Detecting Cancer using Texture Classification

UPPSALA UNIVERSITET

Jo Gay
Hugo Harlin

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Supervisors:
Joakim Lindblad
Nataša Sladoje

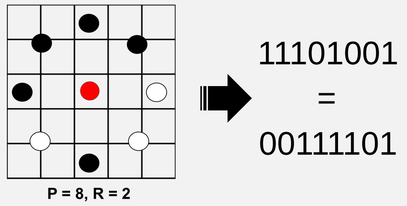
Centre for Image Analysis,
Department of Information Technology

Project Goals

- Compare ability of methods to classify cell images as healthy or cancerous
- Evaluate power of texture descriptors, in particular LBPs, to improve on performance of purely CNN-based approaches
- Implement and compare three recently published models
  - Juefei-Xu et al. [3]
  - Li et al. [4]
  - Marcos et al. [5]
- Compare with previous work using VGG and ResNet [1]

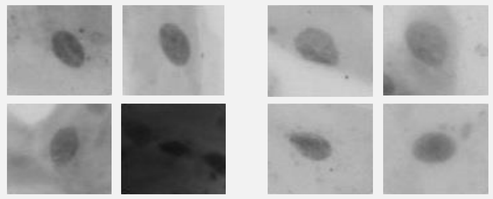
Local Binary Patterns

- LBPs [2] are powerful texture classifiers
- Use intensity level of central pixel to threshold values of P points surrounding it at radius R
- Binary string gives pattern index
- Rotational equivalents and least common (‘non-uniform’) patterns are usually combined
- Histogram of pattern indexes can be used as a feature set in a neural network



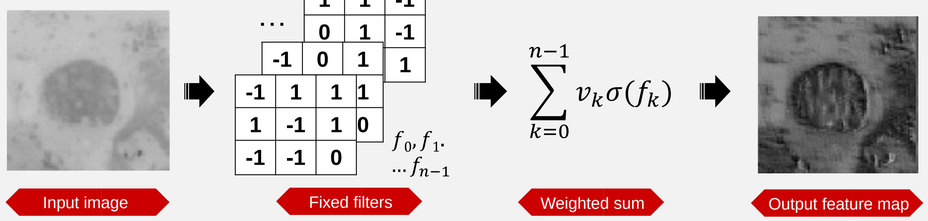
Data

- 6 patients, 3 with oral cancer and 3 healthy
- 10k cell images (80x80) [1]
- Only patient diagnosis known, not individual cell classification
- Training and test data selected from different patients to avoid data leakage



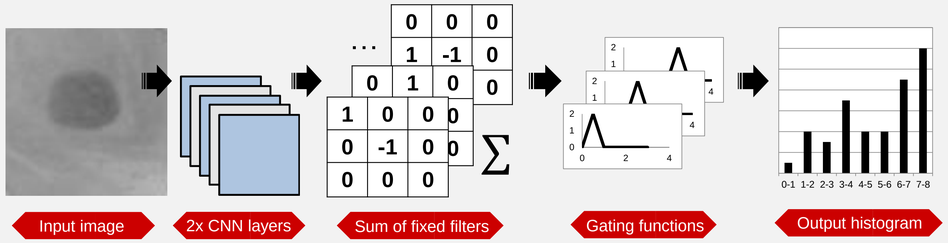
Healthy Cells Cancer Cells

Three CNN Models



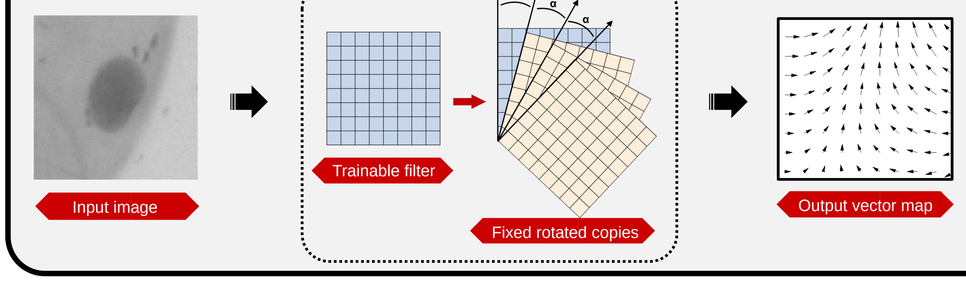
Model 1, Juefei-Xu et al.:

- 512 fixed random ±1 filters f_k, 10% zeros
- Rectified linear activation $\sigma(f_k)$
- Trainable weights v_k used in linear sum to create feature map



Model 2, Li et al.:

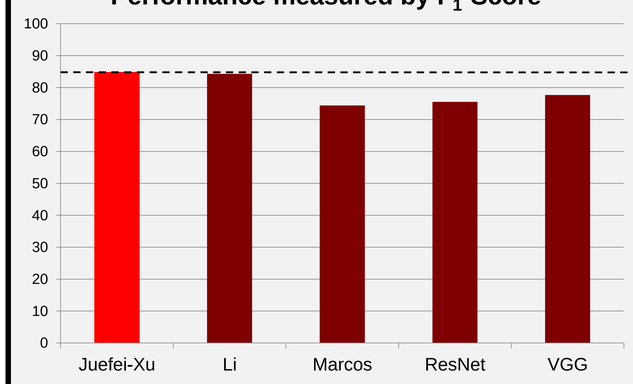
- 8 fixed difference filters
- Sum of sigmoid activations
- 8 Gating functions applied to sum
- Histogram of results



Model 3, Marcos et al.:

- Stack of rotated filters, adapted for vector field input
- The output angle is given by the rotation of the filter with highest activation
- Activation magnitude & direction forms 2D vector field output

Results



Model	Accuracy (%)	F_1-Score (%)
Juefei-Xu et al. [3]	**81.03**	**84.85**
Li et al. [4]	**80.70**	**84.30**
Marcos et al. [5]	**68.37**	**74.41**
ResNet	**78.34**	**75.51**
VGG	**80.66**	**77.68**

[1] H Wieslander, G Forslid, E Bengtsson, C Wählby, J Hirsch, C Runow Stark, S Kecheril Sadanandan. Deep convolutional neural networks for detecting cellular changes due to malignancy. In *CVPR*, pages 82–89, 2017
[2] T Ojala, M Pietikainen, T Maenpaa. Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. *IEEE Transactions on PAMI*, 24(7):971–987, 2002.
[3] F Juefei-Xu, V Boddeti, M Savvides. Local binary convolutional neural networks. In *CVPR,* volume 1, 2017.
[4] L Li, X Feng, Z Xia, X Jiang, A Hadid. Face spoofing detection with local binary pattern network. *Journal of Visual Communication and Image Representation*, 54:182–192, 2018.
[5] D Marcos, M Volpi, N Komodakis, D Tuia. Rotation equivariant vector field networks. In *ICCV* , pages 5058–5067, 2017.