

iPASS: Photoacoustic Catheter Tracking: Checkpoint

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Group 8

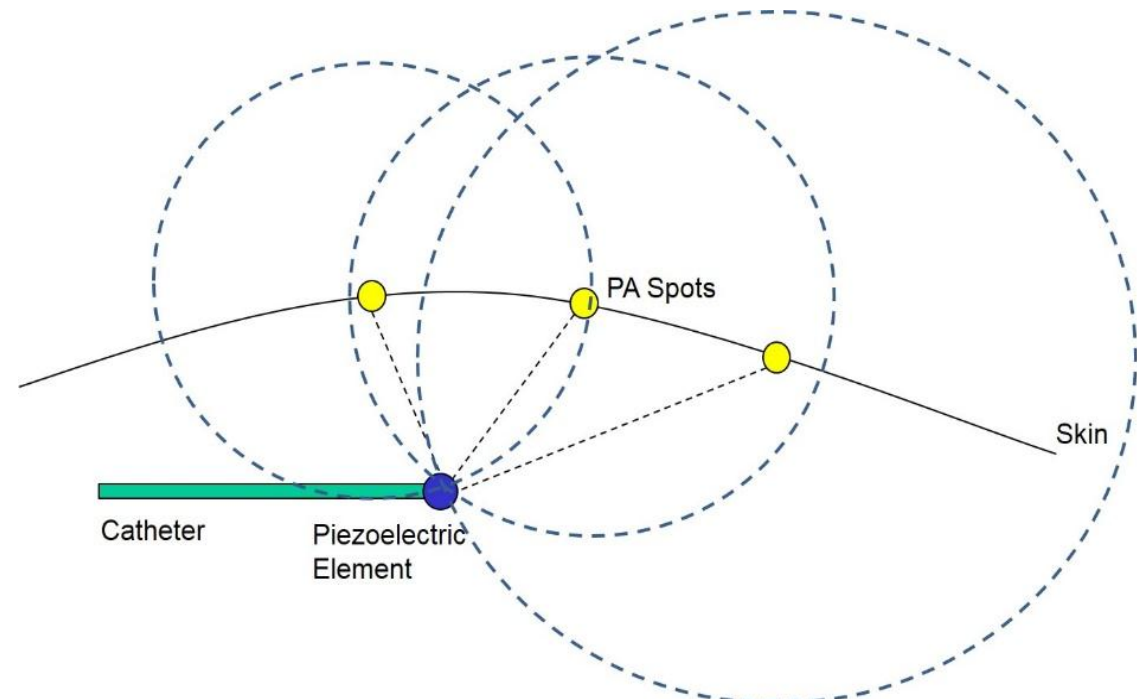
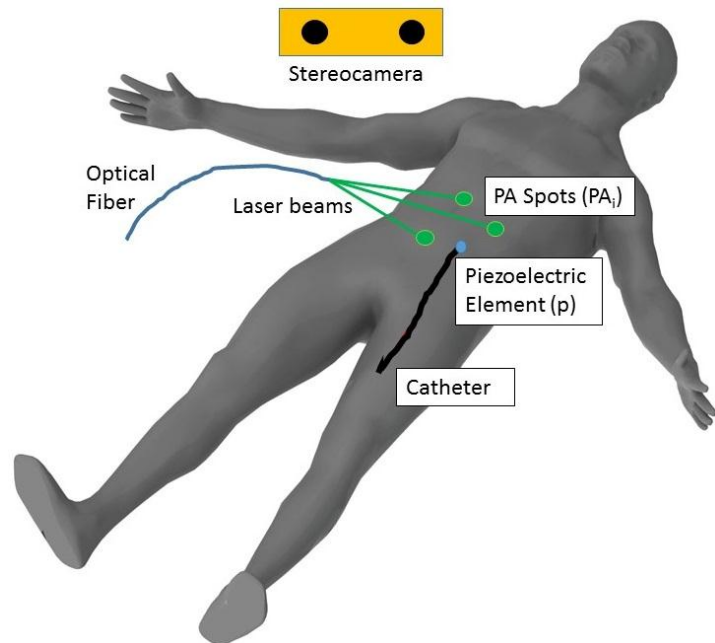
March 29, 2016

