# Automatic Segmentation and Reconstruction of the Inner Ear Vasculature from Histology Slides

*Computer Integrated Surgery II*

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## Introduction

- Researchers have often relied on analysis of histopathology slides of the inner ear to understand the impact that different structures have on the various pathologies in otolaryngology
- Currently, vascular disorders of the inner ear remain poorly understood. Some researchers have hypothesized that abnormal vasculature may play a role in pathologies such as vestibular neuritis. [1]
- The aim of this project is to create software for automatic segmentation and 3D reconstruction of vasculature within the inner ear to facilitate more efficient and spatial analysis of structures within inner ear

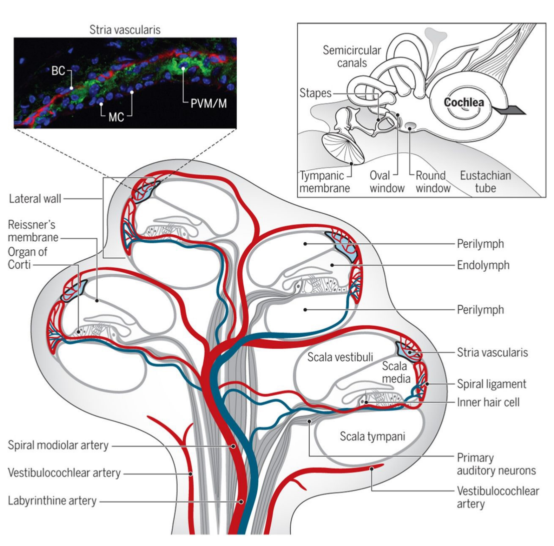

Figure 1. Vasculature of Inner Ear[2]

## The Problem

- Manual analysis of histology slides is both time consuming and subject to poor rater variability. [3]
- Manual analysis is often limited to 2D analysis, limiting the ability for researchers to understand the role of structures in the inner in 3D
- Digital whole histology slides (WSI) are often large and computationally expensive to process

## The Solution

- To resolve some of these challenges, we have proposed a framework for automatic segmentation and reconstruction based on nnUnet[4] , 3D Slicer[5], as well as other packages
- A database of 110 macaque ears sections were digitized. 33 of these slides were labeled with vasculature and the scala media, tympani, and vestibuli.
- An overview of the framework is shown below

