Evaluating Deep Learning for Segmenting Nanobeads on Nanofibers in Electron Microscopy Images

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Abstract

Deep learning (DL) use has intrinsically seen a rapid increase in medical imaging. Imaging modalities vary in analysis complexity, with increasing difficulty from photography to microscopy. Within microscopy, the order progresses from stained microscopy, brightfield microscopy, and unstained brightfield microscopy (UBM) to the more challenging electron microscopy (EM). Several challenges are organized and introduced to researchers with manually well-prepared labelled ground truth images. UBM and EM have often been explicitly excluded from these challenges as they are very challenging modalities [1]. Initial efforts of the use of DL have been reported in the work of Treder et al. [2]. The major challenges in this imaging modality is low contrast, high noise levels [3] and complex textures [4]. In this work, we demonstrate the application of deep learning for segmenting zeolite nanobeads embedded within biocompatible nanofibers, with the objective of developing advanced filtration materials. The presence of nanofibers creates unique challenge in various imaging modalities [5] that can be overcome by using image augmentation, noise reduction and dropout layers. After implementing several optimization techniques a segmentation accuracy of 95% of the nanobeads is achieved.

References

[1] Caicedo, Juan C., Allen Goodman, Kyle W. Karhohs, Beth A. Cimini, Jeanelle Ackerman, Marzieh Haghighi, CherKeng Heng et al. "Nucleus segmentation across imaging experiments: the 2018 Data Science Bowl." *Nature methods* 16, no. 12 (2019): 1247-1253.

[2] Treder, Kevin P., Chen Huang, Judy S. Kim, and Angus I. Kirkland. "Applications of deep learning in electron microscopy." *Microscopy* 71, no. Supplement_1 (2022): i100-i115.

[3] Uka, Arban, Xhoena Polisi, Julien Barthes, Albana Ndreu Halili, Florenc Skuka, and Nihal Engin Vrana. "Effect of Preprocessing on Performance of Neural Networks for Microscopy Image Classification." In *2020 International Conference on Computing, Electronics & Communications Engineering (iCCECE)*, pp. 162-165. IEEE, 2020.

[4] Uka, Arban, Aleks Tare, Xhoena Polisi, and Ina Panci. "FASTER R-CNN for cell counting in low contrast microscopic images." In *2020 International Conference on Computing, Networking, Telecommunications & Engineering Sciences Applications (CoNTESA)*, pp. 64-69. IEEE, 2020.

[5] Uka, Arban, Albana Ndreu Halili, Xhoena Polisi, Ali O. Topal, Gent Imeraj, and Nihal E. Vrana. "Basis of image analysis for evaluating cell biomaterial interaction using brightfield microscopy." *Cells Tissues Organs* 210, no. 2 (2021): 77-104.

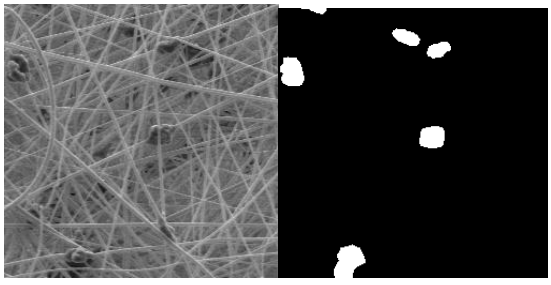

Figure 1: Nanobeads embedded in nanofibers