2019
Research Experience for Undergraduates

The Use of Ultrasound Imaging in 3D Holographic Heart Construction

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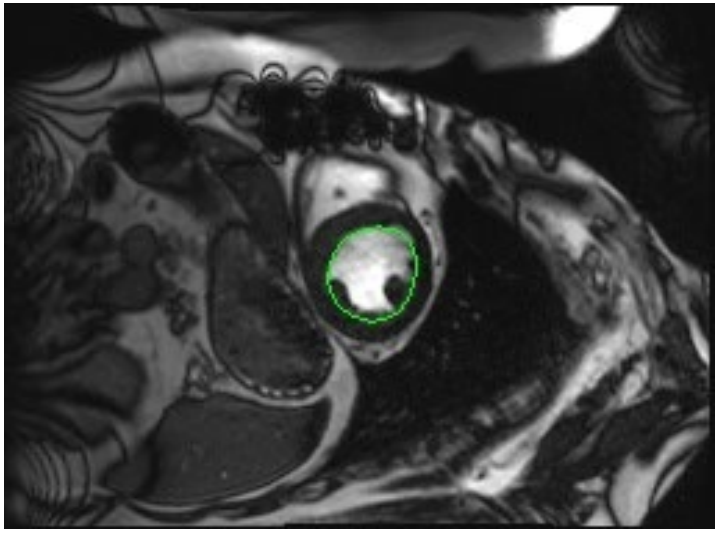
UNIVERSITY of HOUSTON

Goal

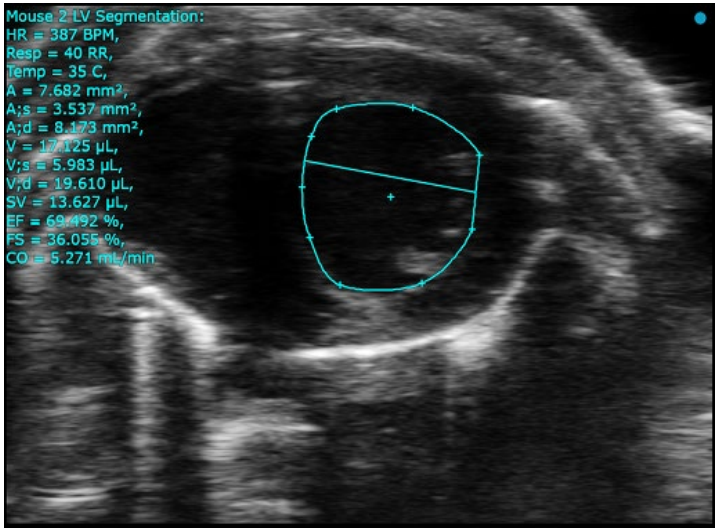
Perform LV (left ventricle) segmentation of mice using ultrasound imaging.

Background

MRI Image



Ultrasound Image



- Ultrasound Imaging can be conducted during surgery
- MRI Images are more clear and detailed

Objectives

1. Perform ultrasounds of 10 different mice, collecting B-Mode, M-Mode, 3D-Mode, and Tissue Doppler Images.
2. Segment the left ventricle of each mouse heart using the VevoLab software.
3. Use this segmentation data in the construction of the holographic heart model.

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

Objective 1: Tasks

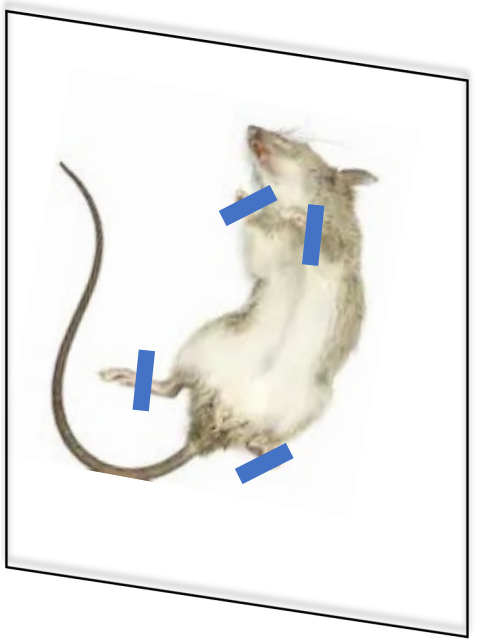
1. B-Mode Ultrasound Images
2. M-Mode Ultrasound Images
3. 3D-Mode Ultrasound Images
4. Tissue Doppler Ultrasound Images

