Segmentation of Individual Cells in Phase Contrast Microscopy Images

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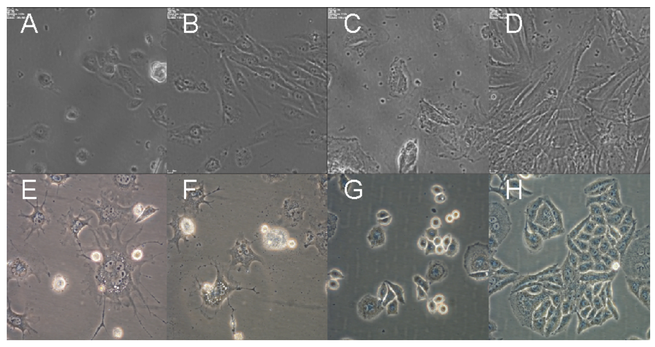
Motivation

Toxiticity/biocompatibility assesment - testing in vitro

Phase contrast microscope images



- strong halo effects
- sometimes poorly focused
- impurities in solution - black dots outside the cells
- nonuniform shapes of cells
- dead cells
- texture-like background

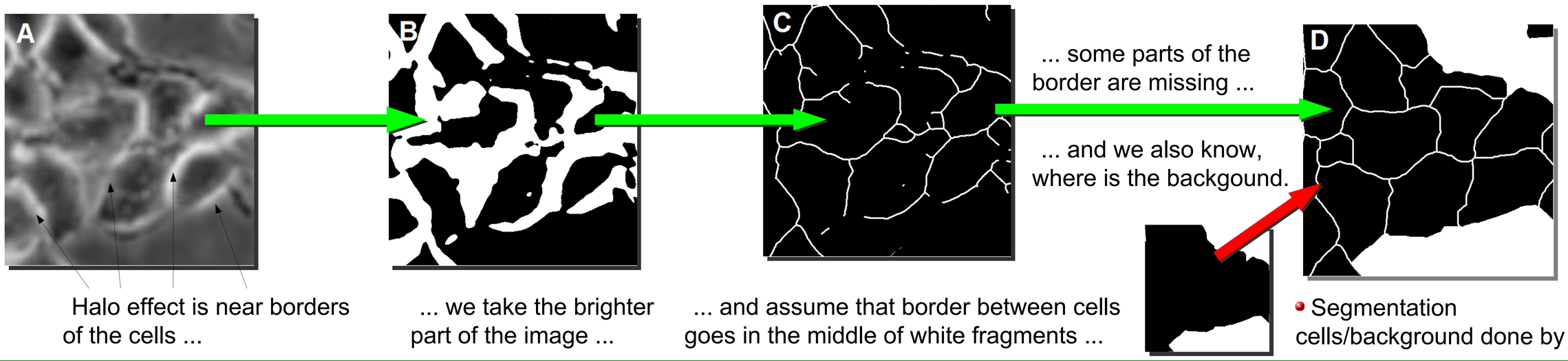
- non-invasive (no protein labeling, low irradiation level)
- interior of the cells is visible
- not affecting behavior of cells as other types of microscopes

Our aims

- Automated processing of time-lapse image series
- Segmentation of moving objects (cells) from background
- Robustness to degradation present in phase contrast microscope images
- Characterize behavior of the cells

Method

- Original image
  - Blurring
  - Otsu thresholding
- Skeletonization - modified algorithm
  - Adding the infromation about background
  - Connecting loose ends using Dijkstra algorithm



Halo effect is near borders of the cells ...

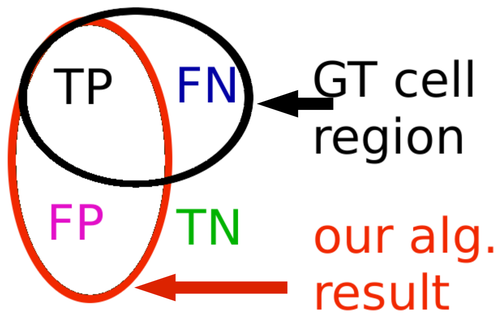
... we take the brighter part of the image ...

... and assume that border between cells goes in the middle of white fragments ...

