Automated 3D Labelling of Fibroblasts in SEM-Imaged Placenta Using Deep Learning

Benita S. Mackay1, Sophie Blundell2, Rohan M. Lewis3, Olivia Etter3, Yunhui Xie1, Michael D. T. McDonnell1, Matthew Praeger1, James A. Grant-Jacob1, Robert W. Eason2 and Ben Mills1

1 Optoelectronics Research Centre, Faculty of Engineering and Physical Sciences, University of Southampton, Southampton, SO17 1BJ, UK;
2 School of Physics & Astronomy, Faculty of Engineering and Physical Sciences, University of Southampton, Southampton, SO17 1BJ, UK;
3 Department of Human Development and Health, Faculty of Medicine, University of Southampton, Southampton, SO16 6HW, UK

1 - Introduction

Analysis of fibroblasts within placenta is necessary for research into placental growth-factors, which are linked to lifelong health and chronic disease risk [1]. 2D analysis of fibroblasts can be challenging due to the variation and complexity of their structure. 3D imaging can provide important visualisation, but the images produced are extremely labour-intensive to construct because of the extensive manual processing required.

Deep learning can be used to automate the labelling process for faster 3D analysis. Here, a deep neural network was trained to label a fibroblast from serial block face scanning electron microscopy (SBFSEM) placental imaging.

2 - Method

3D projections of fibroblasts within the placenta with nanoscale resolution were obtained through automated labelling of serial block face scanning electron microscopy (SBFSEM) images [2] via a neural network. This 3D image was a product of 943 2D images. The neural network architecture for transforming a 2D SEM image into a labelled image was an altered variant designed specifically for image-to-image translation [3]. This network was trained on half of the stack images.

3 - Results

The neural network achieved greater than 98% pixel accuracy, where the automated and manual pixel value are the identical, across all testing images. In the third column (3), the difference between automated (1) and manually (2) labelled images was plotted for easier visual comparison.

4 - Conclusion & Future Work

This study labelling fibroblasts demonstrates how deep neural networks can be used for labelling of complex structures from SBFSEM stacks, allowing for accurate 3D projections with a significant reduction of up to several months of dedicated time required for image processing, therefore overcoming a current drawback to efficient 3D imaging of micro and nanoscale cell structures.

Future work is focussed on labelling a larger range of cell types and determining the minimum number of labelled images per stack needed for accurate automated labelling.

Literature Cited & Acknowledgement


Supported by EPSRC, grant number EP/N03368X/1