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Deep Learning Approach to Improved Image Quality for Medical Diagnostics

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Deep Learning Approach to Improved Image Quality for Medical Diagnostics

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BACKGROUND

Artificial Intelligence

- AI is the simulation of human intelligence processed by computers.

Cardiovascular Imaging

- Noninvasive cardiovascular imaging, ultrasound and photoacoustic imaging, are inherently noisy and difficult to interpret without training.

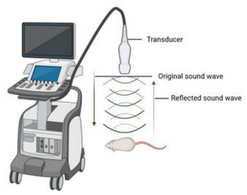

Fig 1. Ultrasound Imaging

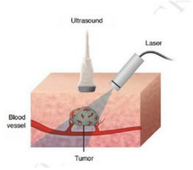

Fig 2. Photoacoustics

METHODS

- Create binary mask dataset

Fig 3. Murine Carotid Artery Binary Masks

- Pass binary mask dataset through MATLAB's k-Wave time-reversal photoacoustic reconstruction algorithm

Fig 4. Murine Carotid Artery Photoacoustic Reconstruction

- Use deep learning denoising algorithm to improve image quality

OBJECTIVES

Overall Goal

- Improve quality of murine vascular images using a deep-learning approach

Specific Aims

- Create realistic simulated database of murine vascular images
- Reduce artifacts and increase signal-to-noise ratio and using a deep learning algorithm

RESULTS

Original Images **Reconstructed Images**

Fig 5. Original and Reconstructed Binary Mask Images from Deep Learning Algorithm

Image	Signal to Noise Ratio (dB)
Average noisy	15.2
Average denoised	19.7
Average delta	4.5

Fig 6. Signal-to-Noise Ratio

Discussion

Conclusion

- Preliminary results suggest the algorithm improves image quality however more testing need to be done as only one dataset has been tested

Future Work

- Expand binary mask dataset to better train the algorithm
- Improve photoacoustic reconstruction algorithm by adding accurate *in vivo* tissue parameters
- Implement these methods on *in vivo* images

ACKNOWLEDGMENTS

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Background & Objectives

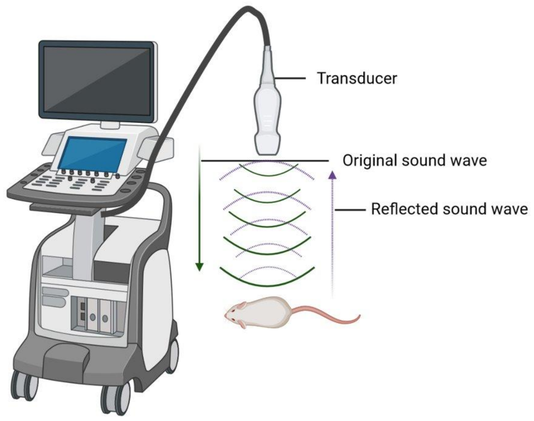
BACKGROUND

Artificial Intelligence

- ❏ AI is the simulation of human intelligence processed by computers.
- ❏ AI has gained popularity in recent years, especially applied to medical diagnostics.

Cardiovascular Imaging

- ❏ Noninvasive cardiovascular imaging, such as ultrasound and photoacoustic imaging, are inherently noisy and difficult to interpret without training.



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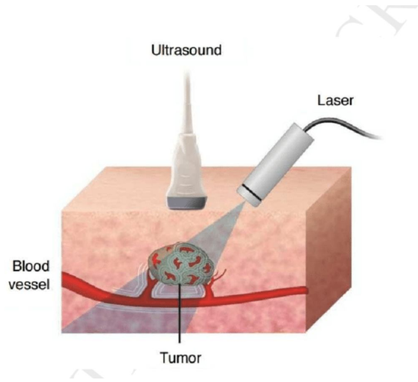
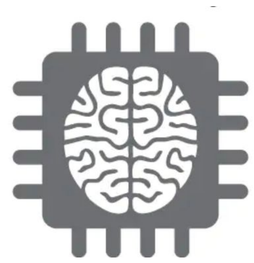


Fig 2. Photoacoustics

OBJECTIVES

Overall Goal

- ❏ Improve quality of murine vascular images using a deep learning approach



Specific Aims

- ❏ Create realistic simulated database of murine vascular images
- ❏ Reduce artifacts and increase signal-to-noise ratio using a deep learning algorithm