Objective 1: Accomplishments

- ✓ B-Mode Ultrasound Images
- ✓ M-Mode Ultrasound Images
- ✓ 3D-Mode Ultrasound Images
- ✓ Tissue Doppler Ultrasound Images

Objective 1: Methodology

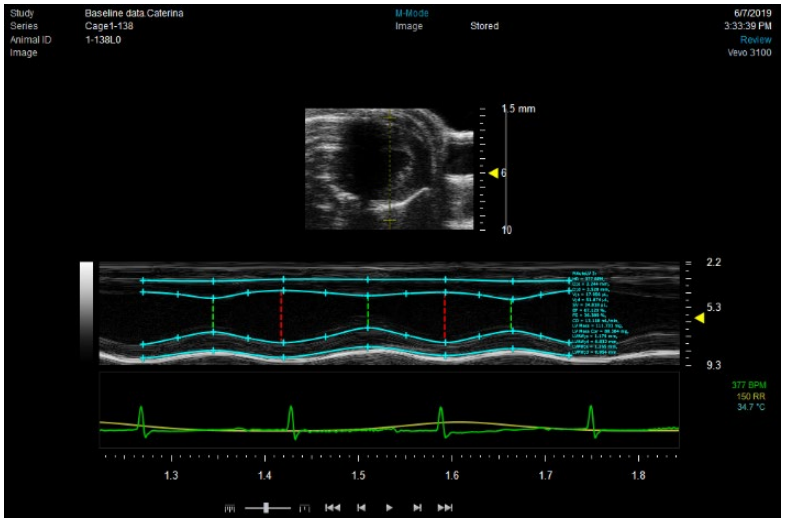
1. Setup mouse on Vevo 3100 Ultrasound Machine
2. Perform ultrasounds collecting B-Mode, M-Mode, 3D-Mode, and Tissue Doppler Images
3. Repeat for ten mice



