

UPPSALA UNIVERSITET



Vironova



elisabeth.wetzer@it.uu.se



ida.sintorn@it.uu.se



joakim.lindblad@it.uu.se



natasa.sladoje@it.uu.se





Towards automated multiscale imaging and analysis in TEM: Glomerulus detection by fusion of CNN and LBP maps

Introduction

Texture Information

- Deep learning approaches show good performance, however hand-crafted texture features can provide additional advancement
- The generation of Local binary pattern (LBP) codes of an image results in an unordered set of binary codes \rightarrow convolution is not meaningful
- Using a modification of the approximated Wasserstein metric between the codes, they can be mapped into a metric space by multidimensional scaling (MDS)
- We evaluate LBPs with radii r=1,2,3,individually and as a combination

Convolutional Neural Networks

- VGG16 with Batch Normalization
- ResNet50
- Trained from scratch
- Stochastic gradient descent
- 20 epochs
- 8x data augmentation

Elisabeth Wetzer¹, Joakim Lindblad¹, Ida-Maria Sintorn^{1,3}, Kjell Hultenby², Natasa Sladoje¹ ¹Uppsala University, ²Karolinska Institute, ³Vironova

Glomerulus detection is an essential initial step in many nephropathological diagnoses, such as minimal change disease, systemic lupus, and many others which can affect the kidney function

Transmission Electron Microscopy (TEM) is the preferred imaging technique, providing resolutions in nanometer scale for this task

Images acquired using MiniTEM, a desktop, low-voltage (25keV) TEM

Automated ROI detection in vast search space saves precious time





Fig. 3: 3D mapping of LBP codes





0.15

0.1

0.05

Fig. 1: A series of magnifications illustrating the vast search space for glomeruli on a 200 meshgrid used for TEM which have characteristic foot processes up to 1 µm



Fusion of Intensity and Texture for CNN

- Early Fusion
- Fusion in the input layer
- Intensities & LBP maps are trained together

Fig. 2: Generation of LBP Codes

Mid Fusion (VGG16 only)

- Fusion in the second fully connected layer
- SVM classifies concatenated 8192 features



- Fusion after the softmax layer
- SVM classifies concatenated 4 probabilities



Conclusions Improvement in CNN classification accuracy when texture information is fused with intensity information. Best results using ResNet50 and Late Fusion of LBP maps and intensity input. Delaying the fusion and reduction of features to the very end leads to the best results for this application.

