

2019

Research Experience for Undergraduates

Physician Immersion into and Manipulation of Holographic Imaging-based Medical Data Project

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Motivation

Minimally invasive surgery has become a growing technique in the medical field. With the visualization on the surgical plane hindered, surgeons must rely on prior scans to view the area of interest.

Goal

Perform ultrasounds of 10 different mice. Segment the left ventricle of each mouse heart. Use this segmentation data to construct the holographic heart model.

Objectives

Collect the following data:

- Cardiac Data (Morphology and Function)
- Doppler Imaging (Vascular Flow)

Utilize VevoLab software to segment the Left Ventricle of the mouse heart in B-Mode.

Expected Impact

Physicians will be able to utilize this research in ultrasound data segmentation in order to capture images in real-time for image guided surgery.

Deliverables

Clean Data:

- B-Mode Images
- M-Mode Images
- 3D-Mode Video
- PW Tissue Doppler Images

Segmented Data:

- Dicom B-Mode Image Frames

Test Subject Information

- Five Female Wild-Type (WT) Mice
- Five Male Wild-Type (WT) Mice
- Age: ~6 Weeks (Born 4/27/2019)
- Strain: C57bl/6J
- Test Date: 6/7/2019

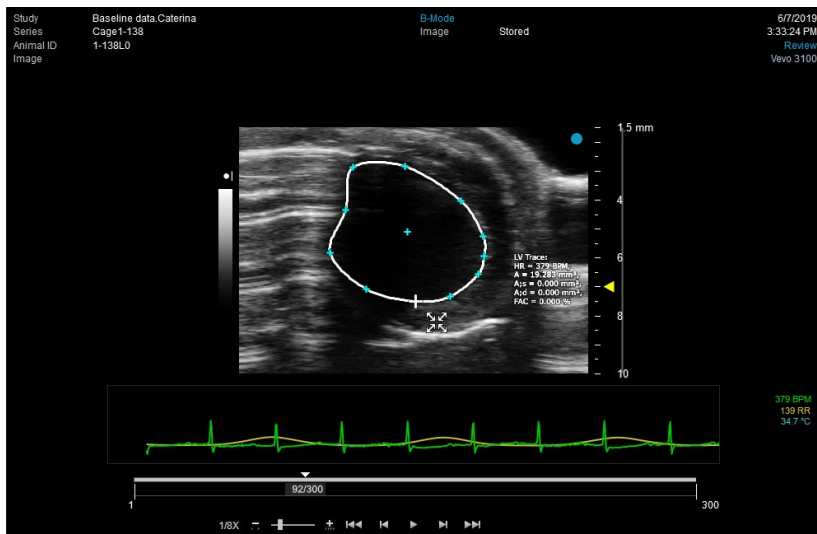
B-Mode

- Brightness Mode
- Displays a 2D image of the body

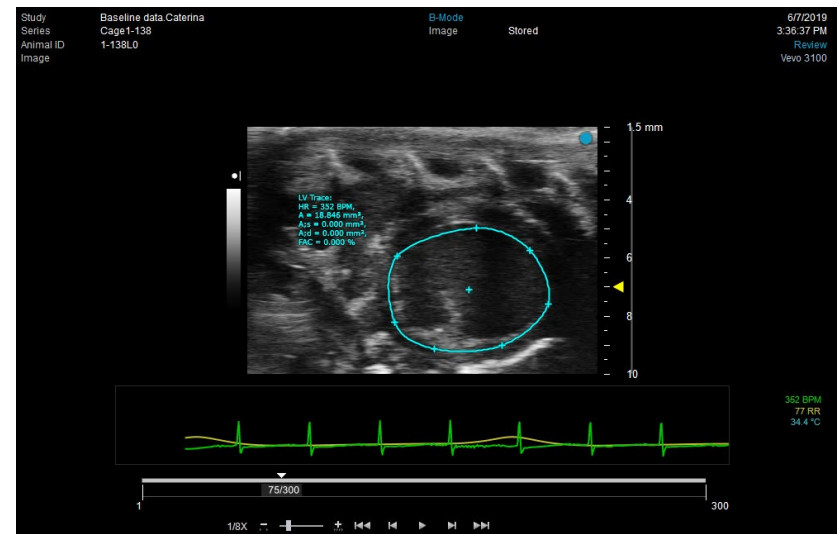
Results: Objective 1

Data was segmented using AutoLV first to test locate region. This feature was deemed inaccurate and the points were then drawn and adjusted manually to trace around the left ventricle as shown.

