Automatic glomeruli detection in histopathology digital slides

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Introduction

Renal biopsy is a key diagnostic tool in the analysis of renal pathology for both native and transplant kidneys. Examination of the biopsy is currently done by several pathologists from a visual examination of several biopsy slides stained by different staining, through a microscope. This screening is very tedious and subject to inter and intra-observer variabilities. One of the first visual task consists in counting glomeruli, a critical element of the kidney, in 2D tissue sections to determine if the tissue sampling is representative of the 3D organ. In this work, we propose to combine image processing and machine learning techniques to automatically detect glomeruli in digital whole slides.

Materials and Methods

We combine image processing techniques and machine learning techniques. The first step detects glomeruli candidates by using image processing [Meas-Yedid, 2011], namely Otsu thresholding [Otsu, 1979], ellipse estimation algorithm [Fitzgibbon, 1999], and superpixel segmentation [Felzenszwalb, 2004]. The second step classifies each of these candidates into positive (glomeruli) or negative objects using a supervised classification model based on extremely randomized trees and random subwindows [Marée, 2014]. We evaluated our methodology on 9 sections with varying staining conditions and acquired in 3 laboratories using 3 different slide scanners (Hammamatsu Nanozoomer, 3DHistech Miraxscan, Zeiss AxioScan).

Results and Discussion

We evaluate our approach using a leave-one-section-out protocol. Step 1 of our algorithm generates a high false positive rate of 37.71% (detected objects that are not true glomeruli). The second step improves detection results and the false positive rate decreases downto 7.65% but it slightly increases the false negative rates upto 4.39%. Classification rate of the supervised classification model is 89.62%. Examples of detections are illustrated on a section in Figure 1. Overall, on our dataset, our automatic procedure to count glomeruli is highly correlated to manual counting by experts (0.97 correlation coefficient).

Conclusion

In this abstract we presented a workflow for automatic detection of glomeruli in whole digital slides based on image segmentation and object classification. In future work we will evaluate our approach on a larger set of hundreds of digital slides from multiple french hospitals by implementing and combining algorithms from Icy [de Chaumont, 2012] and Cytomine softwares [Marée et al., 2013].

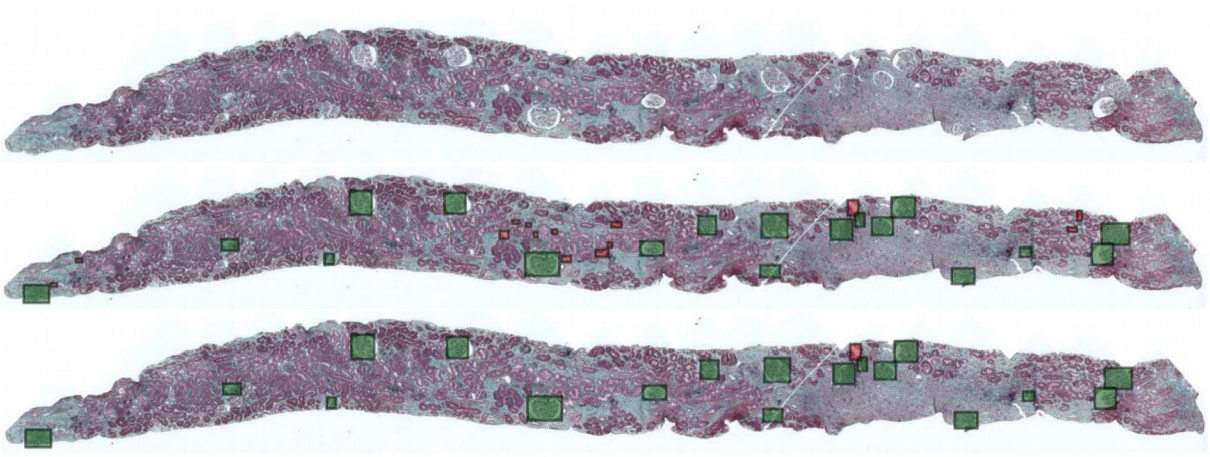

Figure 1. An original section (top), detections of step 1 (middle), detections after step 2 (bottom) where green color correspond to true positives, and red color correspond to false positives.

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