MIN-CUT-SEGMENTATION OF WHO GRADE IV GLIOMAS EVALUATED AGAINST MANUAL SEGMENTATION

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Objective: Glioblastoma multiforme (GBM) is one of the highest malignant neoplasms. The multimodal therapeutical concept involves maximum safe resection followed by radiation and chemotherapy. Despite new technical and medical accomplishments (multimodal navigation, stereotactic radiation) the survival rate still only accounts approximately 15 months. For resection and clinical follow-up exact evaluation of tumor-volume is fundamental.

Methods: Our GBM segmentation method creates 3D-graph within two steps: sending rays through the surface points of a polyhedron, with its center located inside the GBM, and sampling the graph's nodes along every ray. Then, the minimal cost closed-set on the graph is computed via a polynomial time s-t-cut, creating an optimal segmentation of the tumor boundary. For evaluation we used contrast-enhanced T1-weighted MRI-datasets.

Results: Algorithm's results were evaluated against 12 manual segmentations (done by neurosurgeons) yielding an average Dice Similarity Coefficient of more than 80% (intra physician segmentation 90%). Compared with a manual segmentation that takes on average 8±5.18 minutes, the overall automatic segmentation took less than 5 seconds plus one minute to review the results.

Conclusions: In this contribution, a segmentation method for GBM boundary detection that supports the time-consuming process of volumetric assessment of the tumor was presented and evaluated. Intra physician segmentation demonstrates the reproducibility performing manual boundary extraction and hence provides a quality measure for automatic segmentations. In conclusion, exact and automatic segmentation of brain tumors obtained by our novel approach is useful for planning surgical interventions concerning tumor resection and volumetric assessment in clinical follow-up.

References:

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Figures and Table

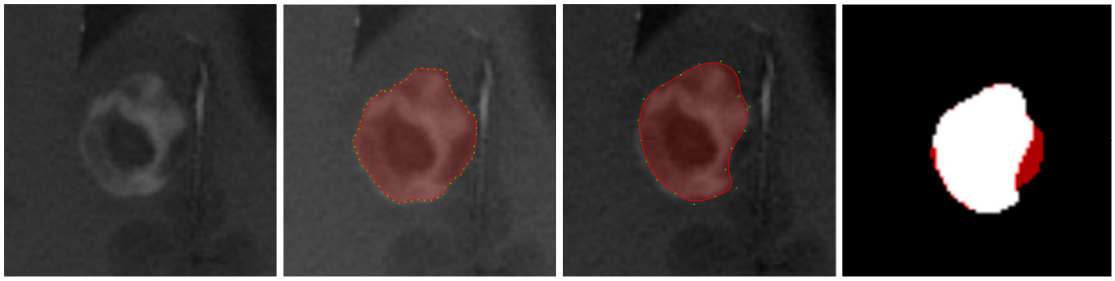

Figure 1 – From left to right: Axial slice of a contrast-enhanced T1 weighted MRI scan of a patient with glioblastoma multiforme. Manual segmentation result of a neurosurgeon. Manual segmentation result of the same neurosurgeon two weeks later. Superimposed segmentation results.

