Leveraging AutoScript for Cross-Platform Deep Learning Solutions in Electron Microscopy

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Python's widespread adoption is supported by a wide community that has developed an extensive toolkit of open-source libraries. Electron microscopy vendors have introduced Application Programming Interfaces (APIs) enabling users to design sequences for comprehensive control over electron optics, detectors, sample positioning, and data acquisition. [1,2,3]
These Python-accessible libraries facilitate classical image processing tasks, including object detection, drift correction, and feature tracking, which have been pillars of electron microscopy scripting for over twenty years. Applications range from Focused Ion Beam (FIB)/Scanning Electron Microscopy (SEM) defect analysis and Transmission Electron Microscopy (TEM) lamella preparation to semiconductor metrology, with TEM image processing and data analysis being particularly prominent.

The adoption of closed-loop image processing in electron microscopy is driven by the increasing volume of multimodal data generated by these instruments. Direct data offloading is inefficient and risks post-processing error identification, leading to valuable time losses.

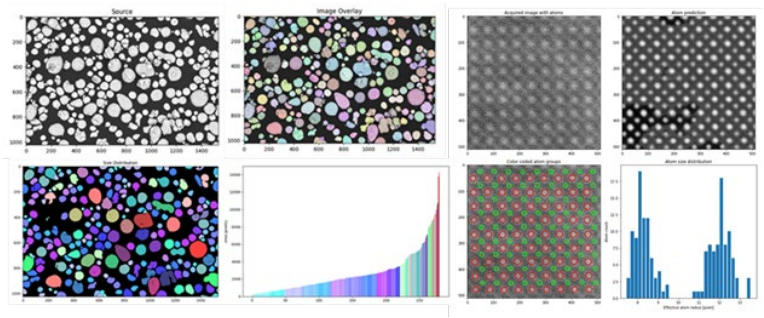
Recent advancements in machine learning and deep learning have significantly enhanced their performance and integration speed, facilitating their inclusion in closed-loop automation sequences for complex tasks such as object detection, classification, and feature extraction.

ThermoFisher Scientific's AutoScript, a cross-platform Python-based API, streamlines and refines electron microscopy workflows by harnessing deep learning techniques. This paper highlights two applications:

1. SEM Feature Analysis: Utilizing a Thermo Scientific Helios microscope, this experiment automates the creation of binary masks for feature analysis on aluminum powder samples. Instance segmentation enables feature separation, counting, and property analysis (e.g., size and shape), allowing real-time experimental optimization based on material properties identified by deep learning algorithms.
2. TEM Atom Detection: Demonstrated with a Thermo Scientific Talos F200, this application automates the detection of atom positions and diameters in HR-STEM images of SrTiO3. Neural networks facilitate rapid atomic structure predictions and interface identification, optimizing imaging parameters on-the-fly.

These cases exemplify the transformative impact of cross-platform, Python-based APIs in electron microscopy, showcasing their potential to enhance efficiency, accuracy, and the scope of achievable experiments through automation and advanced data analysis.

Graphic:



Keywords:

EM Automation, Deep Learning, AI

Reference:

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