Morphologic cirrhosis diagnosis from Ultrasound

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Abstract

Cirrhosis is an endemic disease across the world that leads to observed liver contour irregularities in the Ultrasound images, which can be used to detect and confirm the pathologic condition.

In this work these irregularities are semi-automatically segmented and quantified in order to help the physician in the diagnosis. Results obtained from real data have shown the ability of the method to detect the disease.

The ultimate goal is to use these irregularity features jointly with other features extracted from the liver parenchyma to design a highly discriminative classifier for liver cirrhosis, steatosis and other diffuse liver diseases.

1 Introduction

Cirrhosis is the end-stage of chronic liver disease [4]. It is defined histopathologically and is a major cause of death in many parts of the world [9]. The pathologic features consist in the development of fibrosis to the point that there is architectural distortion with the formation of nodules [9].

Liver biopsy is considered the gold standard in the evaluation of cirrhosis. Its invasive nature, the rise of inadequate liver samples and the morbidity and mortality associated, has motivate studies that aim the possibility of diagnosing cirrhosis by non-invasive methods [1, 10, 6, 4, 9].

Among them, the non-ionizing and non-invasive nature of the ultrasound (US) imaging and its widespread presence in clinical facilities make it one of the preferred method in cirrhosis diagnoses [6].

Using US, cirrhosis is suggested by liver surface nodularity, portal vein mean flow velocity and the enlargement of the caudate lobe [9], [6] refer that nodular liver surface is a reliable sign in the detection of liver cirrhosis and can have a diagnostic accuracy of 70% or more. [10] showed that the observed liver contour irregularities directly correlated with the gross appearance of the cirrhotic liver as seen at laparoscopy. Liver surface nodularity in US sign can be appreciated when ascites is present or when a high-frequency transducer (7.5 - 12 MHz) is used [5]. [6] study result, using a low-frequency transducer (3.5 - 5 MHz), also showed that liver surface is a significantly parameter associated with the histopathological diagnosis of liver cirrhosis.

Nevertheless, as reported by [7] the validity of the different methods to detect changes in the liver surface are very subjective, since the segmentation and contour of such surface is operator-dependent. These fact leads to a subjective and non reproducible method to study the liver surface and consequently to a poor aid of an accurate liver diagnosis.

This study shows a semi-automatic method for the liver surface detection, with the aim of extracting features for classification proposes, based on low-frequency US images.

2 Problem Formulation

In the practice of US the perceived liver capsule and the adjacent overlying membranous strutures (peritoneum, transverse fascia, preperitoneal fat) are not always clear and irregularities due to subfascial or subperitoneal pathology may be falsely described as abnormalities of the liver surface [10]. In order to attenuate these variables, we estimate the original US radio-frequency (RF) envelope signal. From this estimated RF signal the de-noised anatomic information is extracted. The estimation of both images, RF envelope and de-noised information, is performed using the Bayesian methods proposed in [8], where the use of total variation techniques allows the preservation of major transitions, as seen in the case of liver capsule and overlying structures.

Using the de-noised US image, the liver surface contour is obtain using a snake technique [2], which computes one iteration of the energy-minimization of active contour models. To initialize the snake, the operator needs to select four points of the liver surface.

Based on the detect contour, the following features were extracted: root mean square of the different angles produced by the points that characterize the contour, $r_{rms}$, where the first point was assumed as the reference point; root mean
Table 1 shows the classifier results where a high sensitivity, 82.5%, and a low specificity, 58.62%, were obtained, using the proposed algorithm.

<table>
<thead>
<tr>
<th>Classifier</th>
<th>$\omega_N$</th>
<th>$\omega_C$</th>
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<tbody>
<tr>
<td>$\omega_N$</td>
<td>17 (24.6%)</td>
<td>7 (10.1%)</td>
</tr>
<tr>
<td>$\omega_C$</td>
<td>12 (17.4%)</td>
<td>33 (47.9%)</td>
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Table 1: SVM classifier results.

4 Conclusions

In this work a semi-automatic detection of liver surface is proposed to help in the diagnosis of the cirrhosis.

The pre-classification steps showed good results in the aid of the detection of liver surface contour. Results obtained from real data have shown the ability of the method to detect the disease. Nevertheless, the specificity result was very low, which could mean that the used snake needs a better refinement.

In the future the authors intend to include other features to increase the accuracy of the method, as well as use more state-of-the-art automatic snakes, in order to create a fully automatic method.

References