Overview

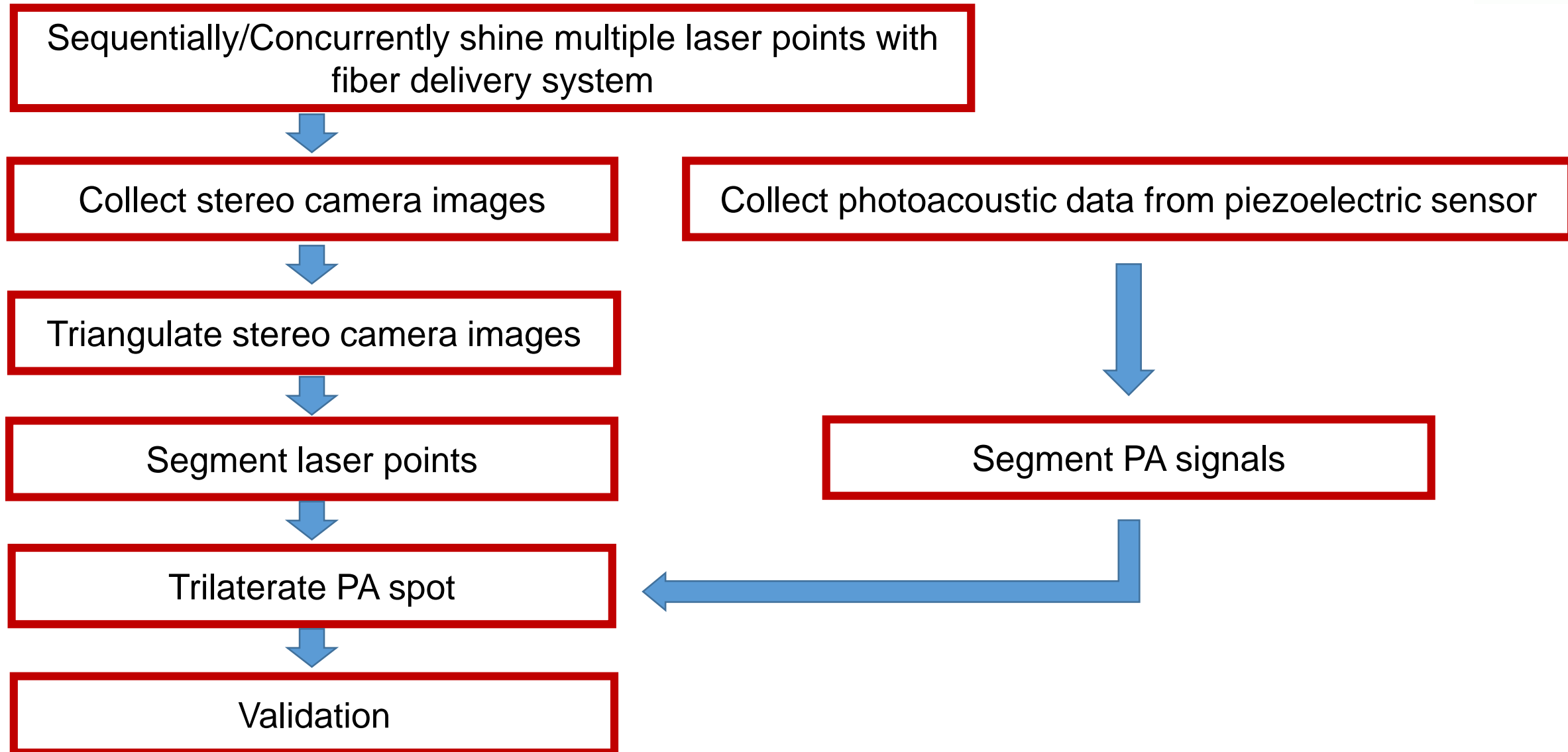
- Summary
- Milestones
- Results
- Deliverables
- Gantt Charts
- References

Summary

- Goal:
 - To track a catheter using a stereo camera with a line of sound by applying laser spots on the surface, which can be seen by the stereo camera and generate a photoacoustic signal observed by the piezoelectric element



