GLAND SEGMENTATION GUIDED BY GLANDULAR STRUCTURES: A LEVEL SET FRAMEWORK WITH TWO LEVELS

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Abstract

Pathologic diagnosis is the gold standard of clinical diagnosis. The identification and segmentation of histological structures are the prerequisites to disease diagnosis. In clinic, doctors often suffer from time consuming and the disagreements from different doctors about observation results. Hence, an automatic precise segmentation method is important for auxiliary diagnosis. We propose a level set framework using 0, k level set representing the boundary of lumen regions and epithelial layers for gland segmentation. The validation has been performed on clinical data of West China Hospital, Sichuan University. The experiment results show that our method has a better performance and is robust to the shape variety of endometrial glands.

Introduction

Why Segmentation of Endometrial Glands?

- Gland segmentation plays an important role in diagnosis of endometrial hyperplasia.
- Diagnosis in an early stage is important.
- The ratio of the areas of gland regions and stromal nuclei is a key metric in the diagnosis.

Difficulties:

- shape variety of glands.
- interference of vessels.

The structure of endometrial glands is shown in Figure 1.

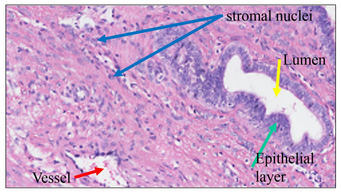

Figure 1. Example of endometrial gland image

Method

The boundaries of lumens and epithelial layers are represented by 0 and k levels of a level set function.

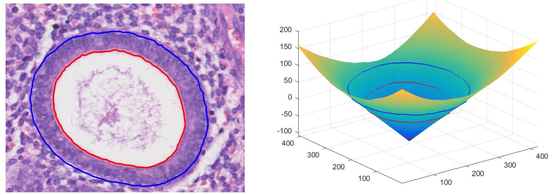

Figure 2. Level Set Representation

The steps of our algorithm and the flow chart are shown in Figure 3 and 4.

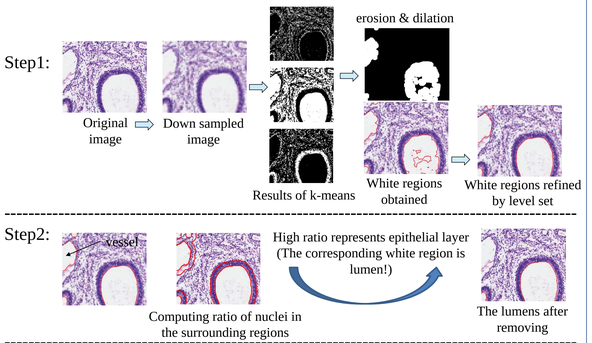

Figure 3. Steps of the proposed method

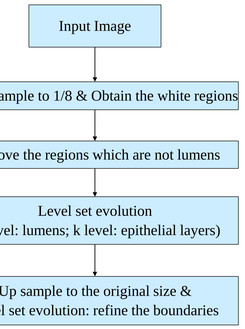

Figure 4. Flow chart

We propose a distance regularized two-layer level set framework:

$$F(\phi) = L(\phi) + R(\phi) + A(\phi)$$

- *L&A*: Data Term
  - use image data to optimize the location of the *0*-level and *k*-level contours.
- *R*: Distance Regularization Term
  - Regularize the distance between *0*-level and *k*-level contours

$$\mathrm{R}(\phi) = \mu \int \frac{1}{2}(|\nabla\phi(x)| - \alpha)^2 dx$$

$$L(\phi) = \lambda_0 \int g(x)\delta(\phi(x))|\nabla\phi(x)|dx + \lambda_k \int g(x)\delta(\phi(x) - k)|\nabla\phi(x)|dx$$

$$A(\phi) = \alpha_0 \int g(x)H\big(-\phi(x)\big)dx + \alpha_k \int g(x)H(-\phi(x) + k)dx$$

Results

Experimental results on clinical data from West China Hospital, Sichuan University are shown in Figure 5.

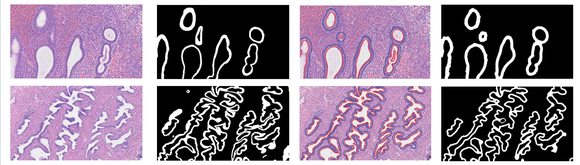

Figure 5. Segmentation results.

The proposed algorithm was compared against Nguyen et al. [1] on 18 endometrial gland images. Two of them are shown in Figure 6.

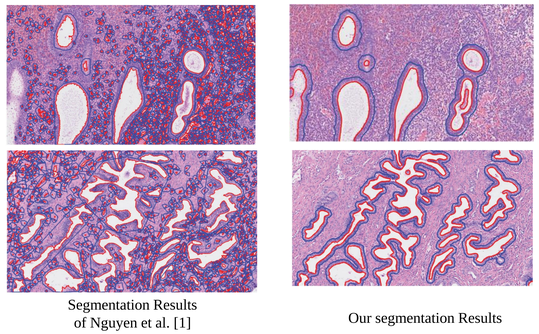

Figure 6. Method Comparison.

Conclusion

In this paper, we proposed a level set framework with 0, k level set for endometrial gland segmentation. For weakening the interference of nuclei and reducing time consuming, we down sample each image as 1/8 and smooth. We only utilize the intensity information of R,G,B channels and morphology structure information to construct the level set framework for segmentation.

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References

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