Enabling High Resolution Computed Tomography Neural Representation Using Batched Rays Sampling

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Introduction and Motivation

• Implicit neural representations (INR) have been at the frontier of the computed tomography (CT) reconstruction field.
• Those neural representations require large amounts of GPU memory to be trained, limiting their usage and accessibility.
• We propose a new approach to breaking down the ground truth to enable higher-resolution CT using smaller GPUs. (Figure 4)

Method

• We considered the conventional inverse radon transform as our baseline method for reconstruction. (Figure 2)
• The inverse Radon transform, however, conventionally reconstructs the whole image, which makes it memory expensive when fitting it to a neural network. (Figure 3)
• We proposed a method to break down the inverse Radon transform into single rays. (Figure 4)
• Each pixel in the sinogram space represents a ray (a vector of pixels) in the image space.
• We computed the associated vectors of pixels with every single sinogram pixel and stored them in a dictionary-like data structure.
• While training the network, we could fit as low as one sinogram pixel as our ground truth enabling the training on smaller GPUs.

Inverse Radon Transform

• Radon Transform (Eq2)
  \[ F(\alpha, s) = \int_{-\infty}^{\infty} f(t \sin \alpha + s \cos \alpha, -t \cos \alpha + s \sin \alpha) \, dt \]
• Inverse Radon Transform (Eq2)
  \[ f(x, y) = \int_{\alpha} f(x, x \cos \alpha + y \sin \alpha) \, d\alpha \]

Proposed Pipeline

Figure 3. Traditional implicit neural network for computed tomography: Input: 50% of the coordinates of the desired CT image.

Conclusion and Future Work

• Our proposed method has enabled high-resolution computed tomography representations in neural networks with conventional GPUs.
• The method is yet to be expanded to 3-D where more applied problems can be addressed.
• The ray (sinogram pixels) sampling method (random vs non-random) is still being evaluated.
• Additional priors can be incorporated to study their effects on the reconstruction quality.

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References