

Study on segmentation of pathological images for anomaly detection

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Abstract: The processing of histopathological images has significant impact on the performance of pattern recognition in anomaly detection within pathological images. In this paper, to improve the efficiency of anomaly detection, we propose a method for segmentation of pathological images. In this method, according to the color information of stained tissues, the pathological image was divided into three regions corresponding to nucleus, cytoplasm and background. In the end, experiments to verify the effectiveness of the proposed method were conducted.

Keywords: Image segmentation; Histopathological diagnosis; Cancer; Automatic detection, Pathological images.

1. Introduction

Today, in Japan there are more than 640 thousand new patients who are diagnosed to be cancerous. And the number will be increased in the future. As a result, the number of cases to be diagnosed by pathologists is also increasing which is forecasted to be 1.7 times from 2005 to 2015^[1]. Because of the huge burdens of pathologists, the diagnostic error or oversight are concerned.

Therefore, to reduce the burden of pathologists and improve the quality and efficiency of diagnosis, computer-aided detection (CAD) technology using Higher-order Local Autocorrelation feature was proposed. Usually the first step of CAD techniques is image processing. However, the processing of pathological images has significant impact on the performance of pattern recognition in anomaly detection. In this paper, to improve the efficiency of anomaly detection, we propose a method for segmentation of pathological images.

2. Anomaly detection from pathological images

2.1 Pathological diagnosis

Pathological diagnosis is the identification of the nature of an illness by observing the specimen taken from human body. Pathology specimens are generally tissues stained by Hematoxylin-Eosin. The pathologists identify each organization by the shade or color of HE-stained pathological images, and diagnose comprehensively according to the magnitude of the

nuclear, balance of nucleus and cytoplasm, and irregularity of the organization.

2.2 Anomaly detection system

Anomaly detection system automatically detects suspicious cancer regions from pathological samples and supports diagnosis. In previous researches, nucleus region was extracted to measure the structural features of the nucleus and cytoplasm^[2]. In these techniques, unknown cancer can hardly be detected, diagnosis can not be conducted if it failed in cell extraction and processing is slow. To overcome these problems we proposed a pathological diagnostic support technology utilizing Higher-order Local Autocorrelation features. In this approach it is possible to extract features from pathological images without cells extraction. Also processing speed is faster because only sum and product are used in the calculation of features.

3. Proposed method

3.1 HLAC feature

HLAC feature is the combinations of mask patterns which comprise reference point and different displacements limited to the 3×3 neighborhood region around the reference point. HLAC feature has the advantage of being shift invariant and computationally inexpensive.

3.2 Configuration of anomaly detection

Fig.1 shows the processing procedure of anomaly detection using HLAC feature which includes learning and detection phase.

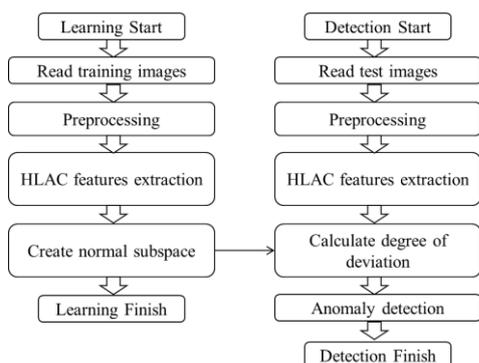


Figure 1 Flow of anomaly detection.

In learning phase, normal pathological images are read as learning samples. Then, HLAC feature is extracted from preprocessed learning samples and generates the normal subspace. Similarly, in the detection phase, HLAC feature are extracted from the preprocessed test images. Then anomaly is detected based on the distance between the features of test images and normal subspace.

3.3 Pre-processing

In order to clarify each part of pathological images and capture the characteristics more easily, the pathological images are categorized into three regions which are background, cytoplasm and nucleus. This method is described in the following.

3.3.1 Background segmentation

The background region of histopathological image has a high luminance value. Pixels which have higher luminance value than the threshold will be considered as background region. On the other hand, as a part of background, red blood cells region presents deep pink or red while other areas have the color information of blue and purple with weak effect of red component. Thus, pixels with strong red component are accounted as background.

3.3.2 Nucleus segmentation

From the preliminary experiments, we can know that there is significant difference in the nucleus region and other areas of the R axis in the RGB color space. When compared with the B and G axis, the pixels which have obviously higher value in R axis are accounted into nucleus region.

3.3.3 Image Integration

So far, two binary images are formed: background and other areas, nucleus and other areas. The

cytoplasm is extracted by the synthesis of the three binary images. Therefore, pathological images are segmented into background, cytoplasm and nucleus.

4. Experiment

4.1 Experimental images

We use 50 normal pathological images and 5 cancerous pathological images as experimental images which have already been diagnosed by the pathologists in advance. Images used in the validation experiments was taken by 20 times magnification of the microscope, and saved in jpeg format in the size of 2560×1920 .

4.2 Verification experiment

To validate the proposed method mentioned in §3.3, we conducted an experiment comparing with previous three-level method [3] using principal component analysis. Table 1 shows the experiment result for each method. From the results, we find that in proposed method false positive rate is reduced.

Preprocessing method	False positive	False negative
Previous method	20%	0
Proposed method	6.5%	0

Table 1 Experiment result for each method

5. Conclusion

In this paper, to improve the efficiency of anomaly detection for pathological images, we proposed an image segmentation method. Compared with the previous image preprocessing method, false positive rate was reduced. In the future, we are aiming to reduce the false positive rate, estimate the degree of malignant and progression of cancer, and extend to other organs besides gastric tissues.

Reference

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