Workflow



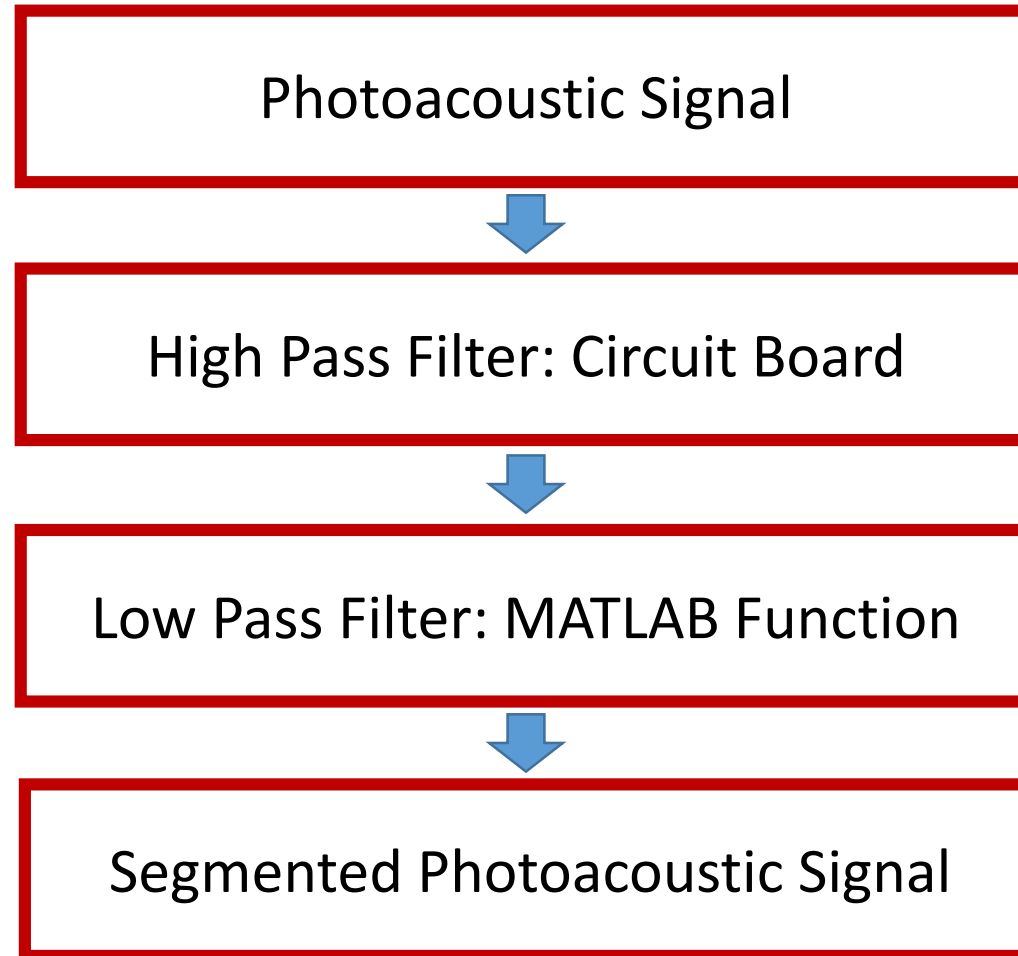
Milestones

- Phantom Acquisition
 - Criteria: Find or create suitable both of synthetic and *ex-vivo* tissue phantoms
 - Date: February 27 : **Achieved**
- Circuit Board Refinement
 - Criteria: Refine hardware filter and match impedance of PZT element for photoacoustic data acquisition
 - Date: February 27 : **Achieved**
- Synthetic Phantom/*Ex-vivo* Experiment
 - Criteria: Design and perform experiment to assess the efficacy of photoacoustic catheter tracking
 - Date: March 12 -----> **March 26 : Achieved. Delayed due to the need of more experiments**
- Analysis and Validation of Experimental Data
 - Criteria: Analyze and validate the experiment data
 - Date: March 19 -----> **April 2 : In progress**

Milestones

- Synthetic/*Ex-vivo* Experiment for optimizing the number and pattern of spots
 - Criteria: Design and perform experiment to assess the efficacy of photoacoustic catheter tracking for optimizing the number and pattern of spots
 - Date: April 16
- Analysis and Validation of Experimental Data
 - Criteria: Analyze and validate the experiment data
 - Date: April 23
- Real-time Tracking System
 - Criteria: Develop a real-time tracking system
 - Date: May 5

