Extraction of Gastric Submucosal Tumor from Endoscopic Ultrasound Image

Kwang Baek Kim
Department of Computer Engineering, Silla University
617-736 Busan, Korea
gbkim@silla.ac.kr

Abstract. This paper proposes a novel method that gastroenterologists are able to analyze gastric submucosal tumor objectively through endoscopic ultrasound images. Thus, we standardize ultrasonographic images using brightness values of the lens area and the border area of lens with little variation of brightness in the images. For objective analysis of gastroenterologists, the proposed method analyzes the size of tumor and the echo of tumor area in ultrasonographics images with numeric translation of the histogram of the tumor area. Then, it automatically extracts the area of Gastritis Cystic Profunda (GCP) from the images. The results of evaluation using endoscopic ultrasound images showed that the proposed method was able to provide effective information to gastroenterologists for the objective analysis on characteristics of submucosal tumor and the disease taxonomy.

Keywords: Endoscopic Ultrasonography, Submucosal Tumor, Gastritis Cystic Profunda

1 Introduction

Commonly, endoscopic ultrasound images are altered according to the subjective decision of gastroenterologists, and so, the objectivity on ultrasonographic images might be improved by the degree of consensus in diagnosis between gastroenterologists. Furthermore, it is expected that the objective analysis of ultrasonographic images is able to make possible analyzing the tissue characteristics of submucosal tumor[1,2].

2 Standardization of Endoscopic Ultrasound Images

The proposed method, at first, extracts the ultrasonic area shown as Figure 1(b) from the endoscopic ultrasonographic image shown as Figure 1(a). Figure 1(c) shows the lens area and the border area of lens be used as the standardization criterion in the extracted ultrasonic area.
The proposed method compensates the images using histogram equalization method increasing the brightness contrast. Next, Edge-Linking method [3] is applied to the compensated image, that applies Eq.(1) to a 3x3 mask area, connects pixels satisfying Eq.(1) with the current pixel and marks the pixels.

\[
\left| \nabla G(x, y) - \nabla G(x', y') \right| \leq Th \tag{1}
\]

The threshold value used in Edge-Link method was set to 130 based on results of clinical trial.

3 Analysis of Submucosal Tumor

To calculate an objective distance between pixels considering the image size, the real size of image is to be calculated by using the graduated ruler appearing at the right side of ultrasonographic images, and the real distance between pixels should be calculated by applying Eq.(2). In Eq.(2), \( Y \) is the real distance between pixel, \( \text{length1} \) and \( \text{length2} \) are pixel heights of an ultrasonographic image and one unit of the graduated ruler, respectively.

\[
Y = \frac{\text{distance}}{\text{length1/length2}} \tag{2}
\]

The proposed method sorts brightness values of pixels in the image in ascending order and takes the median value, and outputs 5’s brightness values with relatively high frequencies. Gastritis Cystic Profunda (GCP), as the benign tumor of gastric mucosa mainly found at the anastomosis region of a patient having undergone the gastrectomy, is the disease that glandular epithelium invades the deep layer and the submucous layer of gastric mucosa and forms cystoma[4].

The submucous tumor doesn't have outer lines of a regular form in ultrasonographic images, and gastroenterologists may not detect the tumor from the images according to photography conditions. So, the proposed method in this paper automatically extracts the area of GCP from ultrasonographic images so that gastroenterologists can detect tumor areas correctly. It extracts the lens area and the
border area of lens from ultrasonographic image and standardizes it using brightness values of extracted areas. Edge-Link method is applied to the standardized images and the outputs are binarized with the threshold value set to clinical experimental value 75. The binarized images are labeled using Grassfire algorithm and noises are removed using morphological information on GCP. Among remaining areas, the area with highest density of pixels is extracted as the area of GCP.

4 Evaluation Results

Table 1 represents the performance of the proposed method as the number of successes in the standardization and the extraction of tumor area among 39’s ultrasonographic images used in the experiment, respectively.

<table>
<thead>
<tr>
<th>Experiment item</th>
<th>Success images / Total images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardization</td>
<td>39 / 39</td>
</tr>
<tr>
<td>Extraction of GCP area</td>
<td>8 / 9</td>
</tr>
</tbody>
</table>

5 Conclusions

This paper proposed a novel method that analyzes characteristics of submucosal tumor appearing in endoscopic ultrasound images and extracts Gastritis Cystic Profunda(GCP) from the images to assist gastroenterologists in diagnosing GCP.

In the experiment using 39’s images, the proposed method succeeded to standardize all images and only failed to extract the area of GCP among 9’s images, and the summarized results of performance evaluation showed that the proposed method is able to provide objective information to gastroenterologists in analyzing and diagnosing submucosal tumor on endoscopic ultrasound images.

References