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High-resolution image reconstruction with unsupervised learning and noisy data applied to ion-beam dynamics

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We want to develop a new numerical analysis tool using artificial intelligence techniques to improve the denoising, segmentation, and reconstruction of images that characterize the beams of accelerated particles. These improvements aim to increase the accuracy of measurements, in particular to better characterize the halo of the beams, and reduce beam losses by ultimately making processes more sustainable. This is a disruptive innovation because the number of works on an international scale in the field is very limited. The exploratory project is at the feasibility study stage, and the next step is to conduct a comparative study with existing AI/ML tools.

The variability of experimental conditions and in particular of the background noise on our installations requires a specific approach with systematic training and relearning. Furthermore, the absence of noise-free images and standardized noise model, as well as the limited number of data for training will orient the study towards recent solutions requiring reduced, unsupervised learning such as that proposed by deep generator networks.

The applications of these developments are numerous and go far beyond the scope of the project in its current version. Indeed, the restoration of corrupted and noisy images using reduced data sets, using unsupervised methods, are useful in astronomy (celestial object detection), in the field of health, medical imaging (in vivo functional imaging to visualize the development of pathology, drug progression in organs, microscopy), life sciences (classification of animal species), and in high-energy physics (trajectory reconstruction for charged particle detectors).

Auteur principal: OSSWALD, Francis (IPHC)

Orateur: OSSWALD, Francis (IPHC)

Classification de Session: ML for accelerators

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