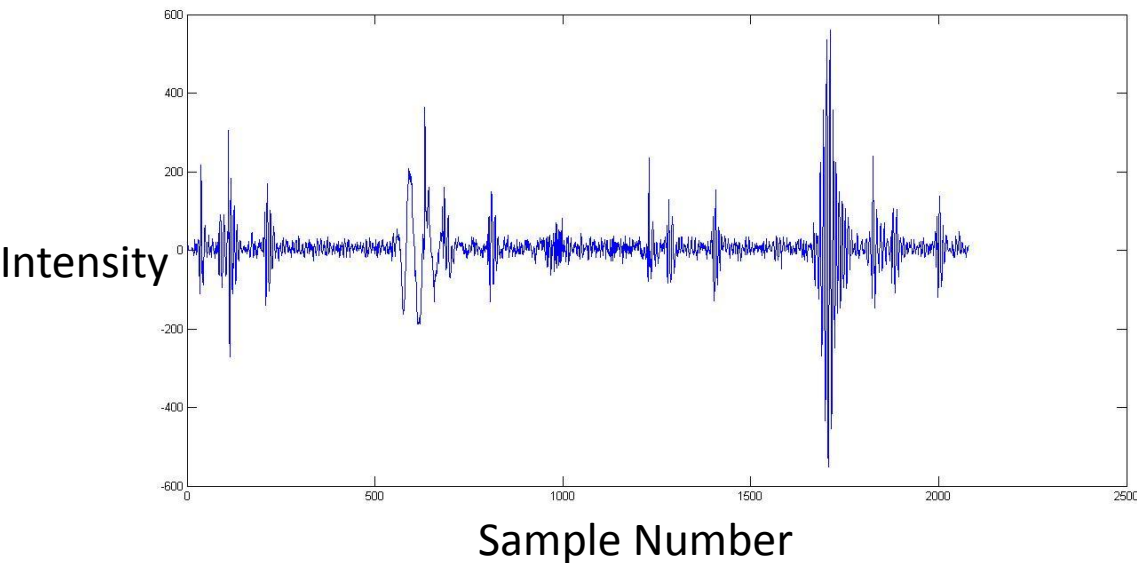
PA Signal Segmentation



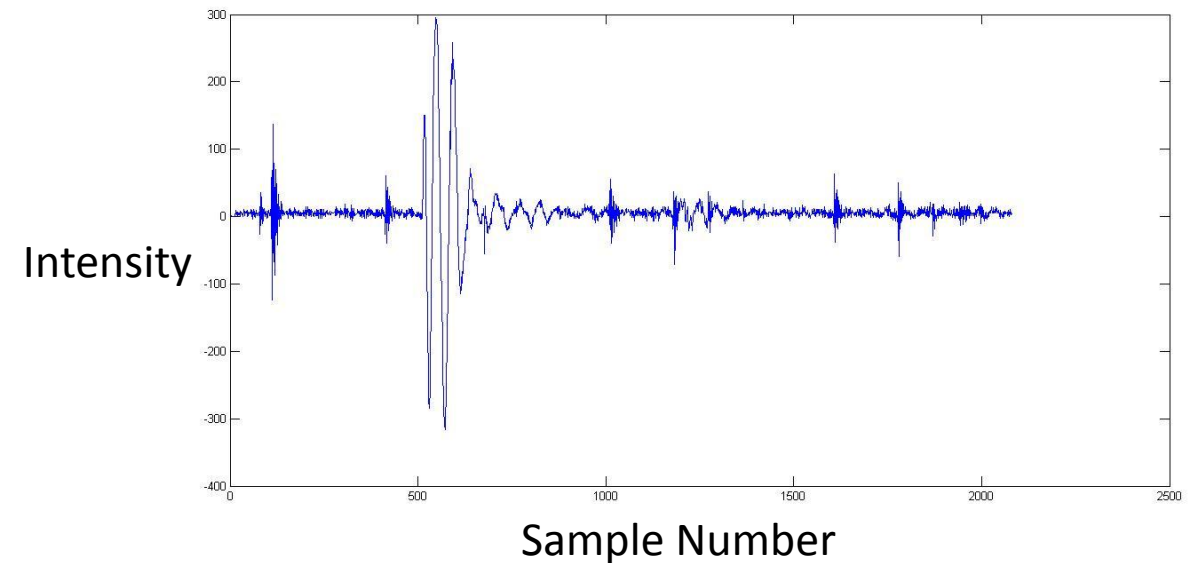
Results (Phantom Experiment)

- PA Signal Segmentation (High Pass Filter: Circuit Board)

