A new 3D Slicer plug-in for the interactive annotation and segmentation of liver anatomy
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Annotation plays a key role in the creation of reference datasets that are useful to evaluate medical image processing algorithms and to train machine learning based architectures. RVXLiverSegmentation is a 3D Slicer plug-in aiming at speeding up the interactive annotation and segmentation of liver anatomy from medical images (e.g. CT or MRI).

**Method**

RVXLiverSegmentation provides 7 main tabs:
- loading and managing medical imaging data;
- liver segmentation;
- annotation of portal veins and segmentation;
- annotation of hepatic veins and inferior vena cava and segmentation;
- editing hepatic veins and inferior vena cava segmentation;
- tumor segmentation.

Once the medical image data is loaded into 3D Slicer:
- the liver can be segmented either by interactive tools or by automatic a MONAI deep learning-based algorithm (CT only);
- the user places the nodes of important branches and bifurcations;
- reconstructions of hepatic vessels are based on graph structures built from those nodes;
- a VMTK (Vascular Modeling Tool Kit) module segments the vessels by using graphs as initialization;
- the user can edit this segmentation;
- the last tab allows the user to segment interactively possible tumors with dedicated tools and export the scene.

**Conclusions**

RVXLiverSegmentation is promising tool for the creation of annotated datasets, and the faithful 3D reconstruction of liver anatomy from medical images. We first would like to integrate advanced deep learning models for liver and hepatic vessels segmentation into our RVXLiverSegmentation plug-in, in order to provide automatic reconstructions that can be then edited by the user. Another important work concerns the VMTK module, which needs more adaptations for MRI processing. Finally, a more complete evaluation protocol will be conducted by considering larger patient cohorts.

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**References**


**Contact Information**

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**Results**

We compared the time of segmentations obtained by:
- RVXLiverSegmentation plug-in;
- embedded image processing General Electric AW solution (Server 3.2).

Our cohort was composed of T1 at portal venous phase MRI acquisitions of:
- G1: 6 non cirrhotic patients;
- G2: 4 patients with cirrhosis and HCC.

<table>
<thead>
<tr>
<th>Segmentation (G1)</th>
<th>GE AW</th>
<th>Our plug-in</th>
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</thead>
<tbody>
<tr>
<td>Liver</td>
<td>10 ± 5 min</td>
<td>3 ± 2 min</td>
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<tr>
<td>Vessels</td>
<td>30 ± 10 min</td>
<td>5 ± 3 min</td>
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<tr>
<td>Total</td>
<td>40 ± 15 min</td>
<td>8 ± 5 min</td>
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<table>
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<th>GE AW</th>
<th>Our plug-in</th>
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<td>4 ± 2 min</td>
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<tr>
<td>Vessels</td>
<td>35 ± 15 min</td>
<td>7 ± 4 min</td>
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<td>Total</td>
<td>50 ± 25 min</td>
<td>11 ± 6 min</td>
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</table>

The 7 tabs of the plug-in

Tabs for annotation and segmentation of the liver (top) and vessels (bottom).

Github project