Blending-NeRF: Text-Driven Localized Editing in Neural Radiance Fields

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Goal

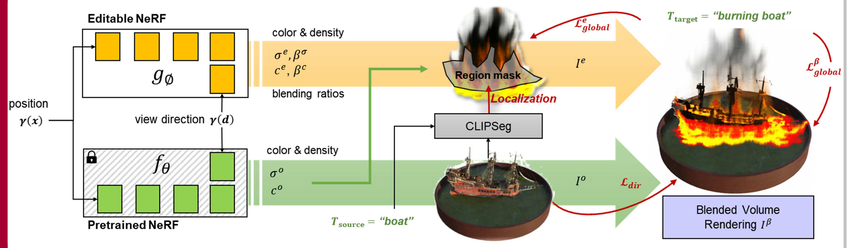
➢ What can we do with Blending-NeRF?

Three types of editing operations

Color change(●) Density addition(●) Density removal(●)

Method

Editing the specific regions of the 3D scene



Capturing the original 3D model information

➢ Editable NeRF

$$\sigma^e, \mathbf{c}^e, \beta^\sigma, \beta^c = g_\phi(\gamma(\mathbf{x}), \gamma(\mathbf{d}))$$

$$\sigma^{o'} = (1-\beta^\sigma)\sigma^o$$

$$\mathbf{c}^{o'} = (1-\beta^c)\mathbf{c}^o + \beta^c\mathbf{c}^e$$

Original Image I^o Editable Image I^e Blended Image I^β

Each blending ratio determines how much the original 3D information is not used.

➢ Blending Operations

<colors>

$$\hat{\mathbf{C}}^o(\mathbf{r}) = \sum_{k=1}^{K} T_k^o\,\alpha_k^o\mathbf{c}_k^o$$

$$\hat{\mathbf{C}}^e(\mathbf{r}) = \sum_{k=1}^{K} T_k^\beta\,(\alpha_k^{o'}\beta_k^c + \alpha_k^e)\mathbf{c}_k^e$$

$$\hat{\mathbf{C}}^\beta(\mathbf{r}) = \sum_{k=1}^{K} T_k^\beta\,(\alpha_k^{o'}\mathbf{c}_k^{o'} + \alpha_k^e\mathbf{c}_k^e)$$

<accumulated opacities>

$$\hat{E}_{\text{acc}}^{\text{add}}(\mathbf{r}) = \sum_{k=1}^{K} T_k^\beta\,\alpha_k^e$$

$$\hat{E}_{\text{acc}}^{\text{remove}}(\mathbf{r}) = \sum_{k=1}^{K} (T_k^{o'} - T_k^o)\,\alpha_k^o \Big/ \sum_{k=1}^{K}\alpha_k^o$$

$$\hat{E}_{\text{acc}}^{\text{change}}(\mathbf{r}) = \sum_{k=1}^{K} T_k^\beta\,\alpha_k^{o'}\beta_k^c$$

$$T_k^* = \prod_{k'=1}^{k-1}(1-\alpha_{k'}^*) \qquad \alpha_k^* = 1-\exp(-\sigma_k^*\delta_k) \qquad \sigma_k^\beta = \sigma_k^{o'} + \sigma_k^e$$

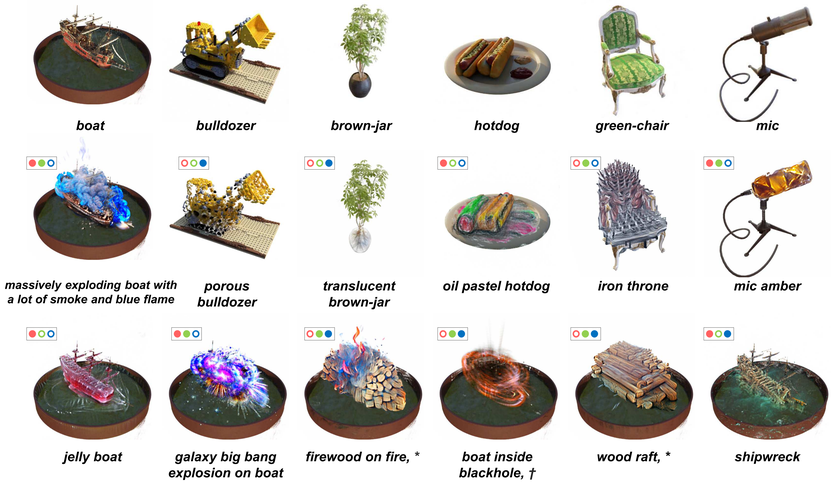
$$* = \{o,\ o',\ e,\ \beta\}$$

➢ Loss

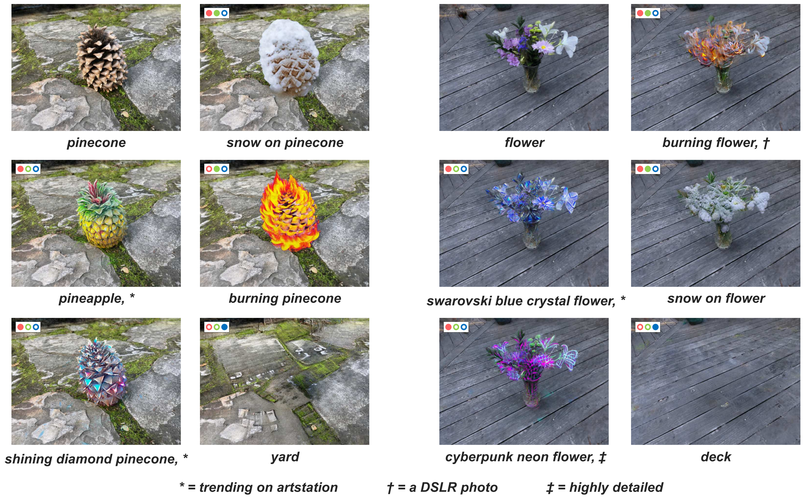
$$\mathcal{L}_{\text{total}} = \mathcal{L}_{\text{clip}} + \lambda_1\mathcal{L}_{\text{region}} + \lambda_2\mathcal{L}_{\text{opacity}} + \lambda_3\mathcal{L}_{\text{reg}}$$

Experiments

➢ Editing on Synthetic Objects



➢ Editing on Real-World Scenes



* = trending on artstation † = a DSLR photo ‡ = highly detailed

➢ Editing Operations

pinecone → burning pinecone, a DSLR photo

Conclusions

- Propose Blending-NeRF that combines a pretrained NeRF with an editable NeRF.
- Introduce blending operations that capture the degree of density addition, density removal, and color change.
  → precisely targeting the specific regions for localized editing.
  → constraining the degree of object editing.

You can watch videos on this project page