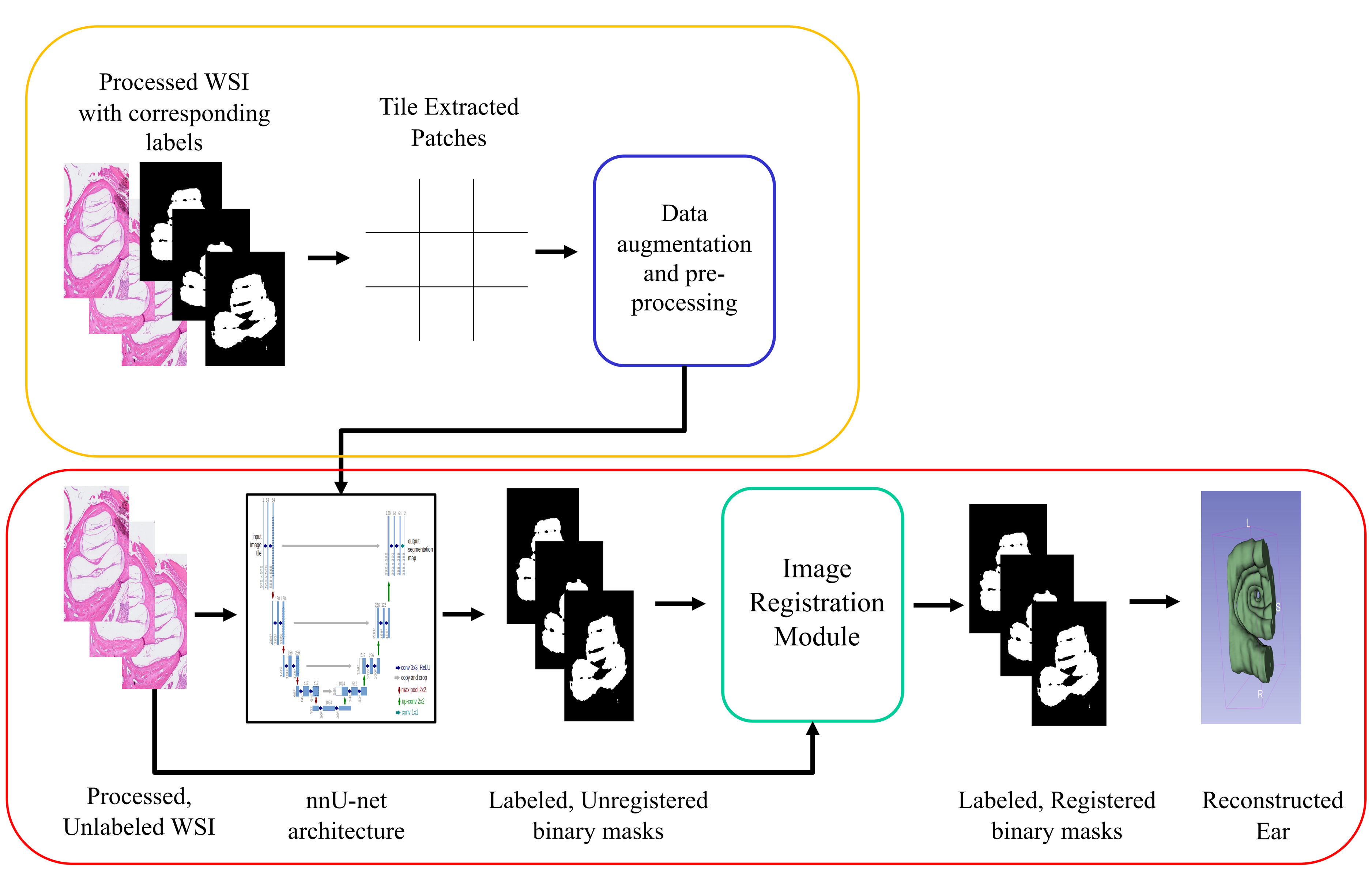


Figure 2. Overview of proposed framework; (top, orange) represents the training pipeline, (bottom, red) represents the implementation and reconstruction pipeline

## Outcomes and Results

- Used DICE coefficients as well as IoU to quantify accuracy of segmentation
- Registration and 3D Reconstruction were qualitatively assessed

