SDEDIT: GUIDED IMAGE SYNTHESIS AND EDITING WITH STOCHASTIC DIFFERENTIAL EQUATIONS

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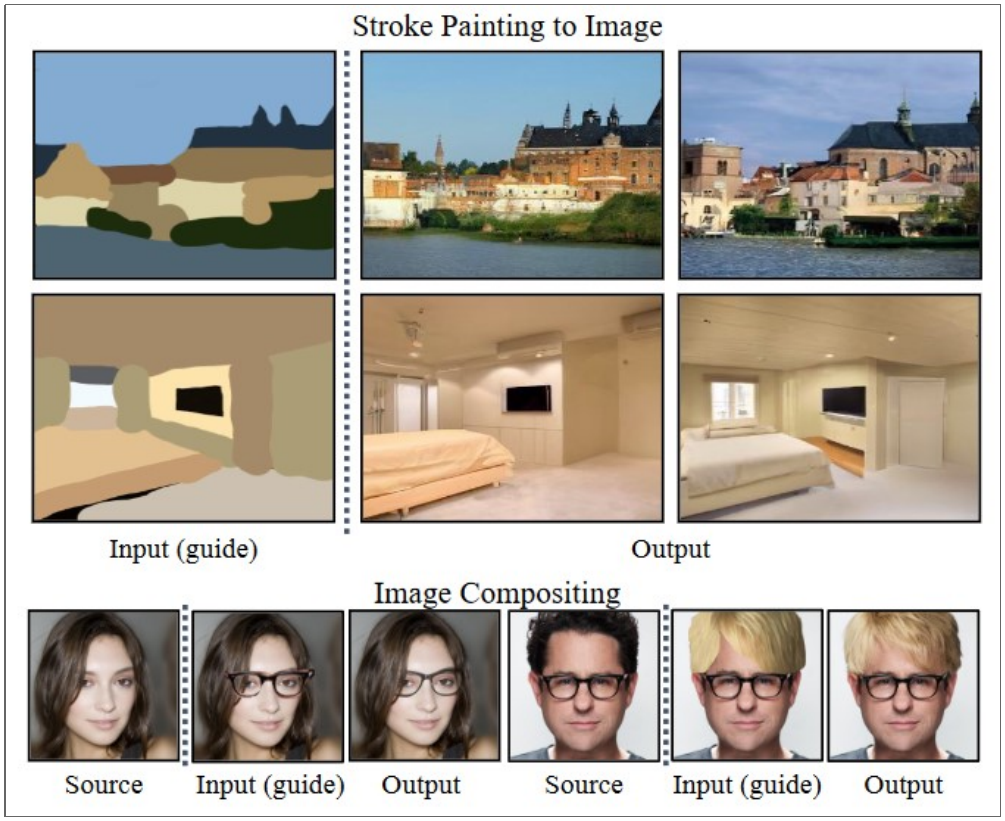
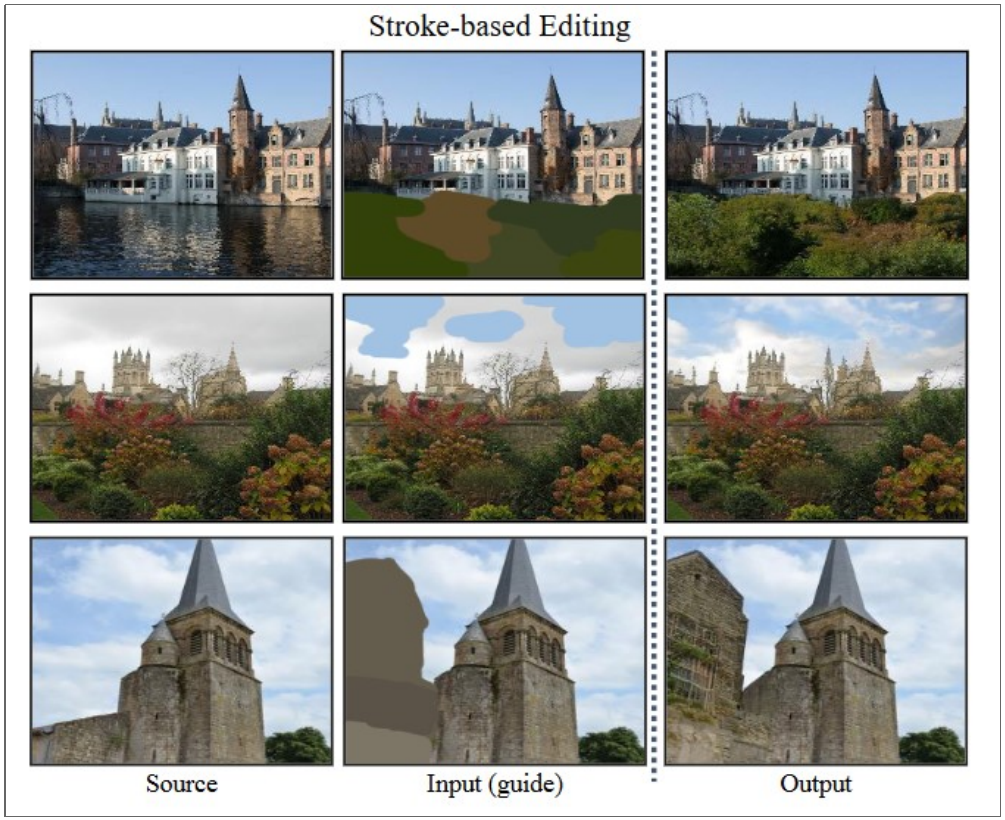
Examples of what we are doing