Before



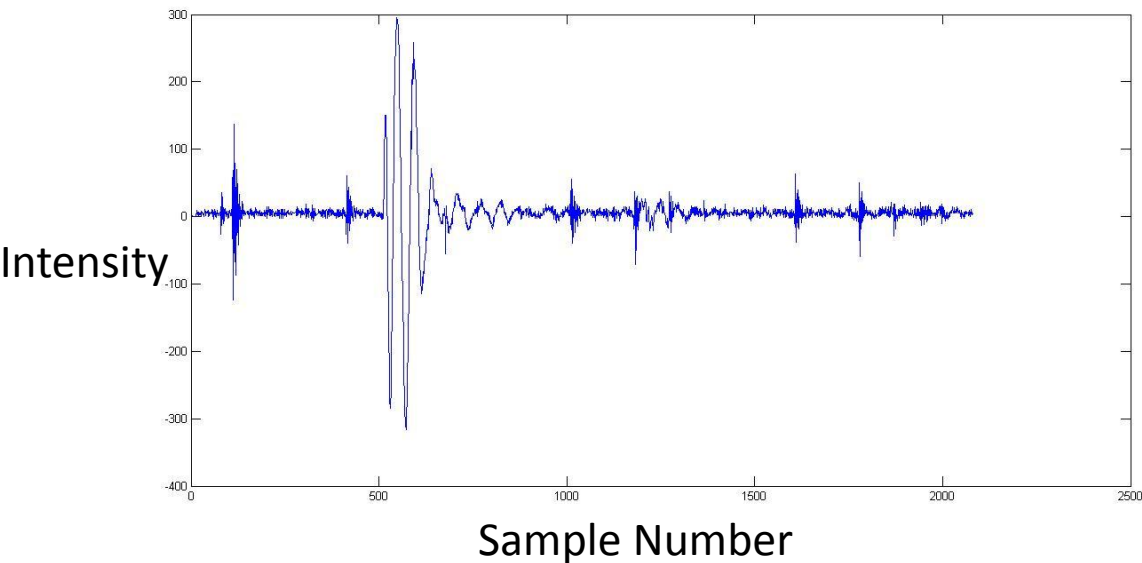
After



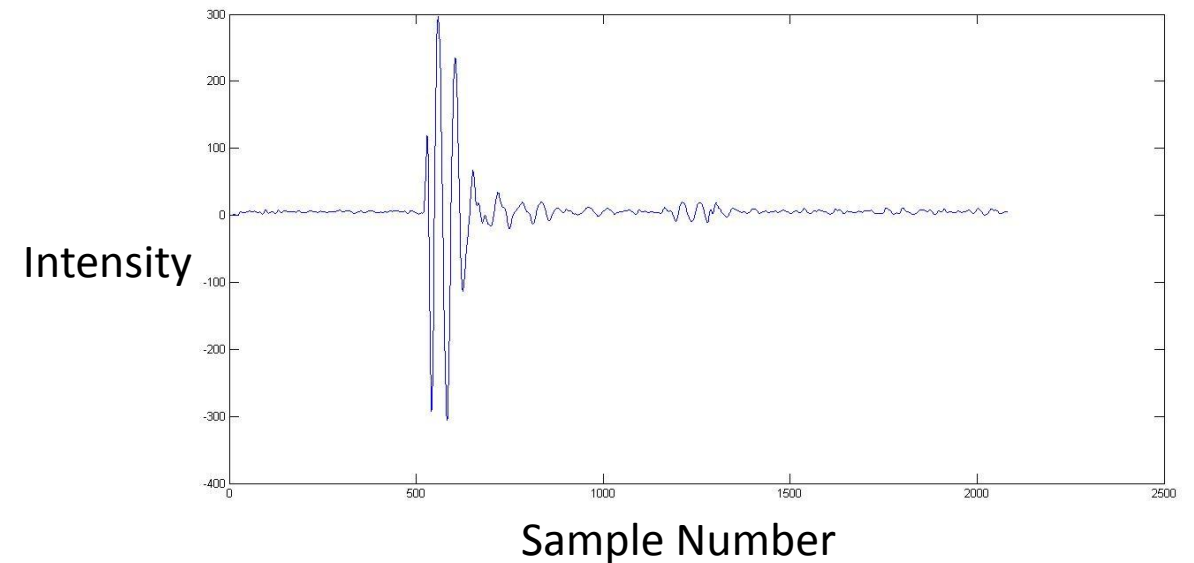
Results (Phantom Experiment)

- PA Signal Segmentation (Low Pass Filter: MATLAB Function)

