Cardiac Image Reconstruction From Low-dosage SPECT Scans via Deep Learning (CIRFLDSSvDL)

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Introduction

- Single-Photon Emission Computed Tomography (SPECT) scans are a type of medical scan
- A patient is injected with a radiotracer, which emits gamma rays that are detected by gamma cameras that rotate around the patient
- Using a series of images collectively referred to as a sinogram, a 3D reconstruction of the patient is created using techniques such as Maximum Likelihood Expectation Maximization (MLEM)
- MLEM takes a long time, but using a neural network can speed up the reconstruction process and allow for a lower dosage of radiotracer to be used

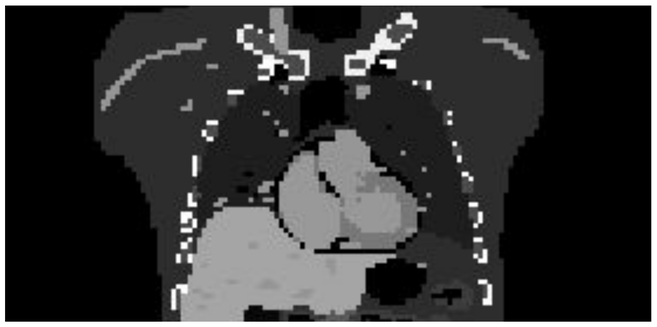
Objectives

- Quickly and accurately reconstruct SPECT scans with low dosages of radiotracer via a neural network.

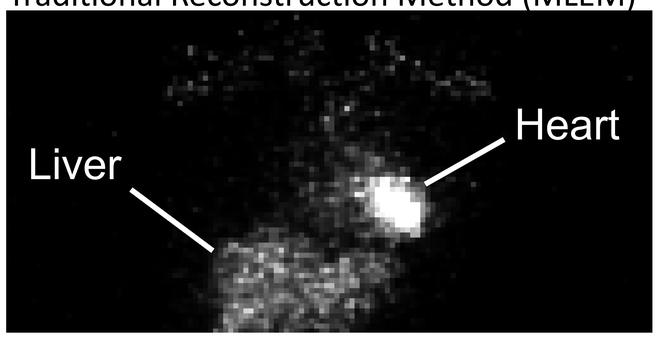
Methodology

- Simulate the GE Infinia SPECT scanner in order to generate training data
- Scan XCAT patient phantoms that are administered low doses of radiotracer in the simulation
- Simulated gamma ray cameras capture images every 3 degrees, creating 120-slice sinograms
- Augment the sinograms via translation and rotation to create more training data
- Train an autoencoder-decoder (AED) with attention with the sinograms as inputs, and volumes reconstructed with MLEM as outputs
- Evaluate model accuracy based off the Structural Similarity Index Measure (SSIM) and Root Mean Squared Error (RMSE) of its reconstructions

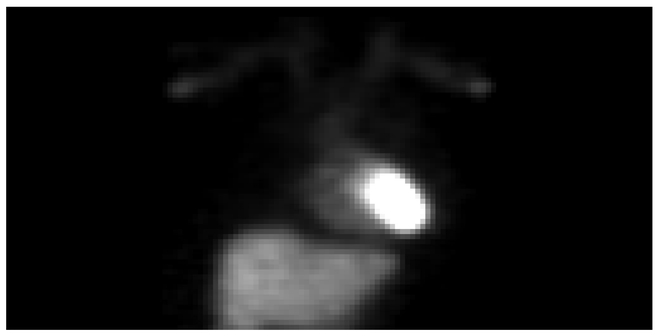
XCAT Slice



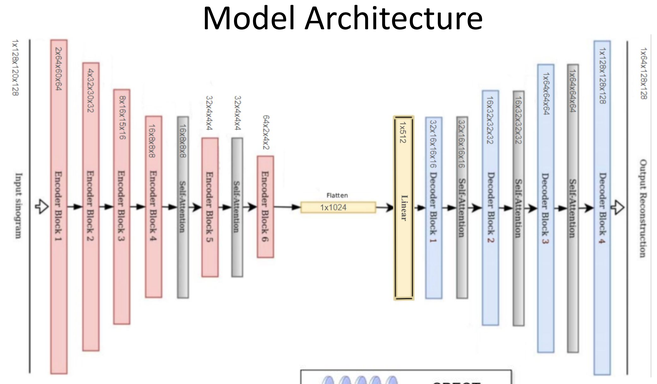
Traditional Reconstruction Method (MLEM)

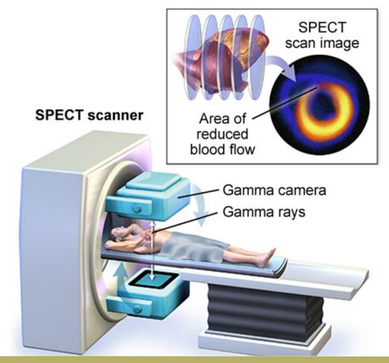


CIRFLDSSvDL



Model Architecture





Results

- We achieved an RMSE of 0.002743, and a SSIM of 0.943770 on an unseen 20% test set of unaugmented input-output pairs after training for 333 epochs.
- Our inference time is near instant compared the standard 45 minutes
- The visual comparison shows a clearer reconstruction than traditional iterative methods

Conclusions

- Efficient high quality reconstruction can be performed using neural architectures.
- Patients' radioactive dosage can be lowered while still producing sufficiently high quality results.

Future Work

Training our model on large amounts of real data could allow it to be used by clinicians to reconstruct SPECT scans in much shorter timeframes. It would also allow doctors to use lower dosages of radiotracer while still getting a quality scan.

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