SAND2015-9482R

Advanced Imaging Algorithms for Radiation Imaging Systems
173669

Year 2 of 3
Principal Investigator: P. Marleau / 08127
Investment Area(s): International, Homeland, and Nuclear Security / Strategic Partnerships

Project Purpose:

Radiation-imaging devices are important to the nuclear security and safeguards communities due to their ability to detect and localize radioactive sources. Because of their low natural background, difficulty to shield, and unique association with SNM, fast-neutron imaging provides a promising means for the detection of SNM. To make these R&D systems useful for end-user applications, robust reconstruction and analysis algorithms must be developed that provide detailed information on the location, energy spectrum, and intervening material. To date, deconvolution, match filtering, and MLEM have been demonstrated. However, the information provided is limited to an approximate location of the source.

The intent of the proposed work, in collaboration with University of Michigan, is to develop the algorithms that will bring the analysis from qualitative images to quantitative attributes of objects containing SNM. The first step to achieving this is to develop an in-depth understanding of the intrinsic errors associated with the deconvolution and MLEM algorithms. A significant new effort will be undertaken to relate the image data to a posited three-dimensional model of geometric primitives that can be adjusted to get the best fit. In this way, parameters of the model such as sizes, shapes, and masses can be extracted for both radioactive and non-radioactive materials. This model-based algorithm will need the integrated response of a hypothesized configuration of material to be calculated many times. As such, both the MLEM and the model-based algorithm require significant increases in calculation speed in order to converge to solutions in practical amounts of time.

We will improve simple backprojection and MLEM reconstruction techniques that will make imaging systems more robust to these various detection scenarios. Such improvements include the development of algorithms to more accurately model a specific measurement scenario. These advanced image reconstruction algorithms can be applied to existing imaging systems and used as a basis for designing and optimizing novel imaging techniques.

Refereed Communications:

J. K. Polack, M. Flaska, A. Enqvist, C. S. Sosa, C. C. Lawrence, and S. A. Pozzi, An Algorithm for Performing Charge-Integration, Pulse-Shape Discrimination and

Estimating Particle Misclassification in Organic Scintillators, Nuclear Instruments and Methods A, vol. 795, p. 253-267, 21 September 2015.

J. K Polack, A. Poitrasson-Rivière, M. C. Hamel, K. Ito, S. D. Clarke, M. Flaska, S. A. Pozzi, A. Tomanin, P. Peerani, Image Reconstruction of Shielded Mixed-Oxide Fuel Using a Dual-Particle Imaging System, in IEEE Nuclear Science Symposium Conference Record, Seattle, WA, November 8-15, 2015.

M. C. Hamel, J. K. Polack, A. Poitrasson-Rivière, D. D. Klemm, M. Flaska, S. D. Clarke, S. A Pozzi, A. Tomanin, P. Peerani, Time-of-Flight Neutron Spectrum Unfolding for Mixed-Oxide Nuclear Fuel and Plutonium Metal Using a Dual-Particle Imager, in IEEE Nuclear Science Symposium Conference Record, Seattle, WA, November 8-15, 2015.

Published Proceedings: J. K. Polack, M. C. Hamel, A. Poitrasson-Riviere, P. Marleau, M. Flaska, S. D. Clarke, S. A. Pozzi, "Spectrum Isolation in Multi-Source Image Reconstruction Using a Dual-Particle Imager", INMM 56th Annual Meeting, 2015

A. Poitrasson-Rivière, J. K. Polack, M. C. Hamel, D. D. Klemm, K. Ito, A. T. McSpaden, M. Flaska, S. D. Clarke, S. A. Pozzi, A. Tomanin, P. Peerani, Angular-resolution and material-characterization for a dual-particle imaging system with mixed-oxide fuel, Nuclear Instruments and Methods A, vol. 797, p. 278-284, 11 October 2015