Short Axis



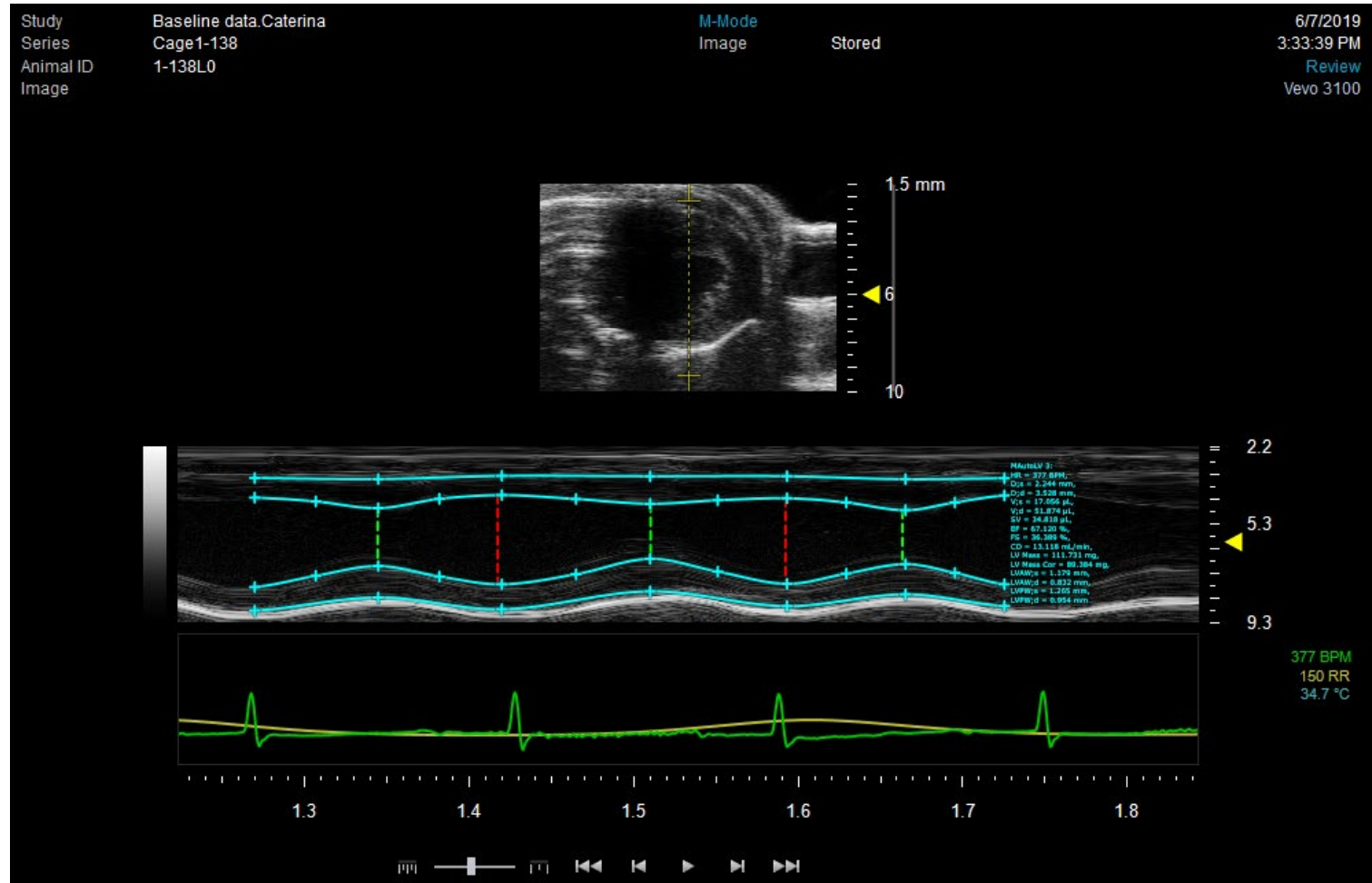
Long Axis



M-Mode

- Motion Mode
- B- Mode image is taken as each pulse is emitted.
- Images are placed in sequence to form a video.
- Measures velocity

Results: Objective 2



3D-Mode

- Uses volume rendering to form image
- Performed mechanically:
 - Probe motor uses tilt feature to capture image slices in a series of different orientations.