- Segmentation cells/background done by [1]

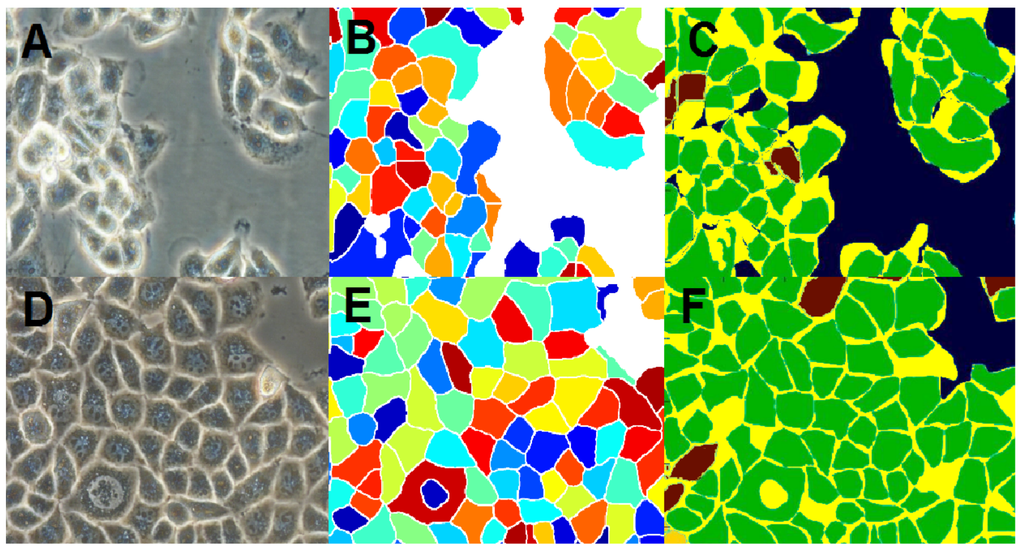
Results

- **P**recision, **R**ecall, **F1** (= Dice coeff)
- P = TP/(TP+FP), R = TP/(TP+FN)
- F1 = 2 PR/(P+R)



- HeLa (human carcino cells), L929 (mouse fibroplast), E6 (vero cells)

- Matlab + java implementation, 30 sec/image (4 MPixel)
- Results: (mean over all of the images) **P = 0.65, R = 0.73, F1 = 0.68**



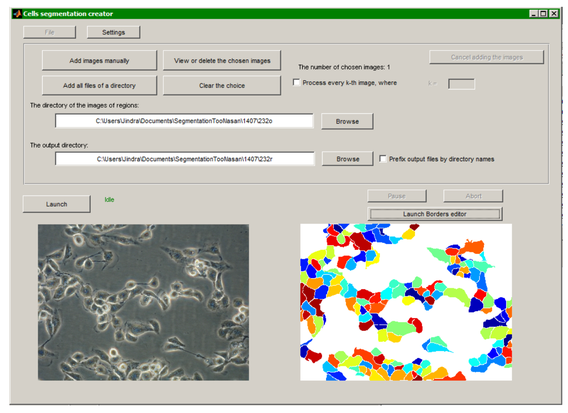
Original images

Examples of segmentation by our algorithm

Correspondence with manual segmentation (green areas are correct, light blue ones are under-segmented and yellow are over-segmented, dark blue is used for background).

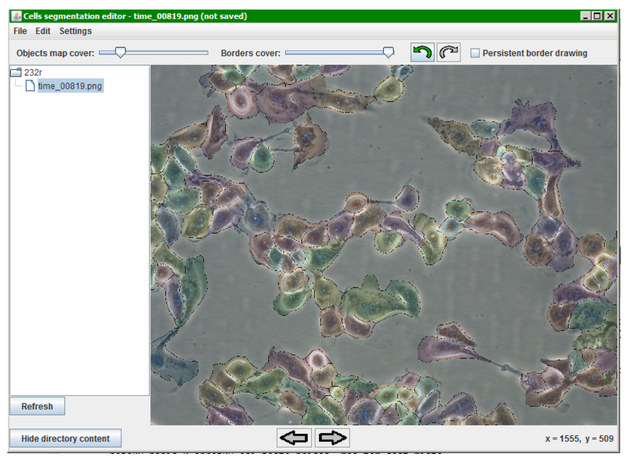
Implementation, gui, editor

- Matlab/Java implementation
- Standalone application with GUI
- Speed: 30 s for 4MPixel image (Dual Core 2.30 GHz
- Batch processing



Screenshot of main program

Screenshot of our editor



- Merging or splitting of the regions
- Overlaying with the original image
- Statistical evaluation of the results
- Multilanguage support
- Undo button
- ....

Literature

[1] Soukup, J.; Cisar, P. & Sroubek, F. Petrosino, A. (Ed.) **Segmentation of Time-Lapse Images with focus on Microscopy Images of Cells,** *17th International Conference on Image Analysys and Processing - ICIAP 2013*, Springer-Verlag, 2013, 8157, Part II, 71-80

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