Before

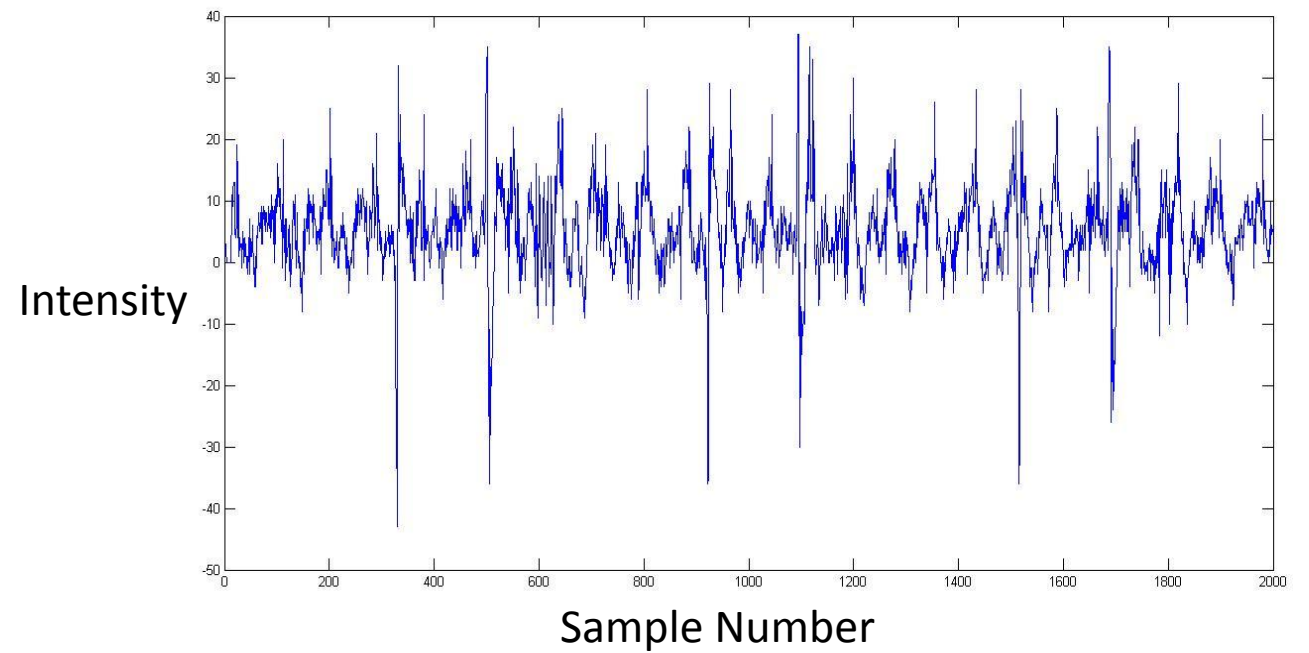
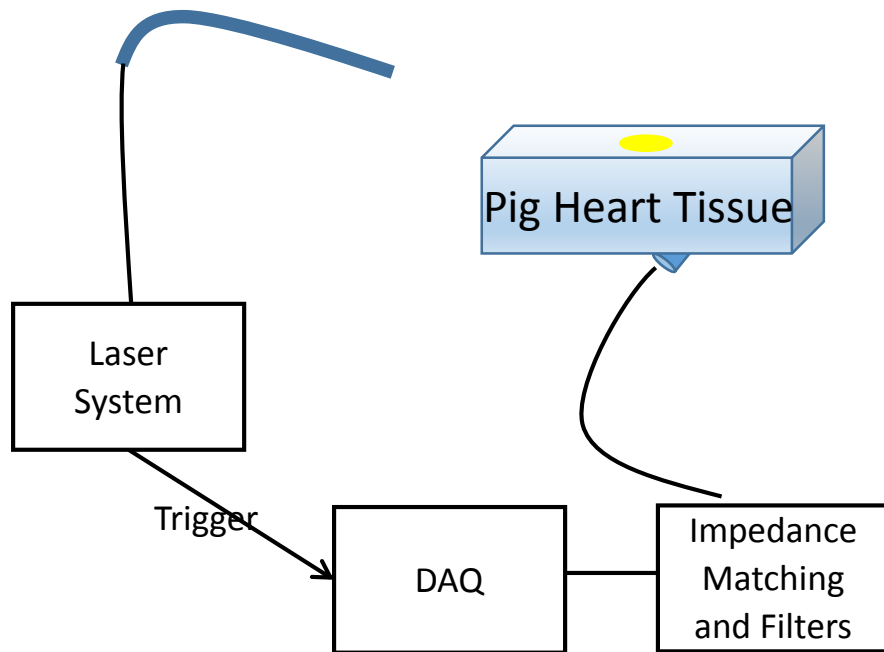


After



Results (*Ex-vivo* Experiment)

