Preoperative Volume Determination for Pituitary Adenoma

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Introduction

Pituitary adenoma: the most common sellar lesion
Disturbs: hormone secretion of the pituitary gland
If large: vision disorders

Manual segmentation: labor intensive
Common tumor volume estimate:
based on the longest axis in cross-sections
fast, but imprecise

Goals

1. Speed (the algorithm should be as fast as using some distance measurement tool)
2. Precision (the obtained volume estimate should be more precise than using spherical or ellipsoid model)

Method initialization

User draws approximate outline on a slice near the center of the tumor. From this we derive:
1. Center of the tumor: CoA→X,Y and slice index→Z
2. Intensity range of tumor tissue (min and max)
3. Radius (as per spherical model)

Algorithm starts with small triangular surface mesh (polyhedron) inserted into image at approximate center.

Iterative steps of the algorithm

1. Split long polyhedron edges
2. Compute curvature estimates and surface normals
3. Move vertices outwards (inflate the mesh)
   a) Maintain smoothness and star-shape
   b) Take care not to go outside of the tumor
4. Smooth the mesh slightly (this helps fight the noise)

Conclusion

Implemented in C++
Tested with: 10 MRI datasets (8 T1 and 2 T2)
Dataset sizes: up to 512x512x80
Execution time: about 1 second per dataset
Run time proportional to: tumor size (not image size)
Precision: 76% DSC (Dice Similarity Coefficient)
see table on the right

References

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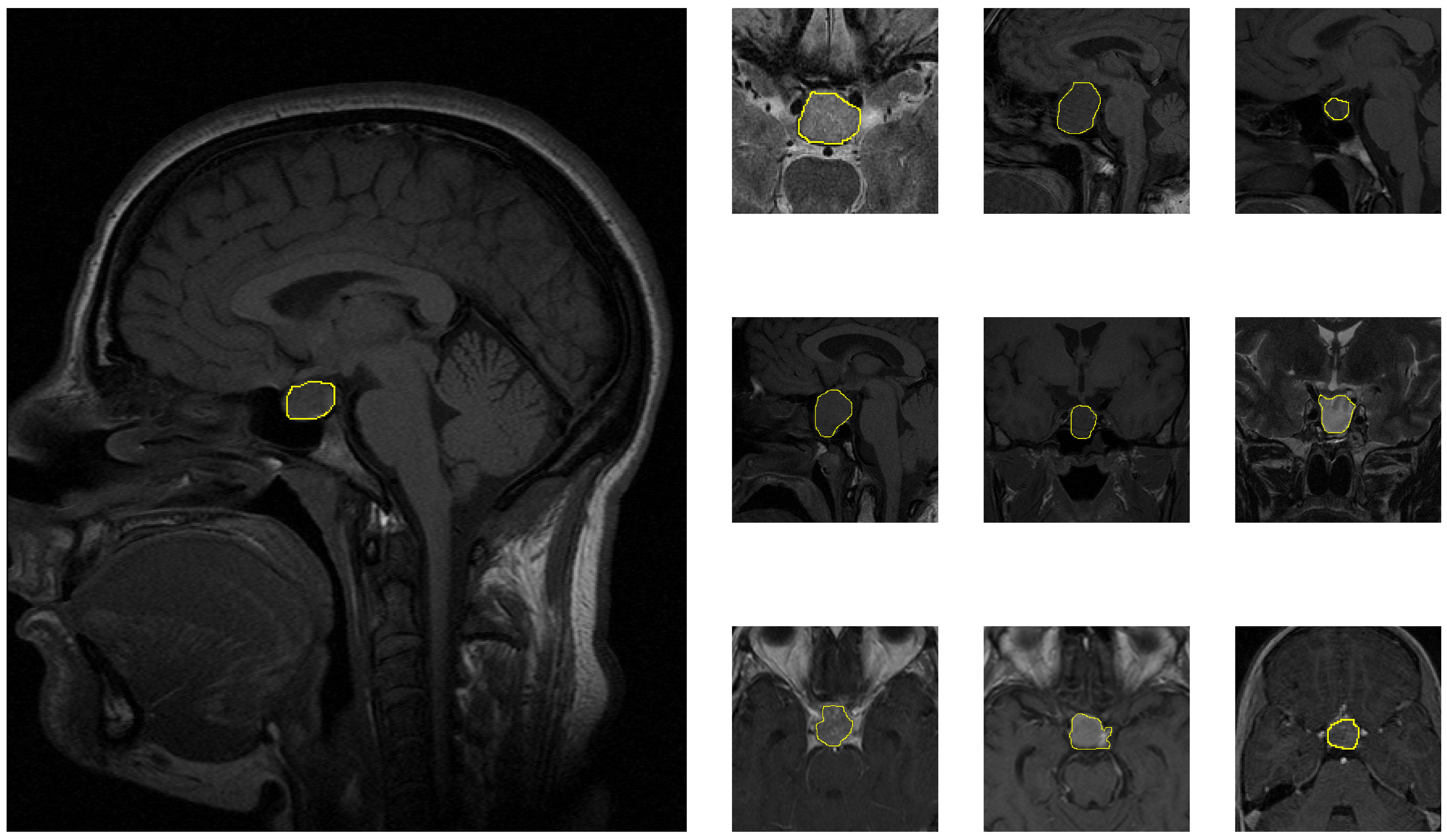
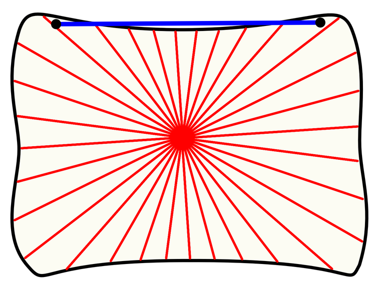
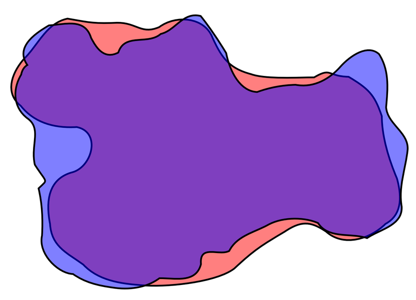


