A novel deep-learning framework applies to analysis the image characteristics of uveal melanoma tissue in MRI

H-G.Nguyen1,2, M.BachCuadra3,5,7, R.Sznitman2, A.Schalenbourg6, J.Hrbacek1, D.C. Weber1,4, A.Pica1

1 Proton Therapy Center, Paul Scherrer Institut, ETH Domain
2 Ophthalmic Technology Lab., ARTORG Center
3 Radiology Department, Lausanne University Hospital (CHUV)
4 Radiation Oncology Department, Inselspital, University of Bern
5 Signal Processing Lab., Ecole Polytechnique Fédérale de Lausanne,
6 Adult Ocular Oncology Unit, Jules-Gonin Eye hospital
7 Medical Image Analysis Laboratory, CIBM, University of Lausanne (all in Switzerland)

Purpose: To evaluate an automated segmentation of UM in MRI using an end-to-end deep learning segmentation without the need of expert’s annotations for training. Towards a precise tumors characterisation to support in prognosis and patient-specific treatment plan, thereby contributing to precision medicine.

Method:
1. Pre-processing
   • Eye cropping
   • Anisotropic diffusion filtering
   • Intensity normalisation

2.1 Statistical shape analysis for prior information

2.2 Attention map extraction

3. Tumor & retinal detachment differentiation
   • Unet
   • Gabor textural separation

Material: MR acquisitions are performed by a 1.5T Siemens scanner with surface coil for both T1w and T2w contrasts at the Paul Scherrer Institute. The study was approved by the Ethics Committee of the involved institutions and all subjects (anonymized and de-identified) provided written informed consent prior to participation.

<table>
<thead>
<tr>
<th></th>
<th>Repetition time (ms)</th>
<th>Echo time (ms)</th>
<th>Flip Angle</th>
<th>Voxel size (mm³)</th>
<th>FOV (Voxels)</th>
<th>Healthy</th>
<th>UM</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1-VIBE</td>
<td>6.55</td>
<td>2.39</td>
<td>12°</td>
<td>0.5x0.5x0.5</td>
<td>256x256x80</td>
<td>28 eyes</td>
<td>24 eyes</td>
</tr>
<tr>
<td>T2-SPACE</td>
<td>1400</td>
<td>185</td>
<td>150°</td>
<td>0.5x0.5x0.5 and 0.82x0.82x0.8</td>
<td>256x256x80</td>
<td>25 eyes</td>
<td>22 eyes</td>
</tr>
</tbody>
</table>

Table 1: MR imaging acquisition parameters at 1.5T with a surface coil.

Result:
Dice overlap coefficient of proposed method are 83.4±4.5% for T1W and 82.7±5.1% for T2W.

(a): On T1-w (93% overlap)  (b): On T2-w (84% overlap)

Conclusion:
- Allowing the UM tumor quantitative from image analysis could further support clinicians to tailor the proton therapy.
- An accurate segmentation without manual segmentation for training.

ACKNOWLEDGMENTS: This work is funded by the Swiss Cancer Research foundation (grant no. GAP-CRG-201602) and is supported by the Center of Biomedical Imaging of Geneva-Lausanne Universities and EPFL, the Fondation Leenaards and Fondation Louis-Jeantet.