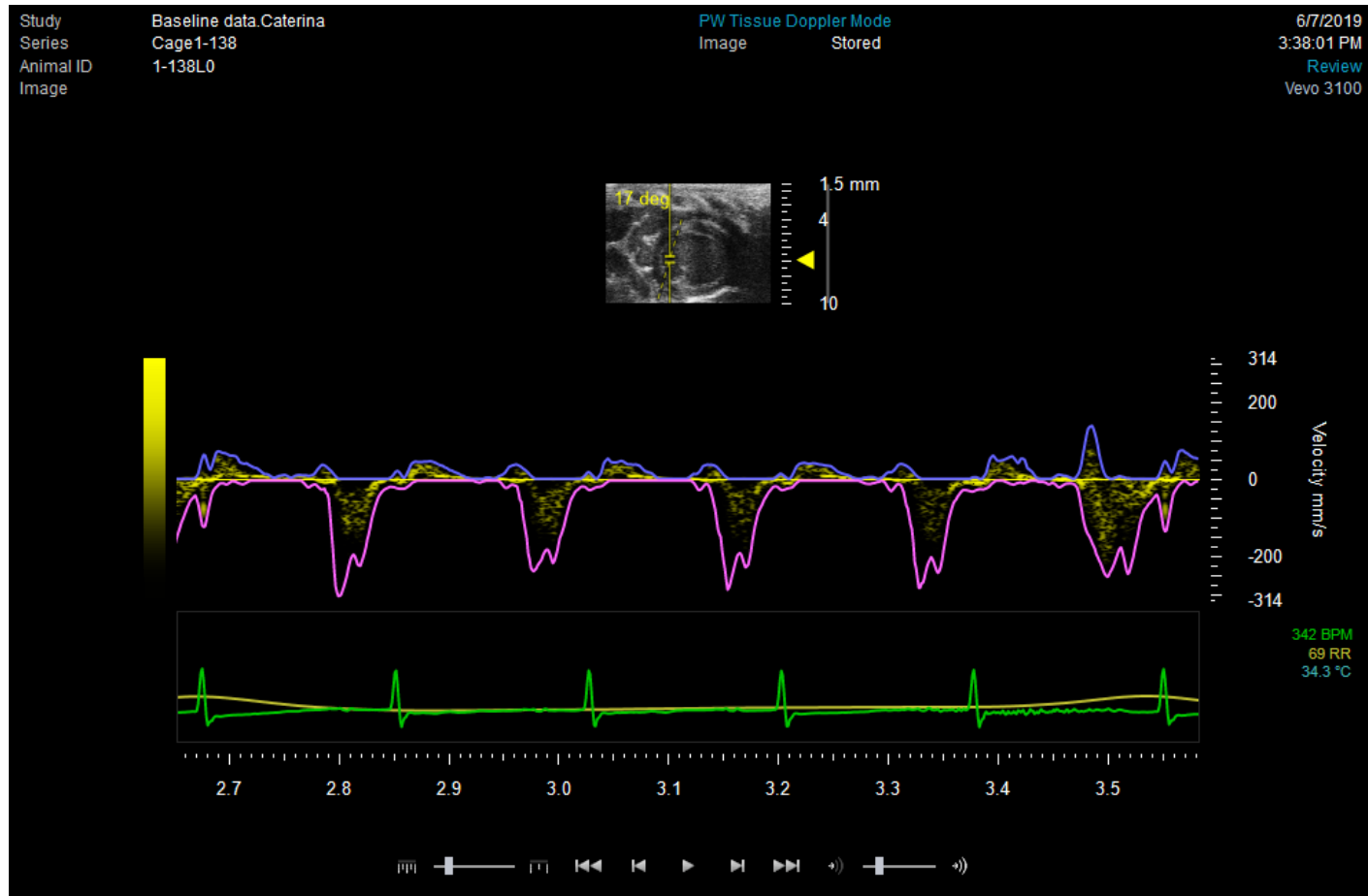
Results: Objective 3



PW Tissue Doppler

- Pulsed Wave Tissue Doppler
- Uses the Doppler Effect:
 - Changes in pitch due to the increase or decrease of sound and light waves as the wave source moves closer or farther from the observer.
- Measures blood flow from a sample volume
- Forms a 2D image
- Blood flow measured on a timeline

