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Deep learning assisted segmentation and mapping of DNA molecules

The laboratory of nanoscale biology (LBEN) at EPFL is offering a semester (master) project related to the image processing of super-resolved stretched DNA.

DNA analysis methods have evolved tremendously over the past decade. One of the goal of such techniques is to be able to recognize the species of origin. As an alternative to DNA sequencing (i.e. reading the whole DNA sequence), we have developed in our lab a way to map the DNA to its corresponding species while avoiding complicated PCR reactions and DNA sequencing.

The method is based on sequence specific labelling of DNA and subsequent stretching on a glass surface. The stretched DNA is then imaged with a super-resolution microscope resulting in a sort of bar-code image (Figure). The intensity profile of each DNA molecules is extracted and matched against a database of species. [1,2]

In order to study the entire microbiome, we need to analyse thousands of images, extract all the individual DNA molecules and match them to their sequences. This is too much for manual selection, a method is needed to automatically detect the DNA strands and extract their intensity profile.

The task of the student will be to optimize a new approach to DNA segmentation based on machine learning and work on the automatisation of the full pipeline, from raw images to meaningful information. The second task of the student (Master project) will be to train another neural network to classify the segmented DNA. We will provide the student with experimental images, supervision and expertise to develop the algorithm (Python and Matlab). The student will be able to work in a highly interdisciplinary group with backgrounds ranging from polymer physics, image analysis, microscopy to molecular biology.

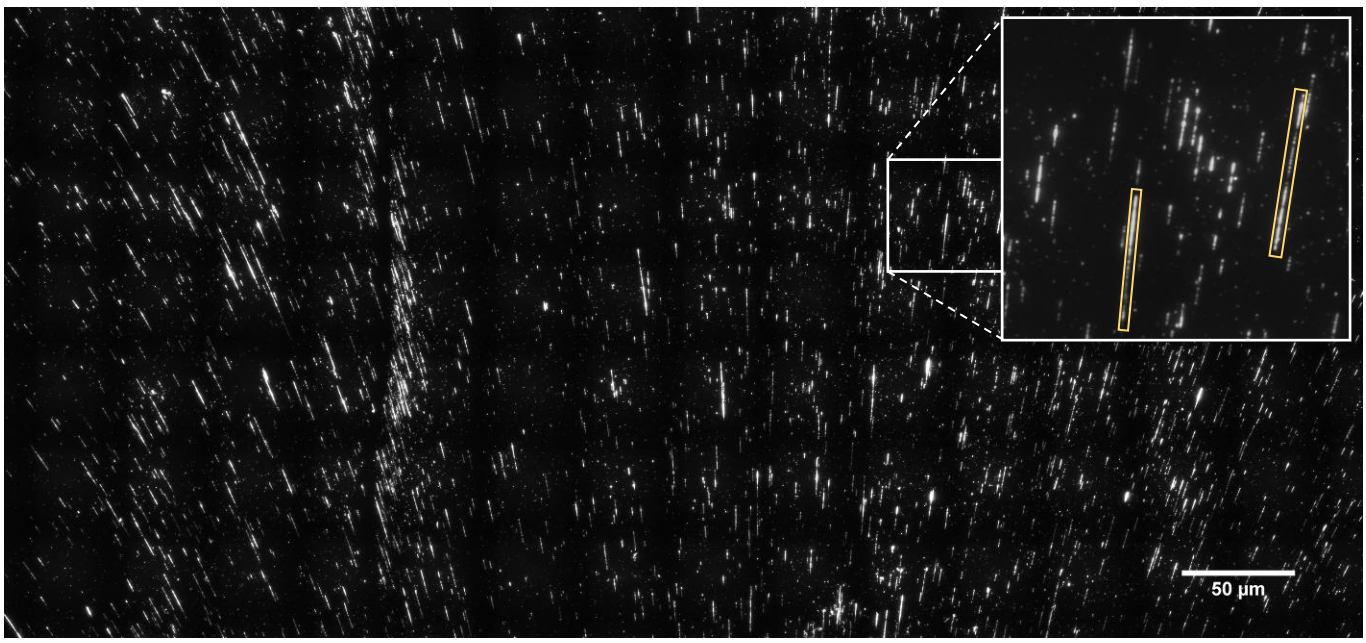

Figure 1. Typical microscopy image of labeled DNA. Inset: Zoom on DNA molecules with manual segmentation

Skills: Knowledge in signal and image processing, machine learning and basics of optical imaging,
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Supervisor: Prof. Aleksandra Radenovic (aleksandra.radenovic@epfl.ch)

References:

1. Deen, J.; Vranken, C.; Leen, V.; Neely, R. K.; Janssen, K. P. F.; Hofkens, J. Angew. Chem. Int. Ed. **2016**, doi:10.1002/anie.201608625
2. Neely, R. K.; Deen, J.; Hofkens, J. Biopolymers **2011**, 95, (5), 298-311.