Nuclei Segmentation of Whole Slide Images in Digital Pathology

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1. Background

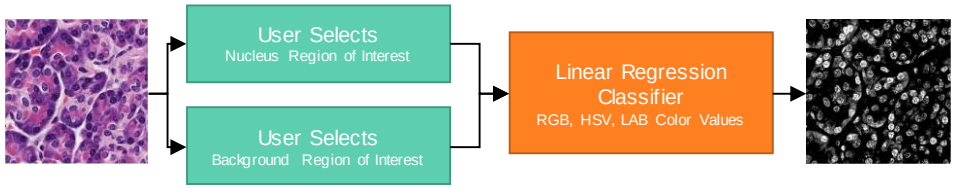
- Pathology is the study of the cause and effect of disease from tissue samples on microscope slides.
- Today, a pathologist inspects a tissue sample visually through a microscope, and makes a diagnosis, prognosis, or judgment. The process is inherently subjective and often causes disagreement amongst pathologists.
- Quantitative image analysis of pathology slides can add objectivity to this important decision process.
- Many quantitative metrics are calculated at the cellular level. As a precursor, it is important to perform nuclei segmentation of the image.

4. Conclusion

- Our nuclei detection algorithm is comparable to other published techniques, whose accuracies range from 77-90%.
- These techniques include learning methods such as SVMs and CNNs, and image processing methods such as MSER, the Hough Transform, and single-pass voting.
- Our image set is particularly difficult to segment, as the hematoxylin (purple stain) is smeared across multiple adjacent cells.
- Using the watershed transform results in better segmentation boundaries, but further works needs to be done to increase the recall of the method.
- Specifically, the quality of the watershed ridge lines needs improvement.

2. Method

Transform RGB Image Into "Nucleus Map"



Nuclei Detection from the "Nucleus Map"

Nuclei Segmentation Using Morphological Operators

Nuclei Segmentation Using Watershed Transform

3. Results

Nuclei Detection Results

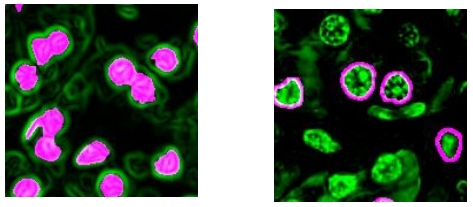
Manual inspection of a region of the whole slide image saw the following results for nuclei detection.

	Predicted	
Actual	123 True Positives	20 False Negatives
	9 False Positives	

The precision of the algorithm was 93%, the recall was 86%, and the overall accuracy was 81%.

Nuclei Segmentation Results

Using only morphological operators (left) results in better recall, but the algorithm is unable to properly segment adjacent cells, and is susceptible to noise.



Using the watershed transform leads to much higher quality nuclei segmentation, but results in significantly lower recall.