Semi-Automated Brain MRI Segmentation

Computer Integrated Surgery II, Spring, 2011
Nathaniel Tippens and Alexander Liu
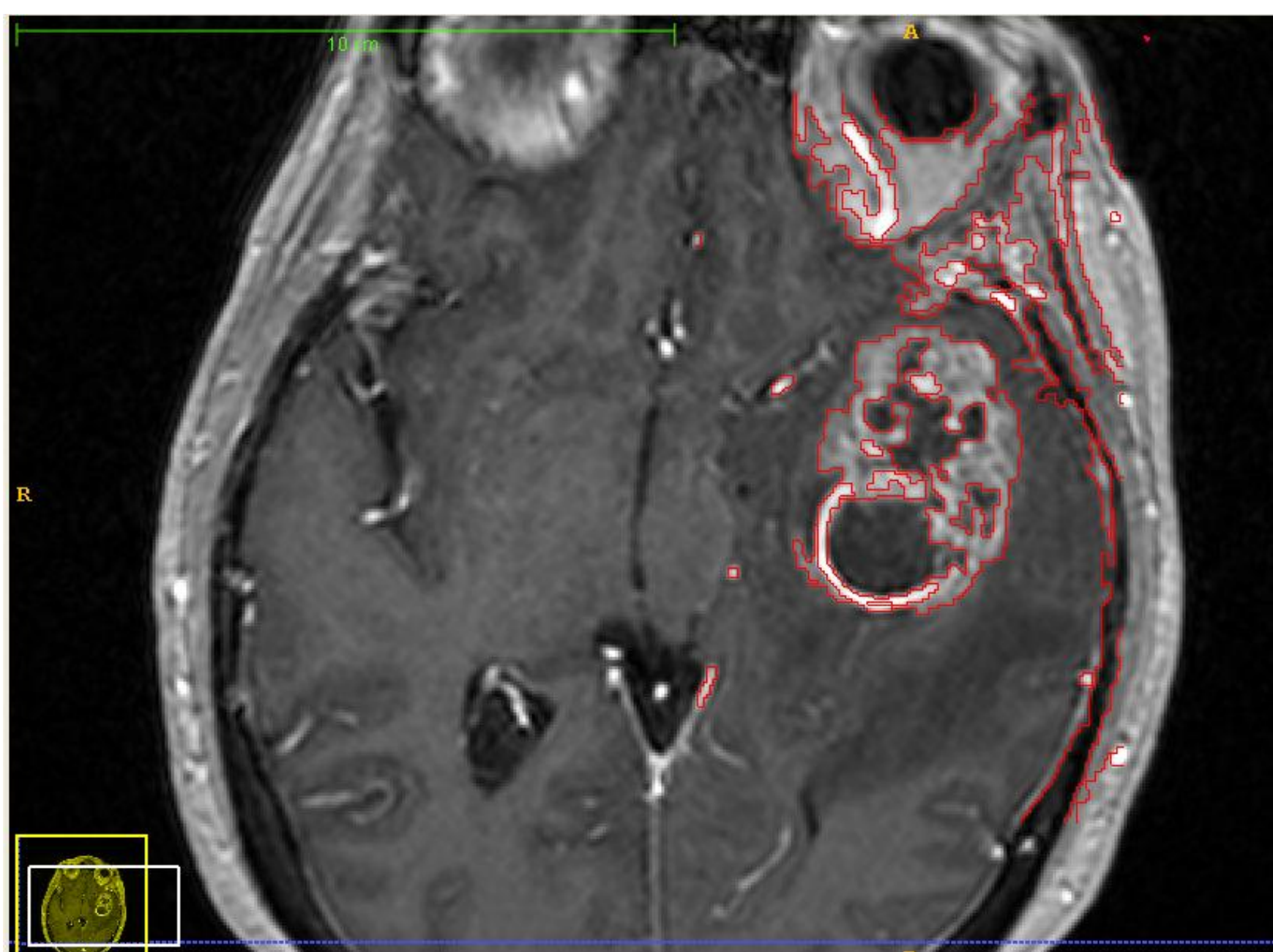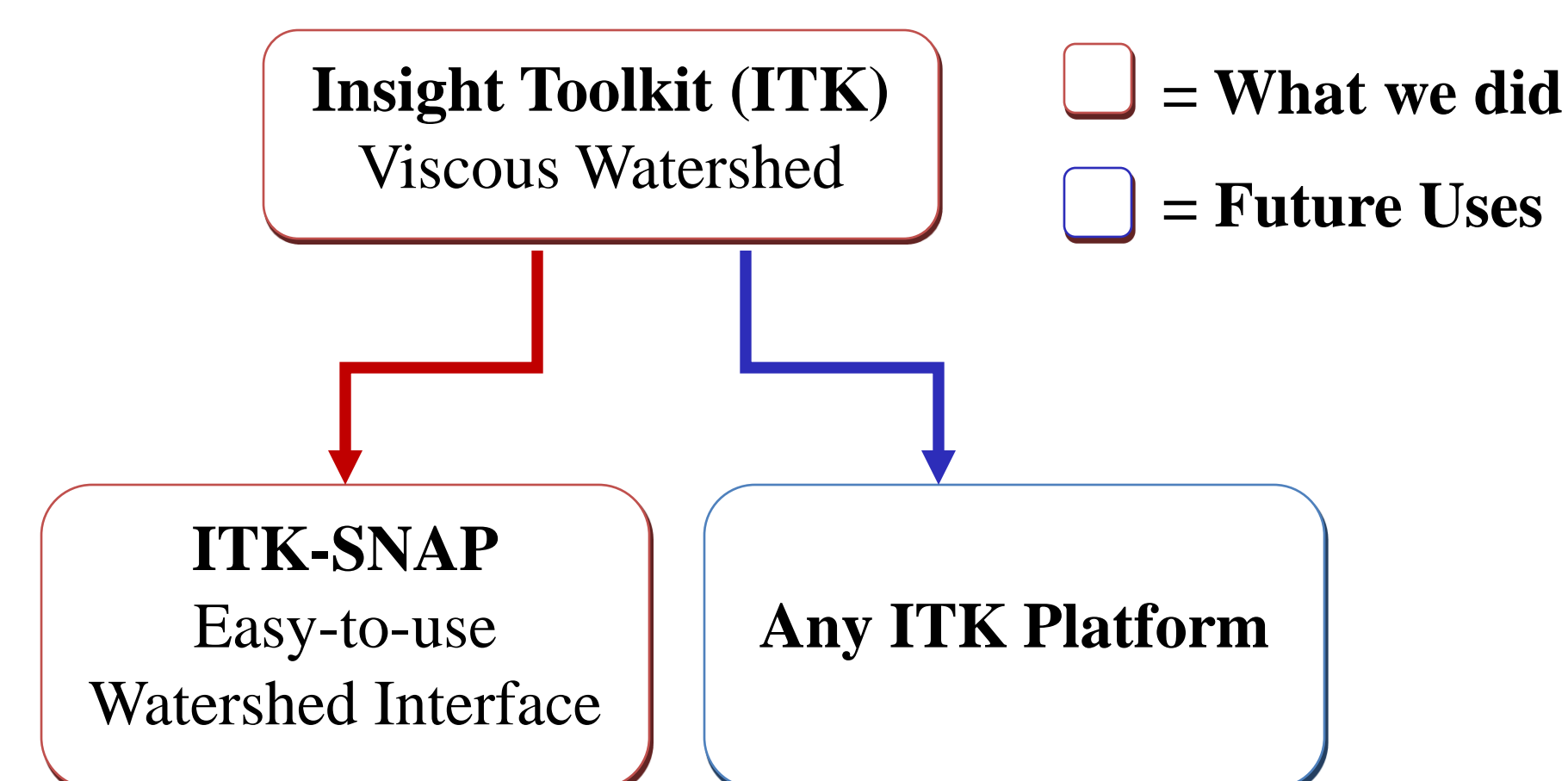*Mentors: Dr. Alfredo Quiñones-Hinojosa and Dr. Hadie Adams*

