National Nuclear Security Administration

Office of Defense Nuclear Nonproliferation
Research and Development

Using Low-resolution Gamma-ray Spectroscopy and Machine Learning as an Information Barrier for Uranium Enrichment Measurements

Principal Investigator: (Kathryn Huff) **Supporting Investigators**: (Mark Kamuda)

Abstract

Well-trained artificial neural networks (ANN) may be able to perform single attribute measurements (i.e. uranium enrichment) in safeguards scenarios without the intervention of a spectroscopist. This makes ANNs prime candidates to perform zero knowledge measurements for safeguards monitoring due to their adaptive nature. Previous work has shown good isotope identification performance when training ANNs on simulated NaI(Tl) gamma-ray spectra. Extending this method to uranium enrichment measurements could provide a powerful safeguards tool to the DNN R&D nonproliferation mission.

Goals, Objectives, and Deliverables

- The main goal of our work is to investigate the feasibility of and best practices for simulating a machine learning training dataset for uranium enrichment measurements using a handheld NaI(Tl) detector.
- This work could add a powerful safeguard tool to the DNN R&D nonproliferation mission.

Results/Technical Challenges

- Current results show that additional environmental factors need to be added to the simulated training dataset to get useful accuracy in real spectra.

- Technical challenges include:
  - Sufficiently simulating the variety of environmental conditions that affect a gamma-ray spectrum below 200 keV.
  - A lack of measured NaI(Tl) spectra of variously enriched uranium to benchmark against.

Planned Accomplishments

- Investigate the effect of additional environmental scattering in the training datasets on model accuracy on real data.
- Investigate theoretical performance on simulated spectra.
- Investigate the feasibility of measuring the enrichment of shielded enriched uranium by including shielding in the training dataset.
- Benchmark method on additional gamma-ray spectra of enriched uranium.

Research Team

Principal Investigator Contact Information:

- Kathryn Huff
- University of Illinois at Urbana-Champaign
- kdhuff@illinois.edu

Supporting Investigators:

- Mark Kamuda

If applicable, indicate which consortia your work is derived from

- CVT–Consortium for Verification Technology
  Director: Prof. Sara Pozzi, UM

Notes

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