Iterative Threshold and Texture Analysis for Histopathology Image Segmentation

Kristine A. Thomas[1], Matthew J. Sottile[1], Carolyn M. Salafia[2]

[1] Department of Computer and Information Science, University of Oregon
1202 University of Oregon, Eugene, OR 97403-1202, USA
[2] Placental Analytics, LLC
93 Colonial Avenue, Larchmont, New York 10538

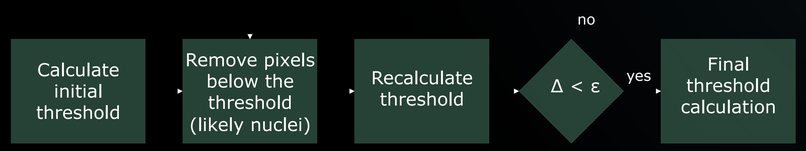
MOTIVATION

Acute inflammation of the placenta is associated with an increased rate of perinatal morbidity and mortality[1]. The standard diagnostic process is qualitative visual examination of Hematoxylin and Eosin (H&E) stained placenta histology slides. This process results in a high degree of variability in diagnosis, even among expert pathologists[2]. Currently the diagnostic gold standard is consensus among expert pathologists which is based on qualitative observation. Our goal is to assemble an unsupervised method to quantify the degree of inflammation in placental tissue which is consistent with expert and lab results and reliable under inconsistent environmental factors such as staining techniques.

METHODS

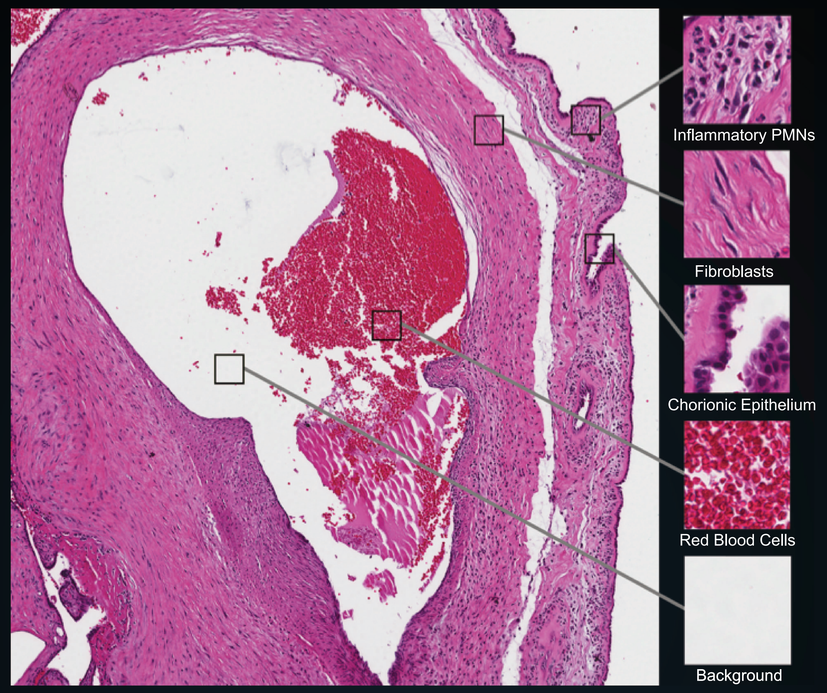
1. Isolate the tissue by removing the background and red blood cells via color thresholding. This both normalizes and reduces the amount of data for further processing.

2. Apply the iterative threshold technique to isolate nuclei from the tissue. This novel thresholding technique is based upon experimental observations which indicate that the optimal threshold value is a function of the intensity after the nuclei are removed. Since the nuclei cannot be removed without first knowing the threshold, we developed a technique which starts with a necessarily low value and approaches the desired value with each iteration as the previously selected pixels are removed.

