single UAVs, but these strategies—particularly the genetic ones—lend themselves to future research into multiple parties.