Ultrasound Image Reconstruction by Solving an Inverse Problem with Denoising Diffusion Restoration Models

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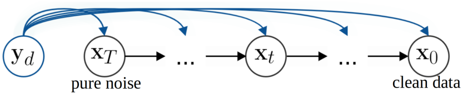

Figure – The sampling process of Denoising Diffusion Restoration Models (DDRM)[1]

$$\mathbf{y}_d = \mathbf{H}_d\mathbf{x}_d + \mathbf{n}_d \quad (1)$$

$$\mathbf{y}_d = \mathbf{U}_d\Sigma_d\mathbf{V}_d^t\mathbf{x}_d + \mathbf{n}_d \quad (2)$$

$$\Sigma_d^{\dagger}\mathbf{U}_d^t\mathbf{y}_d = \mathbf{V}_d^t\mathbf{x}_d + \Sigma_d^{\dagger}\mathbf{U}_d^t\mathbf{n}_d \quad (3)$$

$$\bar{\mathbf{y}}_d = \bar{\mathbf{x}}_d + \bar{\mathbf{n}}_d, \quad (4)$$

$$\bar{\mathbf{n}}_d \sim \mathcal{N}\left(0, \begin{bmatrix} \frac{\sigma_d^2}{s_1^2} & & & \\ & \ddots & & \\ & & \frac{\sigma_d^2}{s_i^2} & \\ & & & \ddots & \\ & & & & \frac{\sigma_d^2}{s_N^2} \end{bmatrix}\right) \quad (5)$$

- Ultrasound inverse problem :

$$\mathbf{CBy} = \mathbf{CBHx} + \mathbf{CBn} \quad (6)$$

C : whitening operator
B : Matched filtering for data compression

- Results (model trained with Imagenet dataset)

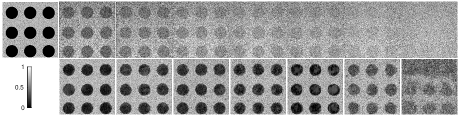

Figure – The ground truth (left top) and the reconstructed images by the traditional method (top) and our approach (bottom)

- Future : train with ultrasound images

[1] Kawar, B., Elad, M., Ermon, S., Song, J. : Denoising Diffusion Restoration Models (Oct 2022). https ://doi.org/10.48550/arXiv.2201.11793, http://arxiv.org/abs/2201.11793, arXiv :2201.11793 [cs, eess]