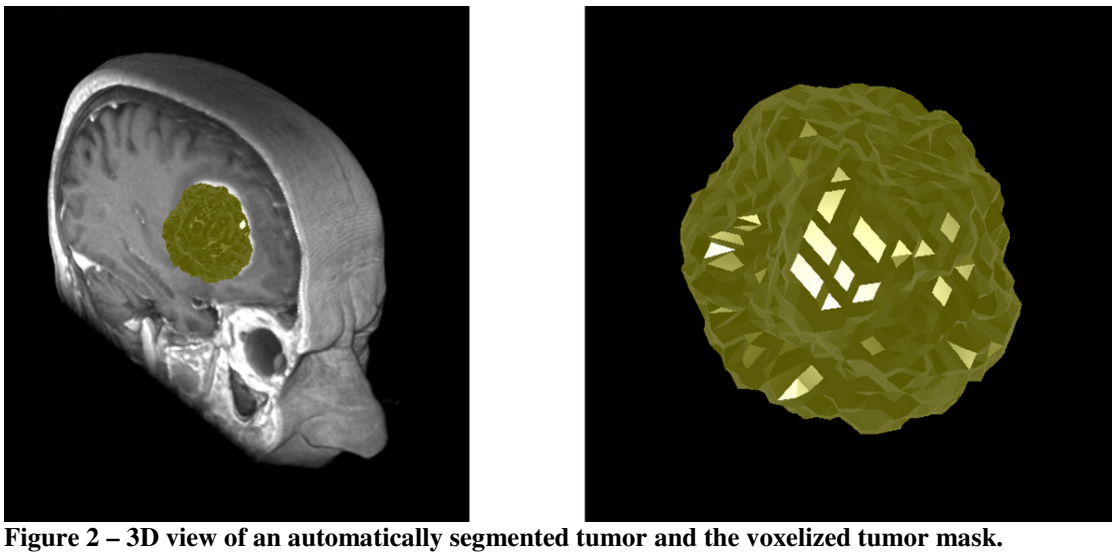

Figure 2 – 3D view of an automatically segmented tumor and the voxelized tumor mask.

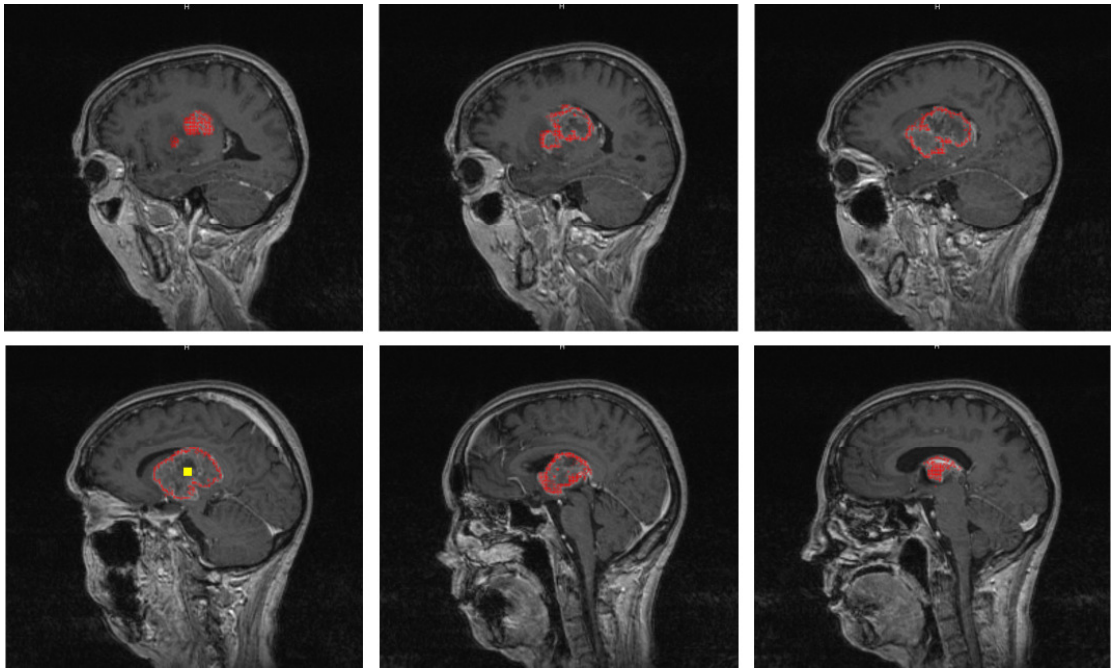

Figure 3 – Result of automatic tumor segmentation (DSC=76.19%). The yellow point (inside the tumor) is the user-defined seed point. Manual segmentation performed by a neurological surgeon took 9 minutes for this data set.

No.	Volume of tumor (cm^3)		Number of voxels		DSC (%)
	manual I	manual II	manual I	manual II	
1	**3435.11**	**2960.56**	**17076**	**14717**	**85.78**
2	**10871.2**	**10397.1**	**54041**	**51684**	**93.91**
3	**2164.53**	**2076.64**	**10762**	**10325**	**89.82**
4	**29513.7**	**28075.3**	**253521**	**241165**	**94.37**
5	**73452.5**	**73378.9**	**78869**	**78790**	**95.16**
6	**43507.7**	**43630.6**	**46716**	**46848**	**96.3**
7	**1631.26**	**1469.92**	**8109**	**7307**	**85.78**
8	**3226.68**	**3175.6**	**16043**	**15789**	**89.79**
9	**9221.88**	**10325.5**	**45851**	**51338**	**84.97**
10	**1526**	**1722**	**1526**	**1722**	**88.79**
11	**39598.7**	**38690.2**	**27240**	**26615**	**94.77**
12	**1488.99**	**1397.91**	**14452**	**13568**	**84.01**

Table 1 – Comparison of two manual segmentations of 12 glioblastoma multiforme.