Software-based Approach for Real-time Photoacoustic Imaging using Vendor Independent US Beamformed Data

Computer Integrated Surgery II

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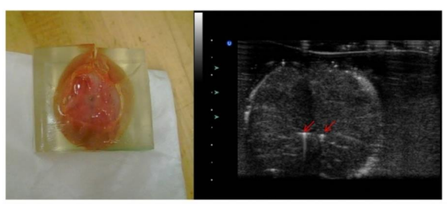
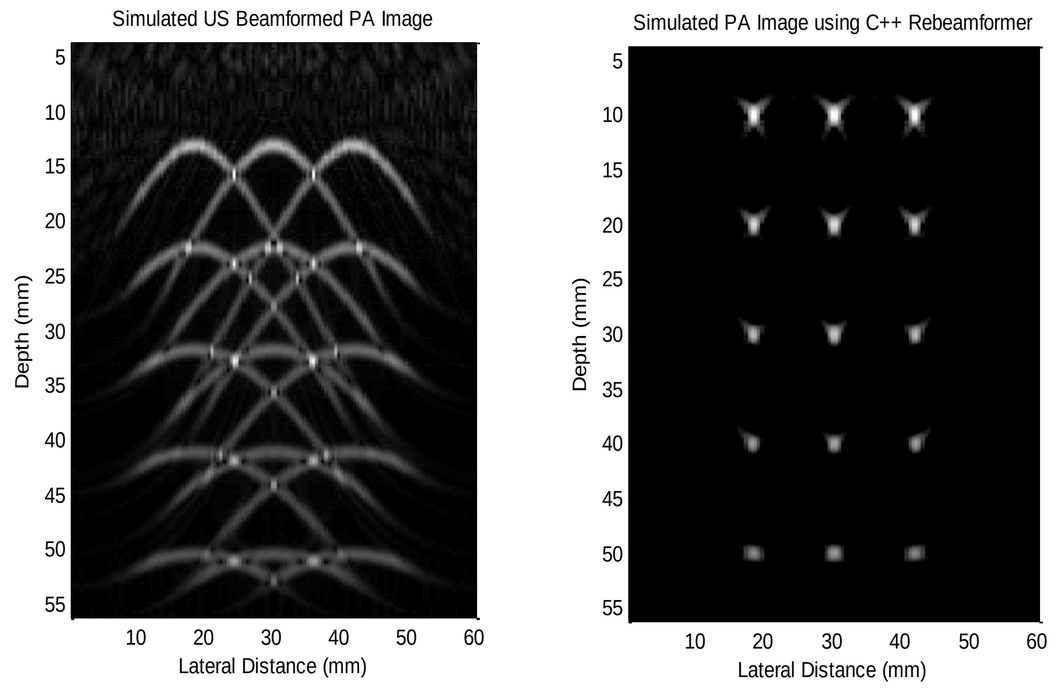
Introduction

- We have developed a fast algorithm for enabling PA imaging using US beamformed RF data.
- The algorithm can process beamformed data independently of any US platform or vendor. Integrated into Ultrasonix Ulterius as a live demo.
- PA imaging is an emerging medical imaging modality whose uses include cancer detection and instrument tracking.



Brachytherapy Seed Tracking (MUSiiC Lab)

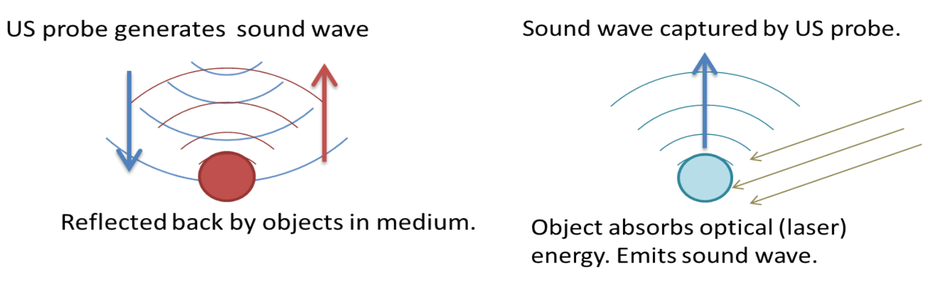
- **<u>Our method circumvents hardware costs for PA imaging</u>** while boasting high framerates. It also **<u>enables PA imaging on any US platform with real-time RF data access.</u>**



Significant PA Image Resolution Improvement due to Synthetic Aperture Rebeamforming

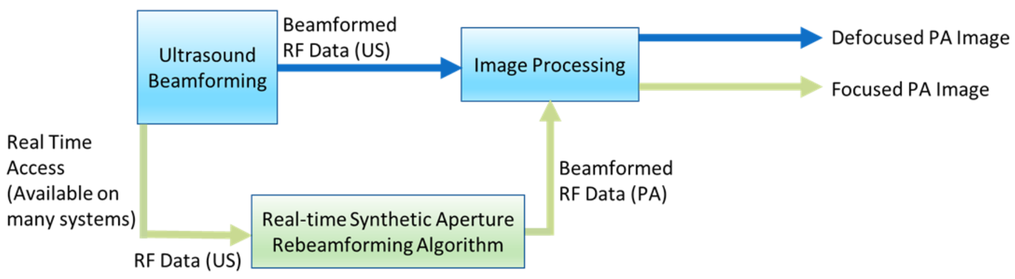
The Problem

- PA signals can be captured by US systems but are defocused due to differences in travel times.



