Cell Segmentation/Quantification of Staining in Histological Sections

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Introduction

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- The Algorithm
- Independent Component Analysis
- The Conclusion
- References

Motivation

Images in medical diagnostics . . .

. . . are the first choice by the medical doctor.

In these images there are a lot of information and Regions of Interest!

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- cracks in bones in the CT-images
- tumors in brains or bodies in the MRI- and PET-images

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In these images there are a lot of information and Regions of Interest!

- cracks in bones in the CT-images
- tumors in brains or bodies in the MRI- and PET-images
- cells and cell nuclei in microscope images

Histological Sections

Made with high resolution microscopes

Histological Sections
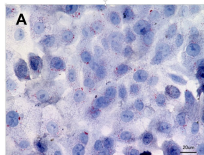
Made with high resolution microscopes

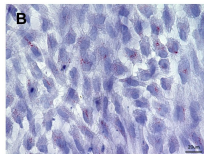Dry eye

Histological Sections

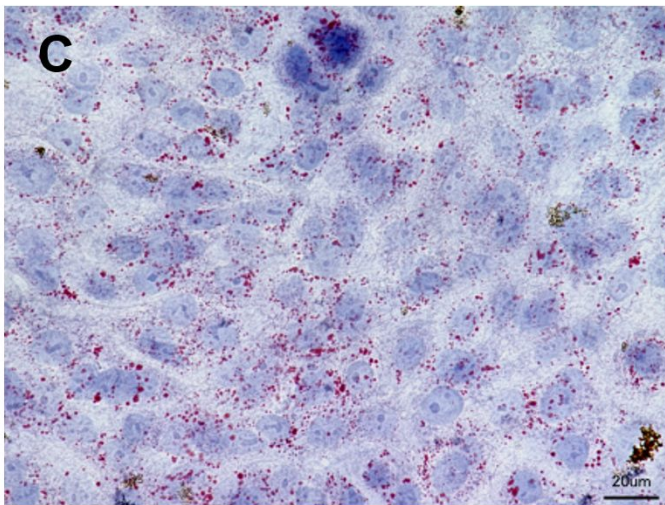Made with high resolution microscopes

Dry eye

- cells and vacuoles
- stained differently

fetal calf-serum 10% 1d
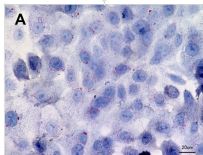

fetal calf-serum 10% 7d

Histological Sections

Made with high resolution microscopes
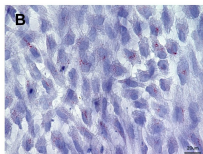
Dry eye

- cells and vacuoles
- stained differently
- investigation of the effects of
  - different substances
  - over time

fetal calf-serum 10% 1d

fetal calf-serum 10% 7d

Different Substances

	FKS20%	Glucose	Lipid	Sebocyte
1d	C	E	G	I
7d	D	F	H	J
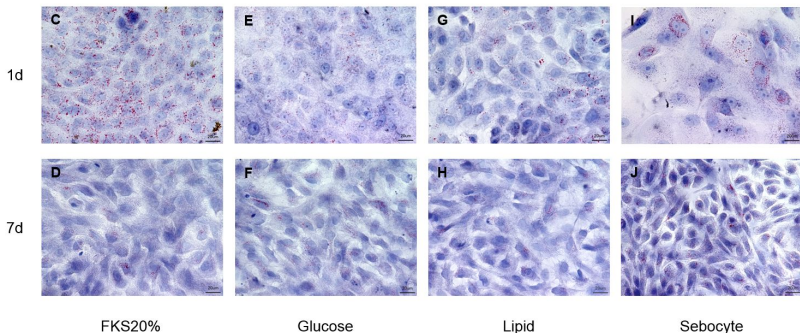
The Algorithm

Automatic Cell Detection [4, 3]

developed by Firas Mualla and Simon Schöll

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What about:

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What about:

- learning based system

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What about:

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- unstained cell detection in bright-field microscope images

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What about:

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- using SIFT . . .

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What about:

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- . . . random forests . . .

