Radiochemistry and AI: Development of an Analytical Capability Using Machine Learning Algorithms for Early Detection of Radionuclides in the Environment

Nair, Anushka

From the 1940’s, radionuclides were widely dispersed in the environment from atmospheric nuclear testing and reactor waste. Since, environmental radioactive monitoring systems have been significantly reduced, and what still exist is time inefficient, labor intensive, costly, and does not share data globally. In the event of a nuclear disruption, the world has no system of targeted emergency response and threat analysis system and there is no current established global baseline of radionuclide concentration. The research objective was to create a system to establish a global nuclear wiki, and be able to conduct threat analysis for targeted rapid emergency response. The system created follows a three steps process: image classification with artificial neural networks (ANN), gamma spectroscopy, and machine learning algorithms for analysis. Lichen was identified as an accurate bio-indicator of radionuclide concentration. The ANN was then trained to classify images as having presence of lichen, the species, lichen/ft^2, and GPS coordinates. The resulting high accuracy made it a viable method for fast lichen collection, identification, and data sharing. A NaI(Tl) detector was built with a lead shield to conduct gamma spectroscopy on lichen. Pulse height histograms were analyzed through three machine learning algorithms for threat analysis to create a composite threat score of an area over a GIS overlay. This data could be used for early prevention and emergency response in the case of nuclear disruptions, as the system is completely automated, and is time and cost efficient. A baseline was established using samples of lichen and the system proved to work in a fast paced manner for governmental intervention in the event of a nuclear disruption, streamlining the entire process.

Awards Won:
First Award of $5,000
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category
Association for the Advancement of Artificial Intelligence: Second Award of $1,000
China Association for Science and Technology (CAST): Award of $1,200