https://www.visualsonics.com/product/imaging-systems/vevo-3100

Objective 1: Results

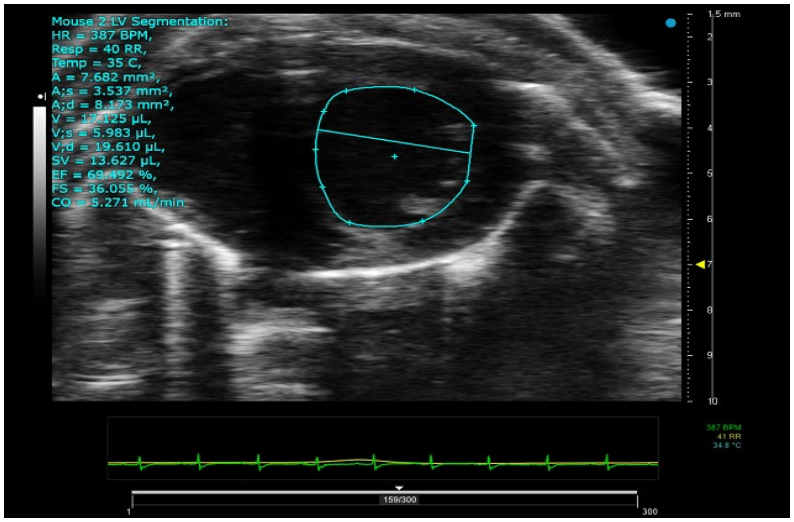
M-Mode



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

Objective 1: Results

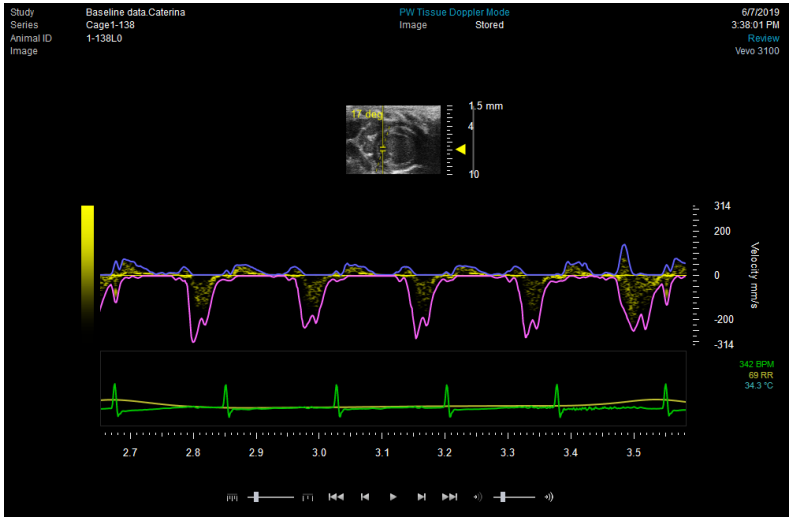
B-Mode



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

Objective 1: Results

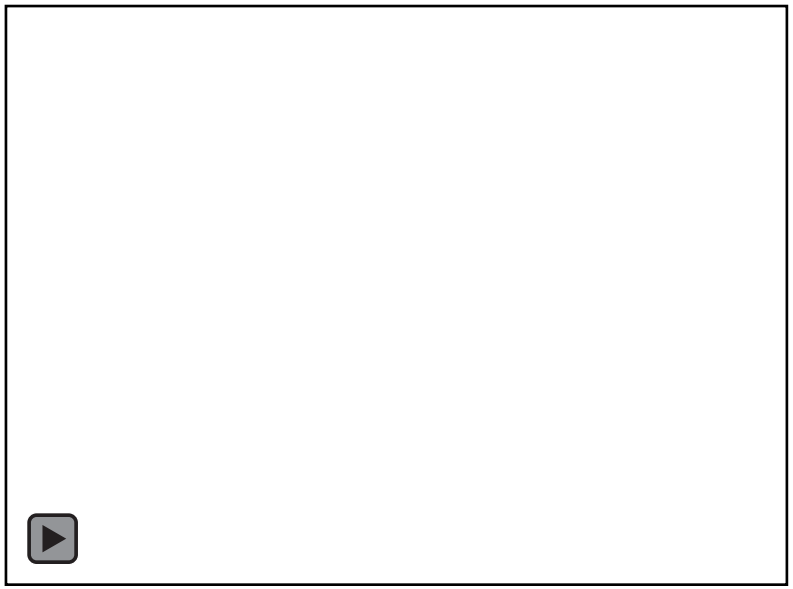
Tissue Doppler



- Pulsed Wave Tissue Doppler
- Uses the Doppler Effect
- Measures blood flow from a sample volume
- Forms a 2D image
- Blood flow measured on a timeline

Objective 1: Results

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.

Objective 2: Tasks

1. Segment the left ventricle of each mouse heart in B-Mode using the VevoLab software.
2. Collect data in various positions (long axis and short axis).

Objective 2: Accomplishments

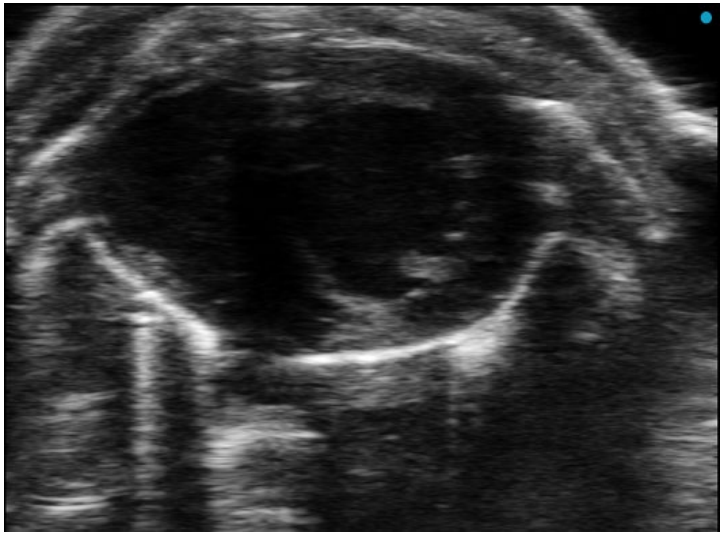
- ✓ Segment the left ventricle of each mouse heart in B-Mode using the VevoLab software.
- ✓ Collect data in various positions (long axis and short axis).

