Prague, Czech Republic June 21-25, 2021

Contribution ID: **51** Type: **Oral presentation**

#11-51 Extended sources reconstructions by means of Coded mask aperture systems and Deep learning algorithm

Friday, June 25, 2021 8:40 AM (20 minutes)

The localization of radioactive sources is a fundamental information in the scope of radiative environment analysis, for nuclear safety or Decommissioning and Dismantling applications. However, performing this localization is challenging since conventional optics cannot be used for high-energy photons. One main method consists of using a coded mask aperture, placed in front of a position sensitive detector for X and gamma photons. This is an indirect imagery method, which necessitates inversion algorithms in order to recover the positions of the sources from the hit map observed on the detector and from the knowledge of the projections of the mask on the detector, also called shadowgrams. Classical algorithms of deconvolution and iterative MLEM (Maximum Likelihood Expectation Maximisation) are usually used to perform this inversion. But since the problem is non injective and these classical algorithms are not intrinsically associated to regularisation methods, they are not able to reconstruct extended sources, neither their shape nor their positions especially when the number of pixels to record a shadowgram is limited to few hundreds. In this paper, we propose to address this problem from the prism of Deep learning algorithms, based on Convolutional Neural Networks (CNN), with an application to Caliste detector. Caliste is a CdTe miniature detector of 16x16 pixels, with a 625 µm pixel pitch, and its spectroscopic capabilities allow to select gamma ray events in narrow energy bands enable hyper-spectral imaging at high energy. We generate synthetic learning data of extended sources in order to train our CNN to localize radioactive sources from simulated hit maps representing the Caliste detection matrix. Once trained, we test the CNN on real data acquired with a gamma camera prototype, equipped of a Caliste detector and a coded mask aperture. We demonstrate the ability of this algorithm to reconstruct real extended sources at the 60 keV emission line of 241Am.

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Session Classification: 11 Current Trends in Development of Radiation Detectors

Track Classification: 11 Current Trends in Development of Radiation Detectors