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Methods

Binary Mask Database

- ❖ Created binary mask simulated database of murine carotid artery images
  - ❑ Binary masks are images with pixels of value either 1 or 0 (black or white)
  - ❑ **No noise** in these images

Fig 3. Murine Carotid Artery Binary Masks

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Methods

Photoacoustic Reconstruction

- ❖ Used MATLAB's k-Wave toolbox to reconstruct photoacoustic images from binary mask data set

  - ❏ Time-reversal photoacoustic pressure reconstruction method

  - ❏ Simulates *in vivo* pressure distribution and constructs image as seen by the imaging sensor

Fig 4. Murine Carotid Artery Photoacoustic Reconstruction

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Methods

Image Quality Enhancement

- Deep learning algorithm constructed in Python to remove noise from binary masks and reconstructed photoacoustic images

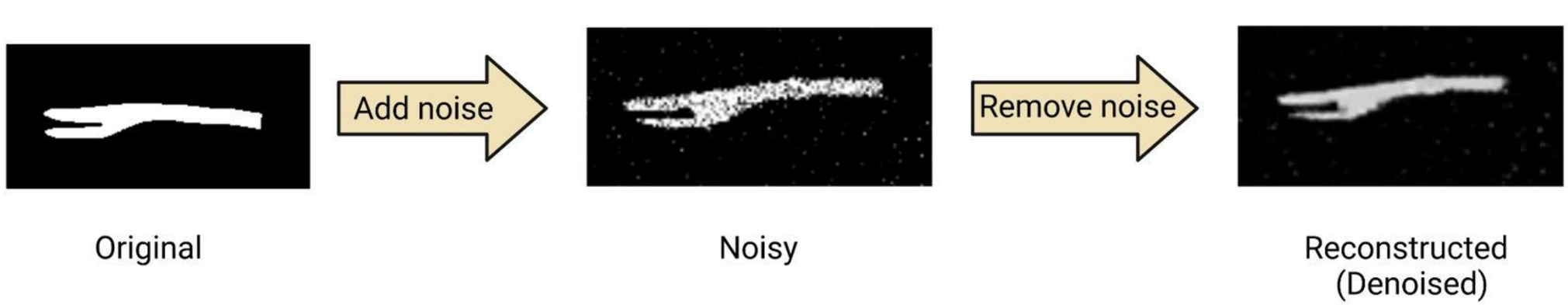

Fig 5. Denoising Algorithm Workflow

- Quantifies signal-to-noise ratio

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Results & Conclusions

Discussion

- Preliminary results suggest improved image quality as signal-to-noise ratio increased

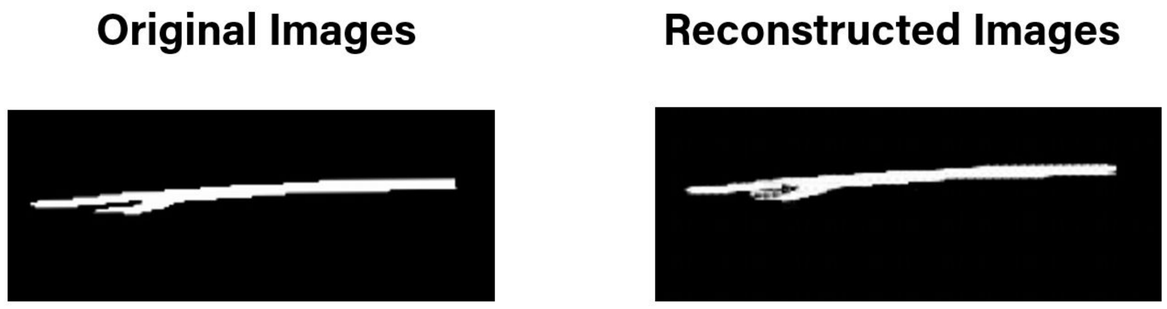

Fig 6. Denoising Algorithm Results

Future Work

- Expand binary mask dataset to better train the algorithm

- Improve photoacoustic reconstruction algorithm by adding accurate *in vivo* tissue parameters

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