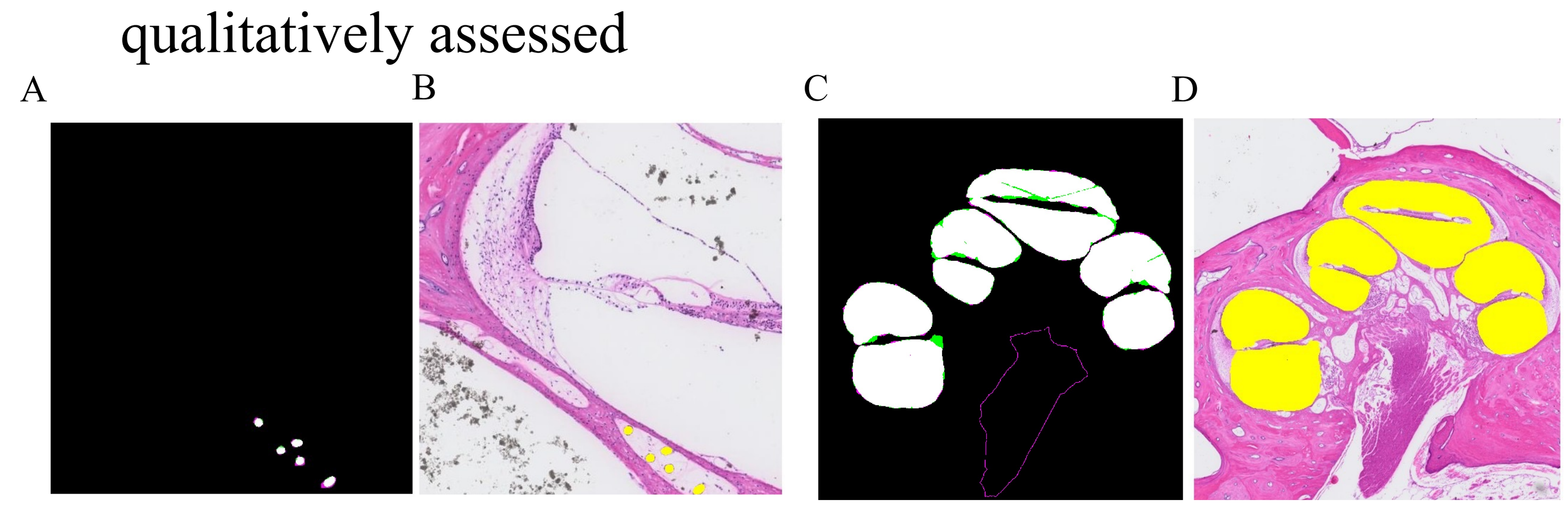


Figure 3. (A, C) Sample overlap between ground truth(GT) and label for vasculature and scala segmentation(purple = GT, green = label) respectively. (B,D) Overlay of label generated on WSI of vasculature and scala respectively.

| | Scala Segmentation | Vasculature Segmentation |
|---|---|---|
| DICE | 0.975 | 0.746 |
| IoU | 0.944 | 0.6636 |

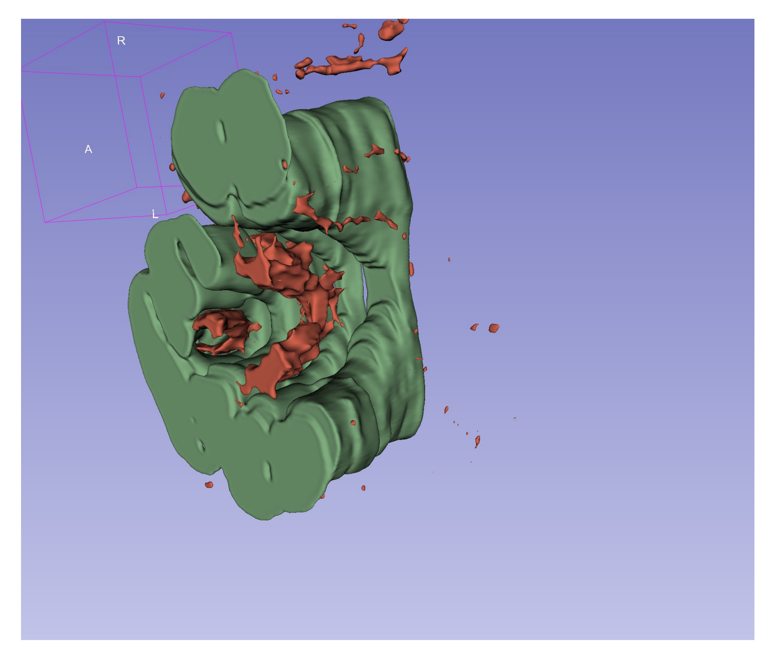

Figure 4. 3D Reconstruction of inner; green represents scala, red represents vasculature

## Future Work

- Plan on expanding pipeline to include other structures such as cranial nerve VII and VIII and stria vascularis (initial results already collected)
- Expand metrics used to evaluate both segmentation and subsequent registration
- Build model into an easy-to-use GUI that facilitates other researchers to study histology slides

## Lessons Learned

- WSI imaging is challenging to work with; significant variations even between adjacent slides
- Deep learning can facilitate removing tedious, manual steps that are used currently for WSI analysis

## Credits

- Aseem Jain created the labels, developed and implemented the pipeline
- Dianela Perdomo and Yassine Balhi, MD assisted in digitization of slides and validating labels

## Publications

- Plan to finish initial draft of manuscript for submission by end of May; will submit to *Laryngoscope*

## Support by and Acknowledgements

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