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Single-shot inline holography using a physics-aware diffusion model: errata

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Abstract: We present an erratum to our paper [Opt. Express **32**, 10444 (2024)]. This erratum aims to address an unintentional error in the methodology presented in Part 3.1. The error may lead to confusion among readers, and we provide additional clarification to ensure a comprehensive understanding of the technique. It is important to note that these corrections do not affect the results or conclusions of the original work.

1.

In our paper [1], the $\nabla_{\boldsymbol{v}_t}$ should be corrected to $\nabla_{\boldsymbol{x}_t}$ in Algorithm 1 and its corresponding schematic figure (Fig. 1) to accurately represent the gradient correction step as

$$\boldsymbol{x}_{t-1} = \boldsymbol{v}_t - \rho \nabla_{\boldsymbol{x}_t} \|\boldsymbol{y} - \mathcal{T}(\hat{\boldsymbol{x}}_0)\|_2^2, \tag{1}$$

where $\hat{\boldsymbol{x}}_0$ is a function of $\boldsymbol{x}_t$, and $\rho = 1/\gamma^2$ is the stepsize. By doing so, we maximize the likelihood $p(\boldsymbol{y} \mid \hat{\boldsymbol{x}}_0)$ of the recorded hologram $\boldsymbol{y}$. It is demonstrated in [2] that an approximation of $p(\boldsymbol{y} \mid \boldsymbol{x}_t)$ can be yield using $p(\boldsymbol{y} \mid \hat{\boldsymbol{x}}_0)$, with the approximation error quantified using the Jensen gap [3]. Thus, this correction step can be associated with the maximization of the intractable likelihood $p(\boldsymbol{y} \mid \boldsymbol{x}_t)$ during the sampling process, which elucidates the rationale behind our correction approach for integrating the physics of the digital holographic imaging system.

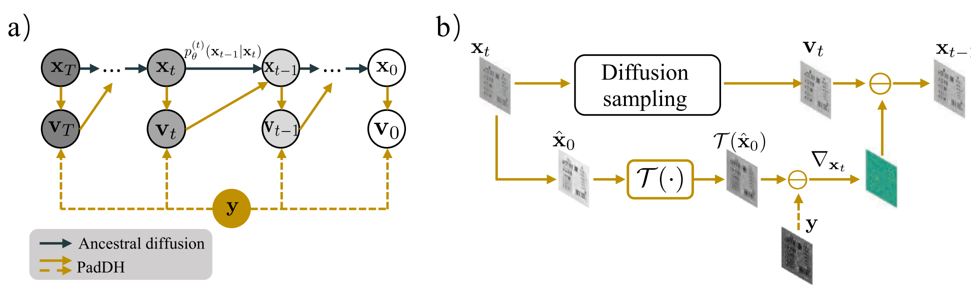

Fig. 1. (a) A comparison between the ancestral diffusion step (depicted in black) and our proposed physics-aware diffusion model (PadDH, represented in orange). It involves an intermediate transformation from $\boldsymbol{x}_t$ to $\boldsymbol{v}_t$ and further transformation into $\boldsymbol{x}_{t-1}$. (b) A detailed visual depiction of the correction step, illustrating the sequence of transformations from $\boldsymbol{x}_t$ to $\boldsymbol{v}_t$ and then to $\boldsymbol{x}_{t-1}$.

The corresponding corrected version is presented in Fig. 1 and Algorithm 1.

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Algorithm 1. Physics-aware diffusion model for digital holographic reconstruction

Require: DH measurement operator $\mathcal{T}(\cdot)$, hologram $\boldsymbol{y}$, stepsize ρ, diffusion solver $\boldsymbol{\epsilon}_\theta$ and σ_θ, number of steps T, variance schedule $\{\beta_t \in (0,1)\}_{t=1}^{T}$, initial stage $\boldsymbol{x}_T$

Initialization: $\alpha_t = 1 - \beta_t$ and $\bar{\alpha}_t = \prod_{s=1}^{t} \alpha_s$

for $t = T$ to 1 **do**

  $\hat{\boldsymbol{x}}_0 \leftarrow \frac{\boldsymbol{x}_t - \sqrt{1-\bar{\alpha}_t}\,\epsilon_\theta(\boldsymbol{x}_t, t)}{\sqrt{\bar{\alpha}_t}}$

  $\boldsymbol{\delta} \sim \mathcal{N}(\mathbf{0}, \mathbf{1})$ if $t > 1$, else $\boldsymbol{\delta} = \mathbf{0}$

  $\boldsymbol{v}_t \leftarrow \sqrt{\bar{\alpha}_{t-1}}\hat{\boldsymbol{x}}_0 + \sqrt{1-\bar{\alpha}_{t-1}}\boldsymbol{\epsilon}_\theta(\boldsymbol{x}_t, t) + \sigma_\theta^2(\boldsymbol{x}_t, t)\,\boldsymbol{\delta}$ ▷ Diffusion sampling

  $\boldsymbol{x}_{t-1} \leftarrow \boldsymbol{v}_t - \rho \nabla_{\boldsymbol{x}_t} \|\boldsymbol{y} - \mathcal{T}(\hat{\boldsymbol{x}}_0)\|_2^2$ ▷ Gradient correction

end for

Return: $\boldsymbol{x}_0$

References

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