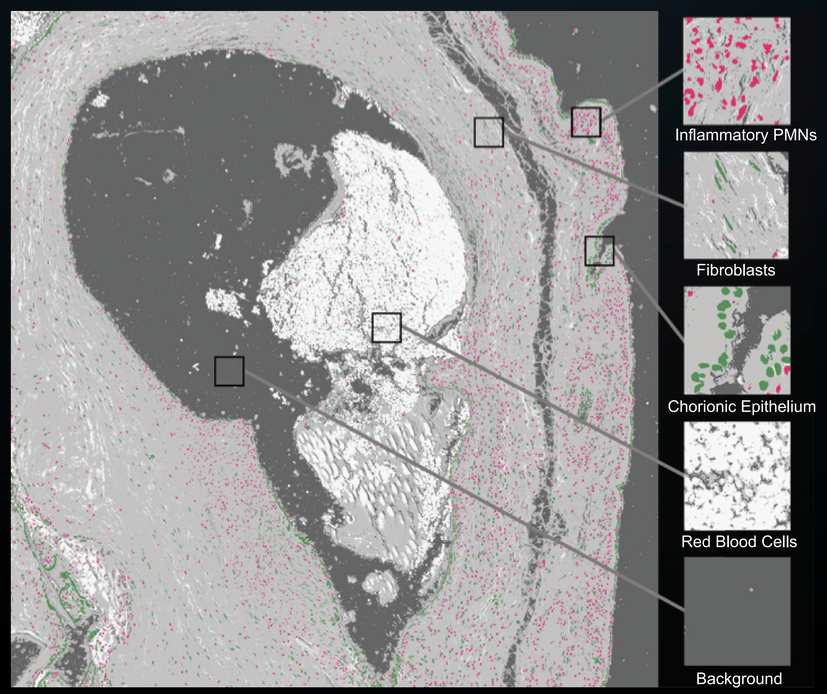


3. Classify nuclei based on morphological characteristics, e.g. size and shape, into two groups: inflammatory Polymorphonuclear Leukocytes (PMNs) and those which are not, such as connective tissue fibroblasts as well as chorionic and amnion epithelium.

4. Quantify results of the classification: number of inflammatory PMNs, area of the tissue and area of the inflammation.



Microscopic image of a blood vessel within the chorionic plate of a placenta.



Microscopic image after processing and isolating the inflammatory cell nuclei (pink).

BACKGROUND

Histopathology is the study of disease through microscopic examination of tissue. Samples are prepared for examination by placing a very thin slice of tissue on a glass slide. The slide is exposed to a stain or dye bath to create contrast between the tissue types and cellular components. H&E is the most widely used and available staining method for medical diagnostics. Hematoxylin turns nuclei blue while eosin turns cytoplasm and connective tissue pink. The methods presented on this poster were created for use with H&E stained tissue samples.

RESULTS

Amniotic fluid proteomic (AFMR) scores are strongly associated with histological grading of inflammatory PMNs in amnion, chorion, decidua, and in the umbilical cord. AFMR scores correlated with the total area of inflammatory PMNs (r=-.546), total area of inflammation vs. total area of tissue (r=0.546), and the number of inflammatory PMNs (r=0.505). Results were consistent across environmental variations such as stain aging and brand combinations. Because the method presented is unsupervised, the results are reliable and reproducible.

FUTURE WORK

Currently we are conducting a new study consisting of 500-700 regions of interest (ROI) ranging all clinical levels of diagnosis. The ROIs will be blindly scored by 3 expert pathologists as well as the algorithm as it is presented here. The results will provide precise comparisons between the qualitative score currently used by pathologists and the quantitative results from this algorithm.

REFERENCES

1. Richard L. Naeye. *Disorders of the placenta, fetus, and neonate: diagnosis and clinical significance / Richard L. Naeye* Mosby Year Book, St. Louis: 1992.
2. R.W. Redline, O. Faye-Petersen, D. Heller, F. Qureshi, V. Savelle, and C. Vogler. Amniotic infection syndrome: nosology and reproducibility of placental reaction patterns. *Pediatric and Developmental Pathology*, 6(5):435-448, 2003.

ACKNOWLEDGEMENTS

This research has been funded by Placental Analytics, LLC.