Cell Mitosis Detection

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Abstract

Mitosis detection is an integrated part of the Bloom and Richardson system for grading of invasive breast cancer which is the second most frequent cancer. Pathologists routinely examine histology slides on standard light microscope which is a cumbersome process and opens scope for inter and intra-observer variability which is undesirable in serious medical cases such as that of breast cancer. Automated mitosis cell detection not only frees pathologists from this tedious task but also gives accurate results which are an important aspect of digital image processing.

Introduction

In this project, we developed a program which learns from training micrograph images and then automatically detects mitotic cells in a micrograph using image processing techniques.

Material

Software: MATLAB

Training Data:
The training set for classifier contained pairs of images, each having an original cell image and the same image but with yellow marks displaying the mitotic regions in the image (Figure 1 & 2).

Test/evaluation Data:
The evaluation data also contains unmarked cell images with both mitotic and non-mitotic regions, similar to the one above.

Method

The following steps were performed throughout the project:

Region Extraction:

1. Mitotic regions from the training data were first extracted from the entire image using Otsu thresholding. (Figure 3)
2. Each training image was then divided into 50x50 sub-images containing mitotic cells.
3. It has been observed that mitosis occurred in the dark areas of the image only hence in order to extract the non-mitotic cells, we were only required to extract the dark regions from the image in which mitosis was not taking place. The remaining areas were automatically filtered out. We obtained these dark regions by Otsu thresholding as well.

Training:
We used two types of filters as descriptors in this project namely, Harelick filter and Gabor filter. Harelick filter is a set of 14 different textural features a few being variance, average, entropy etc.
Gabor filter, named after Dennis Gabor, is a linear filter used for texture analysis. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. [2]
Prototype vectors consisting of Harelick and Gabor textural features were formed for every sub-image extracted out of the training set.

Classification:
Pattern vectors similar to the training set were formed for all the dark regions in the evaluation images after thresholding and segmenting these regions. We used minimum distance classifier for classification in which we decide that x belongs to class 'wi' if there is a prototype vector m assigned to class 'wi' such that no other prototype vector is as near to x as m.

Results

We displayed the results (Figure 5) of this classification using 3 colours:

- Blue for correct detection of mitotic cells
- white for incorrect detection of non-mitotic cells as mitotic.
- Red for cells which were not classified as mitotic but were mitotic.

Discussion

We observed that by altering the classifying threshold from 0.502, the classification was greatly influenced. If we decrease this threshold, we get more white regions that are more and more non-mitotic cells are misclassified but lesser red regions. Similarly, by increasing the ratio, we get less white regions but more red ones.

Conclusions

As shown, the results of mitosis classification in this project are far from accurate. We can obtain much better results by:

- Including more feature vectors in the training hence more accuracy.
- Using a better and efficient classifier. Distance classifier did not turn out be a reasonable choice for this task.
- Instead of analysing mitotic cell and its surrounding region together, we can separately deal with cell and the surrounding region and then combine the results.
- By adjusting the threshold such that the error is reduced significantly.

Figure 1. Experiment Schematic

Figure 2. IR Detector/Emitter circuit schematic.[1]

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