Objective 2: Methodology

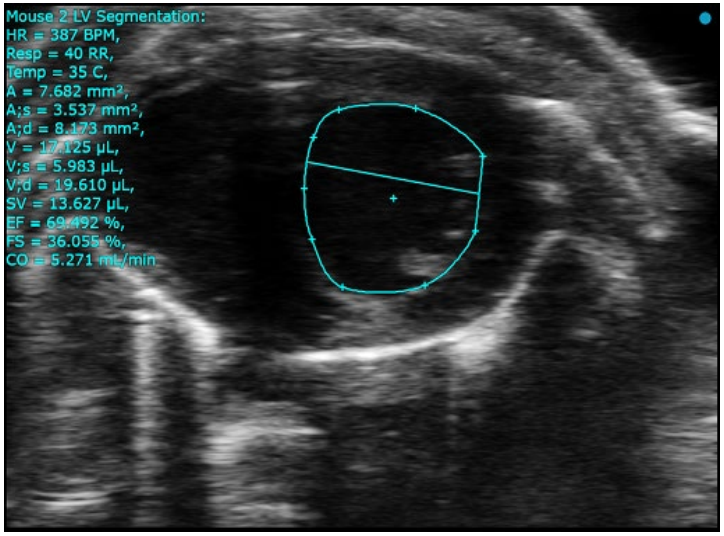
1. Import ultrasound data to VevoLab software
2. Use tracing techniques to manually segment the left ventricle by placing points around the left ventricular wall (excluding the papillary muscles)
3. Repeat tracing for multiple frames as heart contracts and relaxes
4. Export Dicom file

Objective 2: Results

Short Axis (without Segmentation)