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What about:

- learning based system
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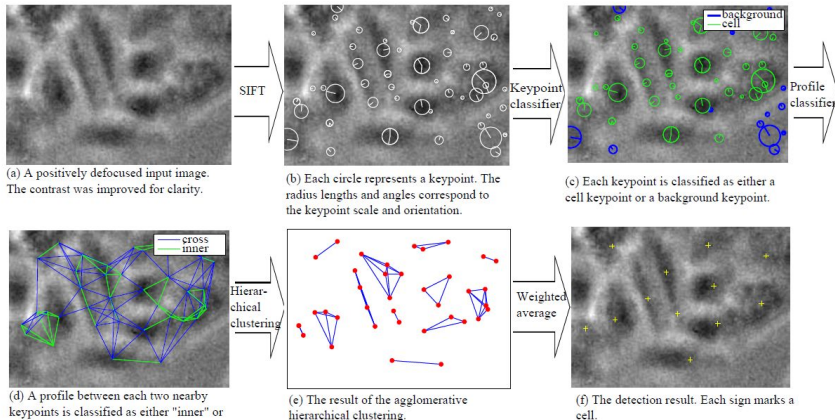- . . . and hierarchical clustering

How it works

(a) A positively defocused input image. The contrast was improved for clarity.

SIFT

(b) Each circle represents a keypoint. The radius lengths and angles correspond to the keypoint scale and orientation.

Keypoint classifier

(c) Each keypoint is classified as either a cell keypoint or a background keypoint.

Profile classifier

(d) A profile between each two nearby keypoints is classified as either "inner" or "cross" profile.

Hierarchical clustering

(e) The result of the agglomerative hierarchical clustering.

Weighted average

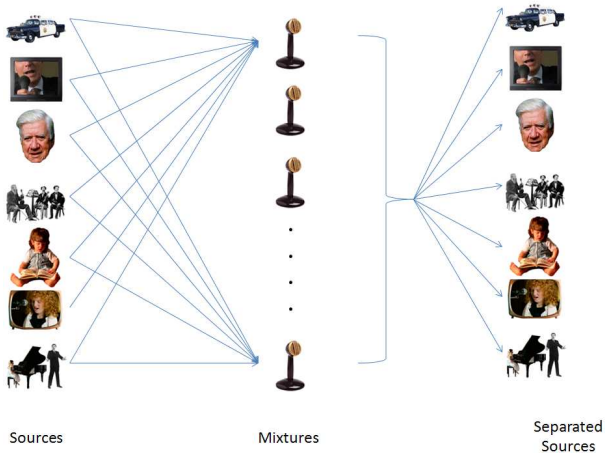(f) The detection result. Each sign marks a cell.

Fig. 1.   A general overview of our automatic cell detection approach.

Independent Component Analysis

Cocktail-Party Problem

Sources   Mixtures   Separated
                                                        Sources

Blind Source Separation

". . . recovery of unobserved signals or 'sources' from a set of observed mixtures . . . " [1, 2]

- technique for uncovering independent source signals
- fairly new technique in biomedical signal analysis
- the usage of it will be investigated

The Conclusion

What's left to do

- differentiate between cells and vacuoles
- measure their average size and ...
- ... their intensity of the staining
- find the coalescence and thus the growth
- mainly their change from substance to substance over time
- evaluation by using Ground Truth images

References

📄 Pierre Comon.
Independent component analysis, a new concept?
Signal processing, 36(3):287–314, 1994.

📄 Christopher J James and Christian W Hesse.
Independent component analysis for biomedical signals.
Physiological measurement, 26(1):R15, 2005.

📄 Firas Mualla, Simon Schöll, Björn Sommerfeldt, and Joachim Hornegger.
Using the Monogenic Signal for Cell-Background Classification in Bright-Field Microscope Images.
In Hans-Peter Meinzer and Thomas Martin Deserno, editors, *Proceedings des Workshops Bildverarbeitung für die Medizin 2013*, pages 170–174, Heidelberg, 2013.

📄 Firas Mualla, Simon Schöll, Björn Sommerfeldt, Andreas Maier, and Joachim Hornegger.
Automatic Cell Detection in Bright-Field Microscope Images Using SIFT, Random Forests, and Hierarchical Clustering.
IEEE Transactions on Medical Imaging, 32(12):2274–2286, 2013.

The End