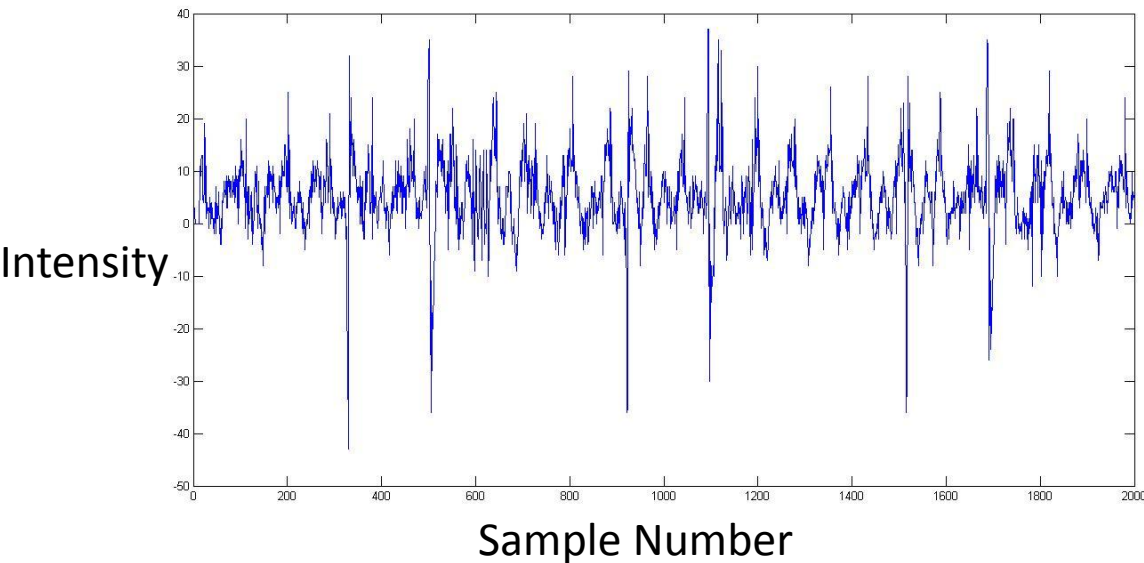
- Pig Heart Tissue



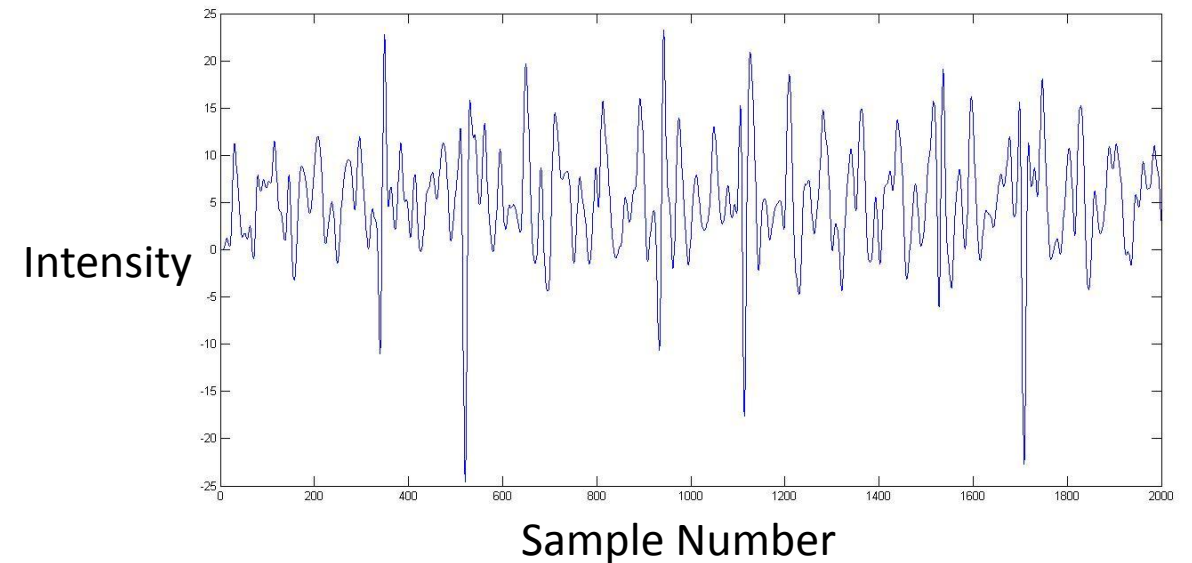
Results (*Ex-vivo* Experiment)