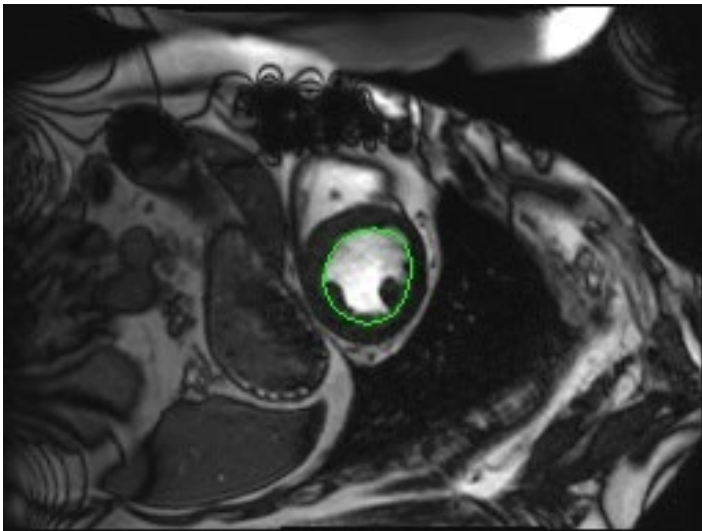
Results: Objective 4



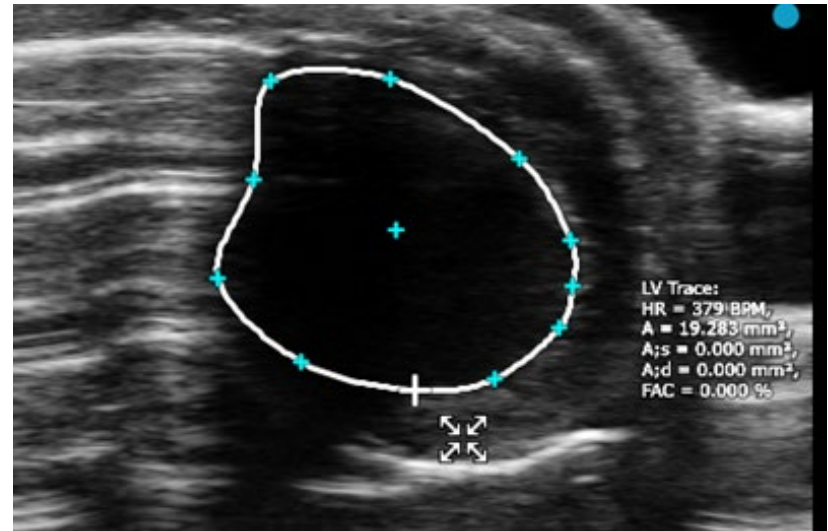
Results

Comparative Images

MRI Image



Ultrasound Image



Remaining Work

- Work with a ultrasound “expert” to validate data.
- Use AutoLV feature and manual segmentation to research other segmentation techniques to heighten maximum segmentation frames allowed.
- Induce congestive heart failure in the mice and perform LV segmentation to obtain a diverse range of data.

Conclusions

After performing each ultrasound test, B-Mode images were deemed the best for segmentation. The VevoLab software is effective in segmentation, yet the automatic segmentation program (AutoLV) is not consistently accurate. Further research could be conducted with diseased hearts. In this research, the B-Mode manual segmentation would be used while understanding that the anatomy would change as heart defects progress. These conclusions would aid physicians in the transition to using real-time image techniques during operation.

Acknowledgements

The REU project is sponsored by NSF under award NSF-1659755. Special thanks to the following UH offices for providing financial support to the project: Department of Computer Science; College of Natural Sciences and Mathematics; Dean of Graduate and Professional Studies; VP for Research; and the Provost's Office. The views and conclusions contained in this presentation are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the sponsors.