Introduction

To assess the progression of disease Duchenne Muscular Dystrophy (DMD), the proportion of fibrosis has been considered an important biomarker to provide prognostic information [2]. In the histo-images, muscle and fibrosis are stained in red and blue; it is critical to have accurate segmentation for muscle and fibrosis in histo-images. While the classical K-Means and Otsu are unable to provide satisfactory results, the popular supervised deep learning method is also difficult to be applied due to the scarcity of manually annotated training sets. In our work, we implement the original u-net [3] by taking great K-Means segmentations as training set. More importantly we innovatively modify the u-net [3] to a noise-tolerant u-net (NTUN) so that the training with noisy segmentations such as those from Otsu is possible. Both methods show improved performance than the K-Means and Otsu.

Objectives

- Apply deep learning in histo-image segmentation with noisy training sets.
- Relieve doctor from manual segmentation.

Innovation

Motivated by the work in [4], we innovate a noise-tolerant layer (Figure 1) to the output layer of a deep learning image segmentation framework u-net (Figure 2), which alleviates the requirement of accurately segmented training images and enables “unsupervised” histo-image segmentation by taking noisy segmentation results of traditional image segmentation algorithms as the training outputs.

We quantitatively evaluate segmentation results based on the uniformity within clustered regions and disparity across regions in Lab color space following [1, 5] since we do not have the ground-truth.

Statistical Results

<table>
<thead>
<tr>
<th>Method</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
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<td>0.1425</td>
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<tr>
<td>NTUN</td>
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<td>0.1870</td>
<td>0.1731</td>
<td>0.1315</td>
</tr>
</tbody>
</table>

Table 1: Performance comparison by E for five groups: KM: K-Means; OS: Otsu; UN: u-net trained with K-Means segmentation; UN*: u-net trained with Otsu segmentations; and NTUN: NTUN trained with Otsu segmentation.

Conclusion

We have developed a noise-tolerant version of the u-net, which enables “unsupervised” deep learning for reliable segmentation of histo-images. Our preliminary experimental results show clear advantages of NTUN over the u-net and other traditional histo-image segmentation algorithms.

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References


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