- PA Signal Segmentation

Before

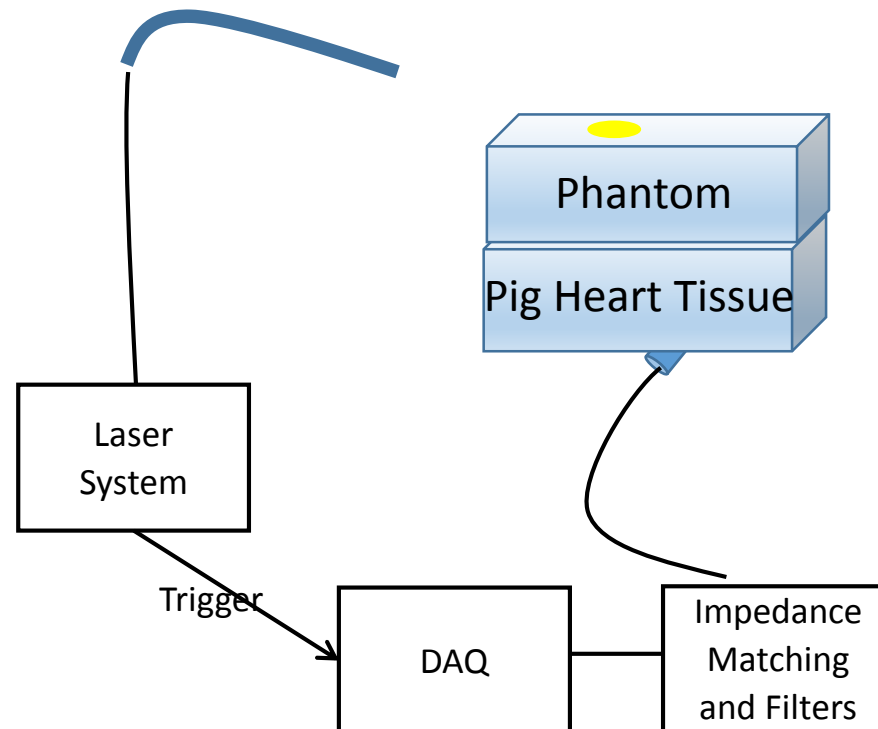


After



Results (*Ex-vivo* Experiment)

- Possible Cause: The laser absorption property of tissue
- Solution: Place the phantom on the top of the tissue



Validation

- Repeatability : **In Progress**

- Shine 30 different laser spots, then choose a subset of 3 spots, compute the result
- Compare the results from the different subsets of those spots

- Relative Distance

- Move the PZT element to the certain point OR
- Shift the stereo camera with known distance OR
- Add the distance to the data of laser spots (Software)
- Compare the results from the system

Deliverables

- Minimum
 - Refined circuit board for collecting data :Achieved
 - System configuration setup :Achieved
 - Phantom and *Ex vivo* data for sequential projection :Achieved
 - ~~In vivo experimental protocol~~
 - Analysis and validation of accuracy and precision measures of experimental data ←
- Expected
 - Optimization of the number and pattern of spots
 - ~~Concurrent projection of multiple laser points~~
 - Repeat the experiment with multiple points
- Maximum
 - Real-time tracking system
 - ~~In vivo experiment feasibility study~~

Original Plan

Minimum

Expected

Maximum

Task	14 Feb	21 Feb	28 Feb	6 Mar	13 Mar	20 Mar	27 Mar	3 Apr	10 Apr	17 Apr	24 Apr	1 May
Phantom Acquisition	█	█										
Circuit Board Refinement	█	█										
<i>In vivo</i> Experimental Protocol	█	█										
Synthetic/ <i>Ex vivo</i> Experiment		█	█	█								
Analysis and Validation of Experimental Data			█	█	█							
Concurrent Projection Method Development						█	█					
Synthetic/ <i>Ex vivo</i> Experiment for optimizing the number and pattern of spots							█	█	█			
Analysis and Validation of Experimental Data								█	█	█		
Real-time Tracking System										█	█	█
<i>In vivo</i> Experiment Feasibility Study										█	█	█

Revised Plan

Current Status

Minimum

Expected

Maximum

Task	14 Feb	21 Feb	28 Feb	6 Mar	13 Mar	20 Mar	27 Mar	3 Apr	10 Apr	17 Apr	24 Apr	1 May
Phantom Acquisition	Blue	Blue										
Circuit Board Refinement	Light Blue	Light Blue										
In vivo Experimental Protocol	Blue	Blue										
Synthetic/Ex vivo Experiment		Light Blue	Light Blue	Light Blue	Yellow	Yellow						
Analysis and Validation of Experimental Data			Blue	Blue	Blue	Yellow	Yellow					
Concurrent Projection Method Development						Light Blue	Light Blue					
Synthetic/Ex vivo Experiment for optimizing the number and pattern of spots								Blue	Blue			
Analysis and Validation of Experimental Data								Light Blue	Light Blue	Light Blue		
Real-time Tracking System										Blue	Blue	Blue
In vivo Experiment Feasibility Study										Light Blue	Light Blue	Light Blue

References

- Xiaoyu Guo et al. “Active Ultrasound Pattern Injection System (AUSPIS) for Interventional Tool Guidance”. PLoS ONE 9(10) 2014
- Alexis Cheng et al. “Catheter Tracking in an Interventional Photoacoustic Surgical System”. Submitted to CLEO 2016
- A.Wiles, D. Thompson, and D. Frantz, “Accuracy assessment and interpretation for optical tracking systems,” Proc. SPIE 5367, 421–432 (2004)
- Alexis Cheng et al. “Direct three-dimensional ultrasound-to-video registration using photoacoustic markers”. Journal of Biomedical Optics 18(6), 066013 (June 2013)
- M. Xu and L. Wang, “Photoacoustic imaging in biomedicine,” Rev. Sci. Instrum. 77, 041101 (2006)
- Alexis Cheng et al. “Direct ultrasound to video registration using photoacoustic markers from a single image pose”. SPIE 2015

Questions?