

# Novel Ultrasound Imaging Methods to Distinguish Cancer and Improve Surgery

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## Overview

### Three Research Highlights:

- I. Coherence-Based Ultrasound Beamforming
- II. Photoacoustic-Guided Surgery
- III. Deep Learning Approach to Image Formation

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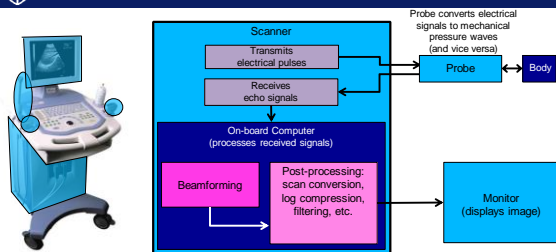
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## Ultrasound (US) System Architecture



I. Coherence Beamforming II. Photoacoustic-Guided Surgery III. Deep Learning IV. Summary

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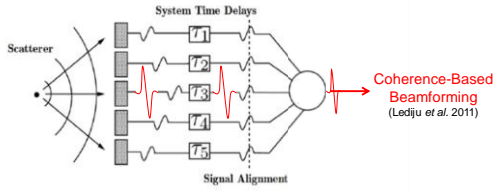
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## Delay-and-Sum (DAS) Beamforming



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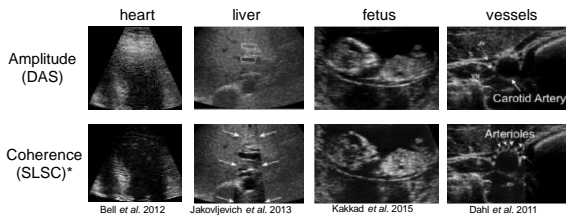
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## Amplitude vs. Coherence Beamforming



\* SLSC = Short-Lag Spatial Coherence, Patent Awarded in 2016

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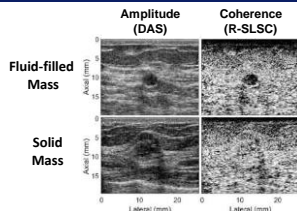
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## Coherence-Based Breast Imaging

### Challenges:

- Difficult to distinguish fluid masses (benign) from solid hypochoic breast masses (benign or malignant)
- High false positive rates
- Biopsies, aspiration, follow-up
- Patient anxiety



Wiaciek et al., Robust Short-Lag Spatial Coherence Imaging of Breast Ultrasound Data: Initial Clinical Results, IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, 66(3):527-540, 2019

I. Coherence Beamforming II. Photoacoustic-Guided Surgery III. Deep Learning IV. Summary

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### Working Prototype for Neurosurgery

Without Bone | With Bone

B Eddins, MAL Bell, *Journal of Biomedical Optics*, 2017

**FULSE** | I. Coherence Beamforming | II. Photoacoustic-Guided Surgery | III. Deep Learning | IV. Summary

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### Deep Learning Approach to Beamforming

- Goal: Map signal sources to the correct location

Input: RF channel data

Train algorithm with simulated ultrasound & photoacoustic data

feature extraction (<http://parse.ole.tue.nl/education/education/>)

classification

Create images from learned parameters

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### Point Source Simulation

Axial Position (mm)

Lateral Position (mm)

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# Acknowledgements

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[pulselab.jhu.edu](http://pulselab.jhu.edu)

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