Initializations used (1 full view, 9 closeups)

Star-shaped, not convex

Convexity is a too strong constraint. Enforcing star shape allows prevention of self intersections of polyhedron's surface



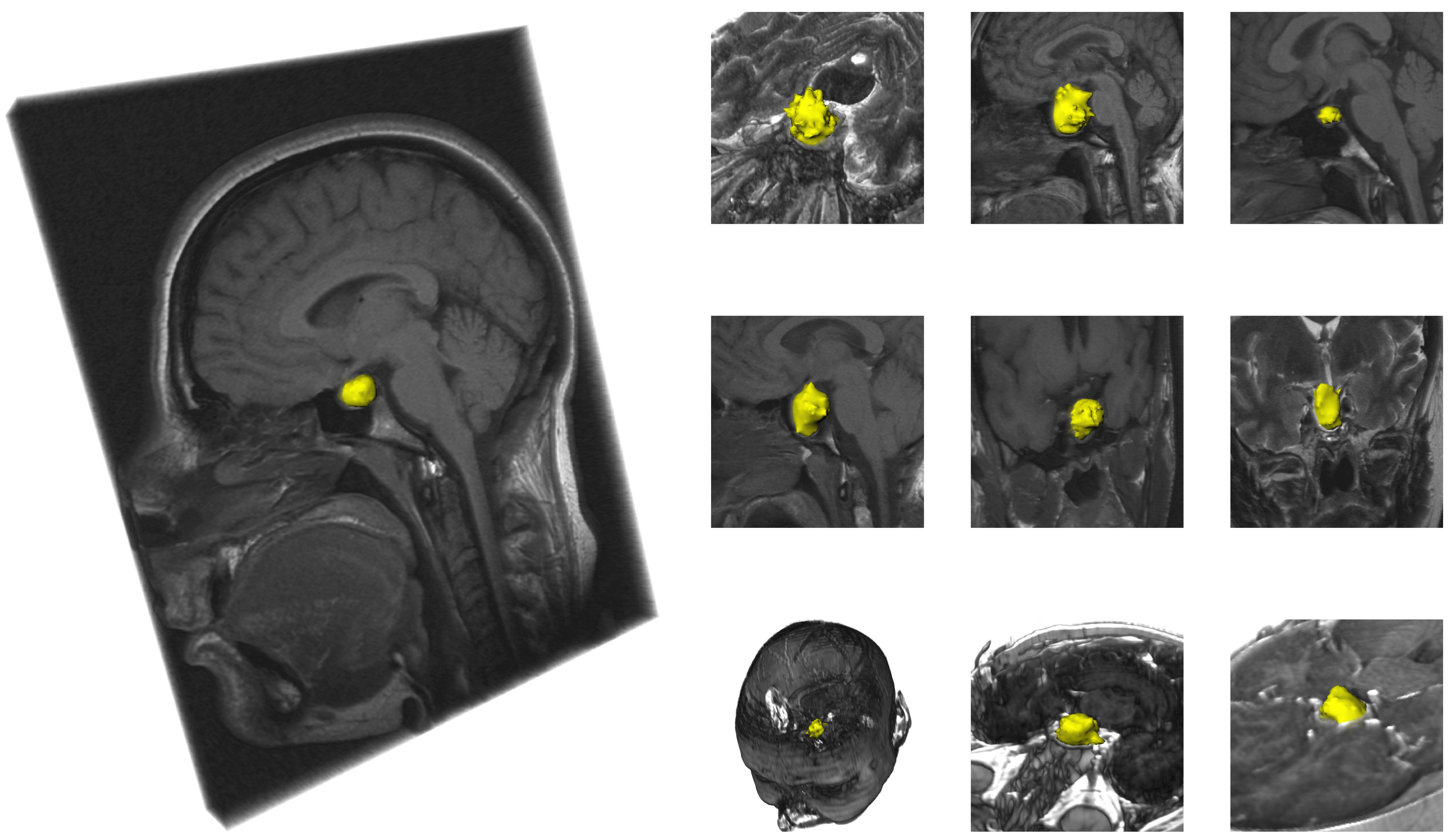


A (red)
B (blue)

$$DSC=\frac{2\times V(A\cap B)}{V(A)+V(B)}$$

Using 10 test datasets, we obtained following results:

	Tumor volume (cm^3)		Dice Similarity Coefficient (%)	Manual seg. time (min)
	Manual	Algorithm		
min	0.84	0.6	63.74	3
max	15.57	13.05	86.08	5
μ(±σ)	6.3±4.07	4.69±3.58	75.92±7.24	3.91±0.54



Visualizations (2 full sized views, 8 closeups)

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