Introduction

- The first implementation of the Viscous Watershed Transform was developed in ITK.

- An easy-to-use interface was integrated into ITK-SNAP, so that neurosurgeons could easily test the algorithm on real data.

- A rapid and accurate method for tumor segmentation on MRI scans is needed to determine whether aggressive surgeries are best for brain tumor patients.

The Problem

- The current method of brain tumor segmentation requires the user to trace the tumor manually using a simple paintbrush tool.

- Manual segmentation is time-consuming and inaccurate: studies have demonstrated that even trained operators are prone to significant differences between their own segmentations.

- Volumetric analysis has produced conflicting results because interpretations differ between operators. Therefore a standard procedure for determining tumor volume may yield more consistent results, even between different operators.

The Solution

- Implement and test the latest theoretical improvements to image segmentation: specifically, the Viscous Watershed Transform (C Vachier and F Meyer, 2007). Developing an easy-to-use tool required modification of existing MRI segmentation software.

Insight Toolkit (ITK)
Viscous Watershed

☐ = What we did
☐ = Future Uses

ITK-SNAP
Easy-to-use Watershed Interface

Any ITK Platform

The viscous watershed partition of an MRI.

Outcomes and Results

	Watershed	Viscous Watershed
Pros	• Detects very fine details • Faster	• Meaningful boundaries • Slower
Cons	• Sensitive to noise • Unnatural region shapes • Underestimates objects with low-contrast edges	• Misses very thin objects • Assumes rounded object shape in low-contrast areas

- Quantitative evaluation of algorithm performance by neurosurgical residents delayed until further improvements to the segmentation tool.

Future Work

- Develop post-processing step dedicated to segmentation of thin rings.

- A study of the software's accuracy and variability will be conducted in Nijmegen, the Netherlands this summer in collaboration with the UMCN Radboud department of neurosurgery.

Lessons Learned

- Segmentation algorithms must adapt to vastly different levels of detail within the same image.

- It is harder to have one algorithm try and segment everything, than to have separate algorithms identify different types of objects.

Credits

- Nathaniel – Learned ITK Watershed code and implemented Viscous Watershed

- Alex – Integration into ITK-SNAP, Documentation

Publications

- Technical paper, documentation, and test code is being prepared for submission to Insight Journal.

- F. Meyer and C. Vachier, "On the regularization of the watershed transform", Advances in Imaging and Electron Physics, vol. 148(3), p.194-249. Acad. Press 2007

Acknowledgements