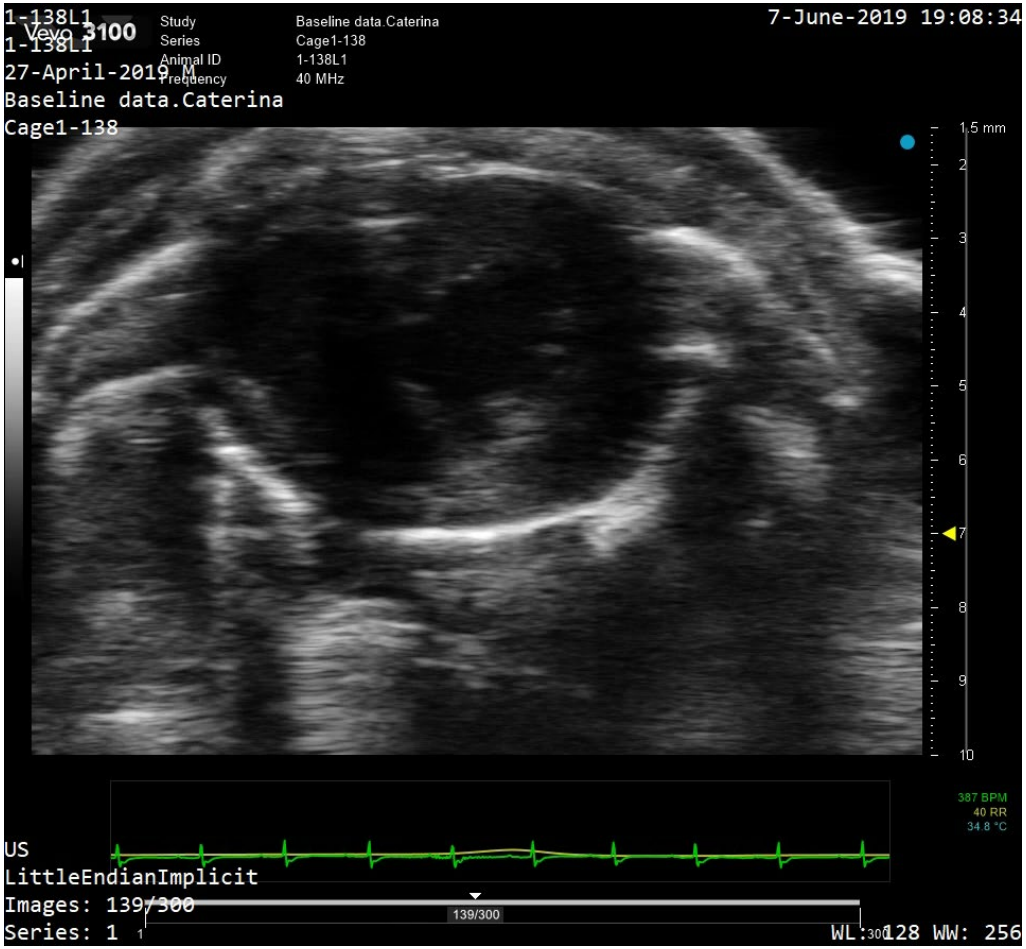


Short Axis (with Segmentation)



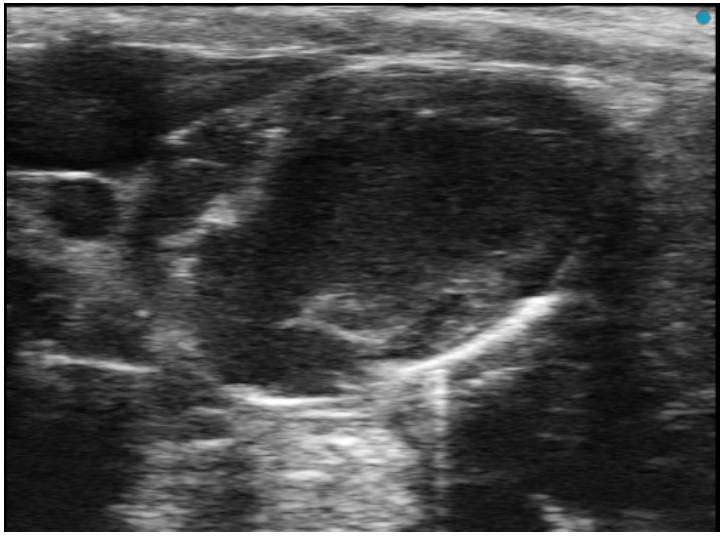
Objective 1: Results

Short Axis Segmentation

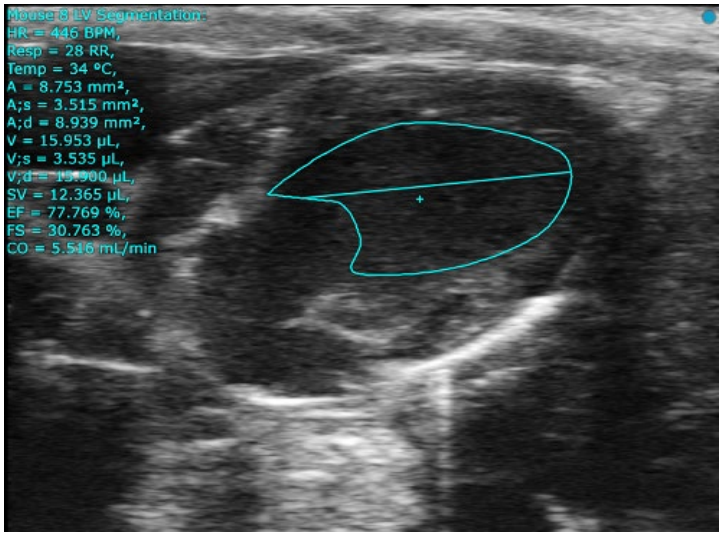


Objective 2: Results

Long Axis (without Segmentation)



Long Axis (with Segmentation)



Objective 1: Results

Long Axis Segmentation

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Deliverables

1. Clean Data:
   - B-Mode Images
   - M-Mode Images
   - 3D-Mode Video
   - PW Tissue Doppler Images
2. Segmented Data:
   - Dicom B-Mode Image Frames

Limitations

1. No automatic segmentation license to check data accuracy
2. Lack of prior information on research topic

Future Work

This work will be continued as a part of the "Physician Immersion into and Manipulation of Holographic Imaging-based Medical Data" Project in order to extrapolate segmentations and use imaging techniques to construct holographic heart model.

Conclusions

- B-Mode images were deemed the best for segmentation
- Further research could be conducted with diseased hearts
- Automatic segmentation feature is inaccurate

Acknowledgements

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