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Deep Adaptive Beamforming for Photoacoustic Computed Tomography

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// Introduction

Photoacoustic Computed Tomography (PACT) is a relatively new imaging modality that takes advantage of the natural optical contrast of biological tissues and combining this with a high ultrasonic resolution. The limited amount of ultrasound transducers together with the bandlimitations of conventional piezoelectric transducers cause limitations in acquiring the underlying map of scatterers

Here we propose a deep learning approach to adaptive beamforming which improves image contrast by calculating data-adaptive apodization weights using a convolutional neural network. Together with a deep UNET to find extend the bandwidth of the bandlimited sensors.

// Training Data

We apply our network to the acquired photoacoustic data for PACT in the breast. For training, data simulated using the photoacoustic simulation tool K-wave is used. For additional training, the beamforming part of the network is also trained using Minimum Variance Distortionless Response (MVDR) beamformed in vivo data.

// Network setup

The network consists of a Beamforming and Bandwidth extension network.

1) Beamforming (BFN)

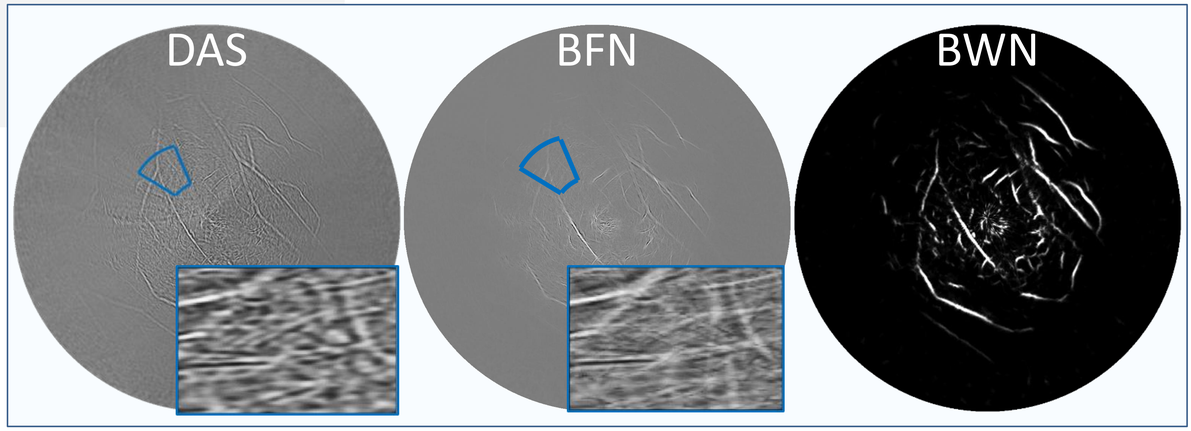
The beamforming network uses multiple 1D convolutional layers in the sensor direction to find the final image. It also applies a dynamic range preserving activation function (antirectifier) in the first layer.

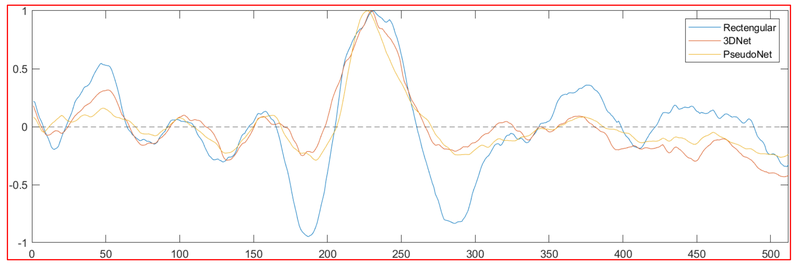
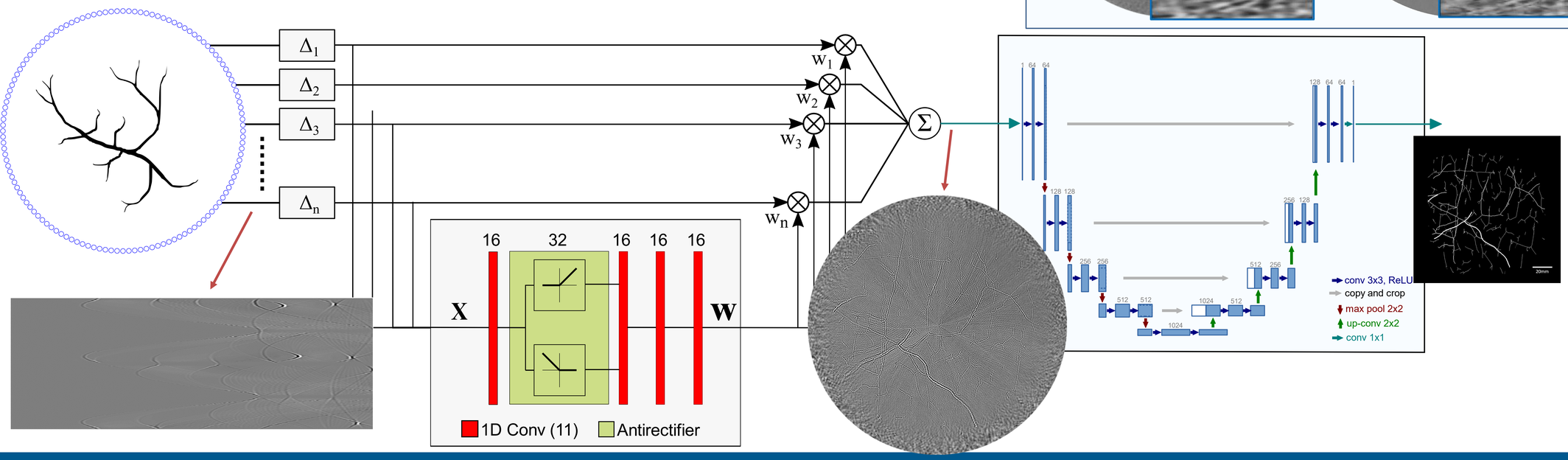
3) Bandwidth Extension (BWN)

The bandwidth extension network uses more Common UNET structure.

// Results

The figure to the Right demonstrates the performance of the deep learning based beamformer on In vivo data.



// Conclusion

The beamforming network shows great improvements in resolution as compared to regular beamforming. The bandwidth extension however shows similar results as compared to using a UNET on regular delay and sum beamformed data.