- Several current methods to enable PA imaging on US systems require channel data acquisition or beamformer reconfiguration (Frame rates of 3-4 Hz).
- These options are not available on many conventional US systems.

The Solution

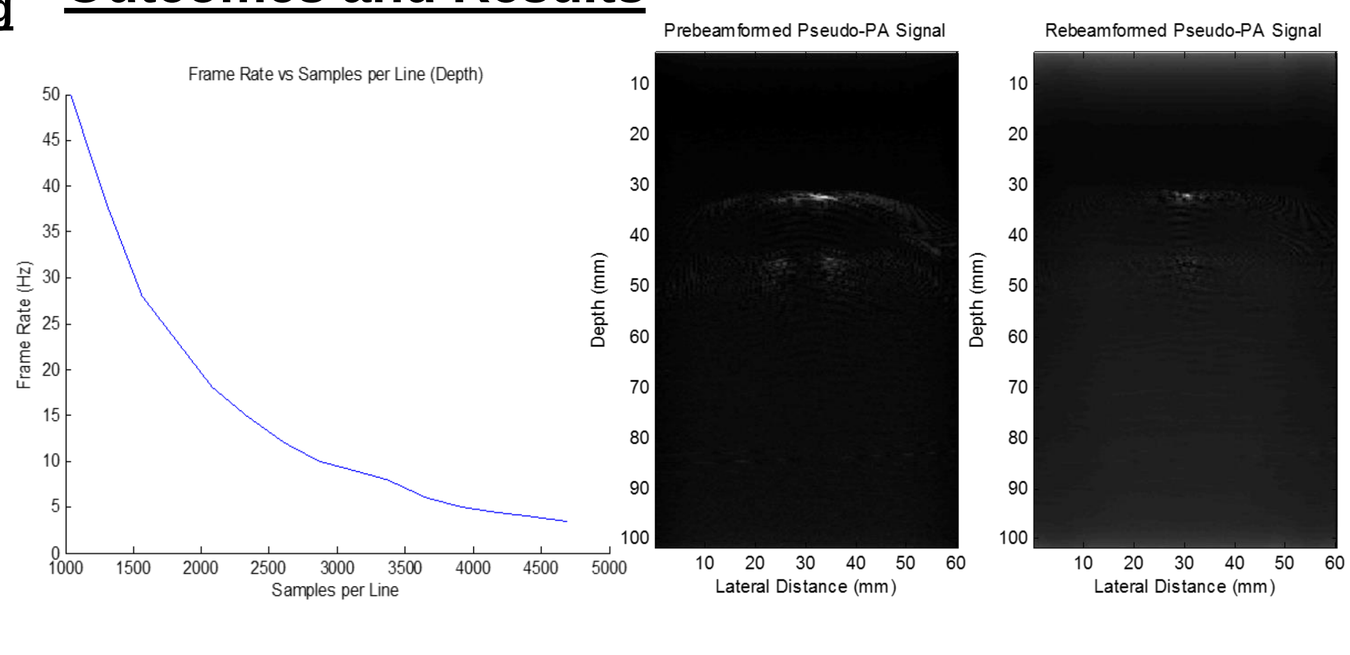


- Kai's synthetic aperture PA rebeamforming algorithm allows for fast refocusing of PA signals.
- Implemented the algorithm in C++ and optimized runtime by using precomputed tables. Calibrated algorithm with real RF data.
- To demonstrate its effectiveness, created a PA imaging demo using the SonixTouch US machine.
- Software dependencies for the demo include Cmake, Qt4, OpenCV, and Ultrasonix Sdk6. Coding was done on Visual Studios.

References

1. Zhang, Kai, et. al. "Synthetic Aperture Based Photoacoustic Image Re-beamforming From Ultrasound Post-beamformed RF Data". Unpublished Manuscript.
2. Kang, Hyun-Jae, et al. "Software framework of a real-time pre-beamformed RF data acquisition of an ultrasound research scanner." SPIE Medical Imaging. International Society for Optics and Photonics, 2012
3. Kuo, Nathanael, et al. "Real-time photoacoustic imaging of prostate brachytherapy seeds using a clinical ultrasound system." Journal of biomedical optics 17.6 (2012): 0660051-0660057.

Outcomes and Results



- Live demo produces PA images in real-time with frame rates **<u>up to 50 frames per second</u>** (for images with lower target depth). Maintains real-time performance for all depths.

Future Work

- Will test system on additional real-time PA imaging setups.
- Optimize performance using parallel computing.
- Integrate future results into report for publication.

Lessons Learned

- UI development for real-time PA imaging.
- Code optimization (for faster rebeamformer).
- Planning and individual project management.

Credits

- Howard Huang (C++ Rebeamformer, Ulterius Demo)
- Mentor: Kai Zhang (Rebeamformer Algorithm)

Support by and Acknowledgements

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- I would also like to thank Chen Lei for providing reference code for modifying the Ulterius interface.
- Thank you to Dr. Bell for teaching medical imaging modalities over intercession (sparked my interest in PA imaging).
- Finally, thank you to Dr. Taylor, Alexis, and everyone in CIS II !!! ☺