sdedit1png.png

More examples



sdedit2.png

The Technique

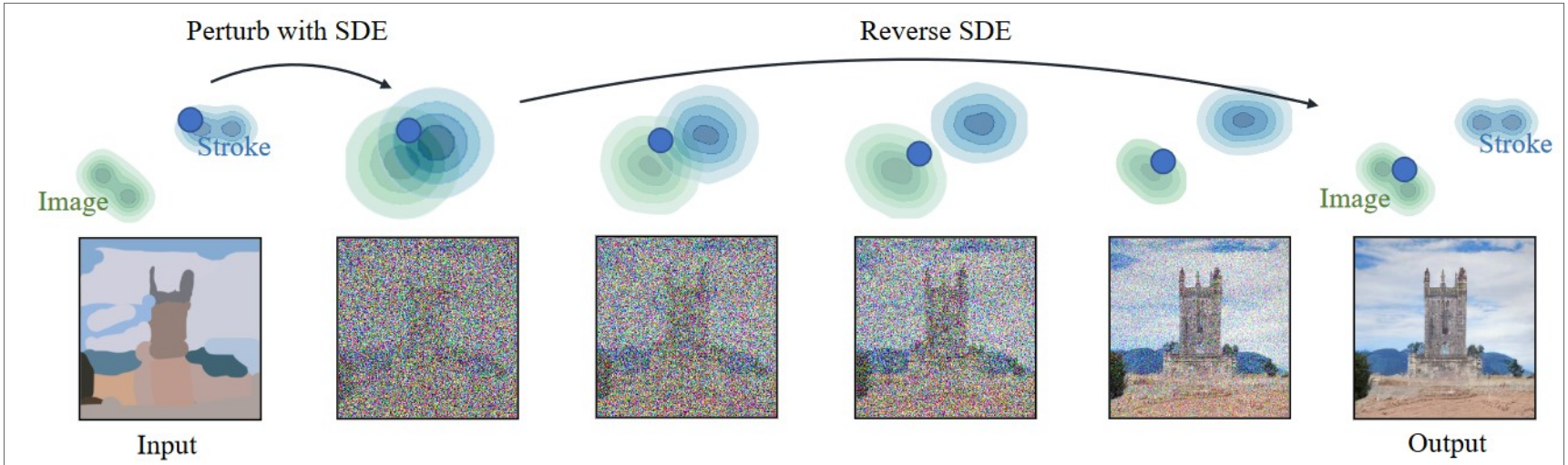
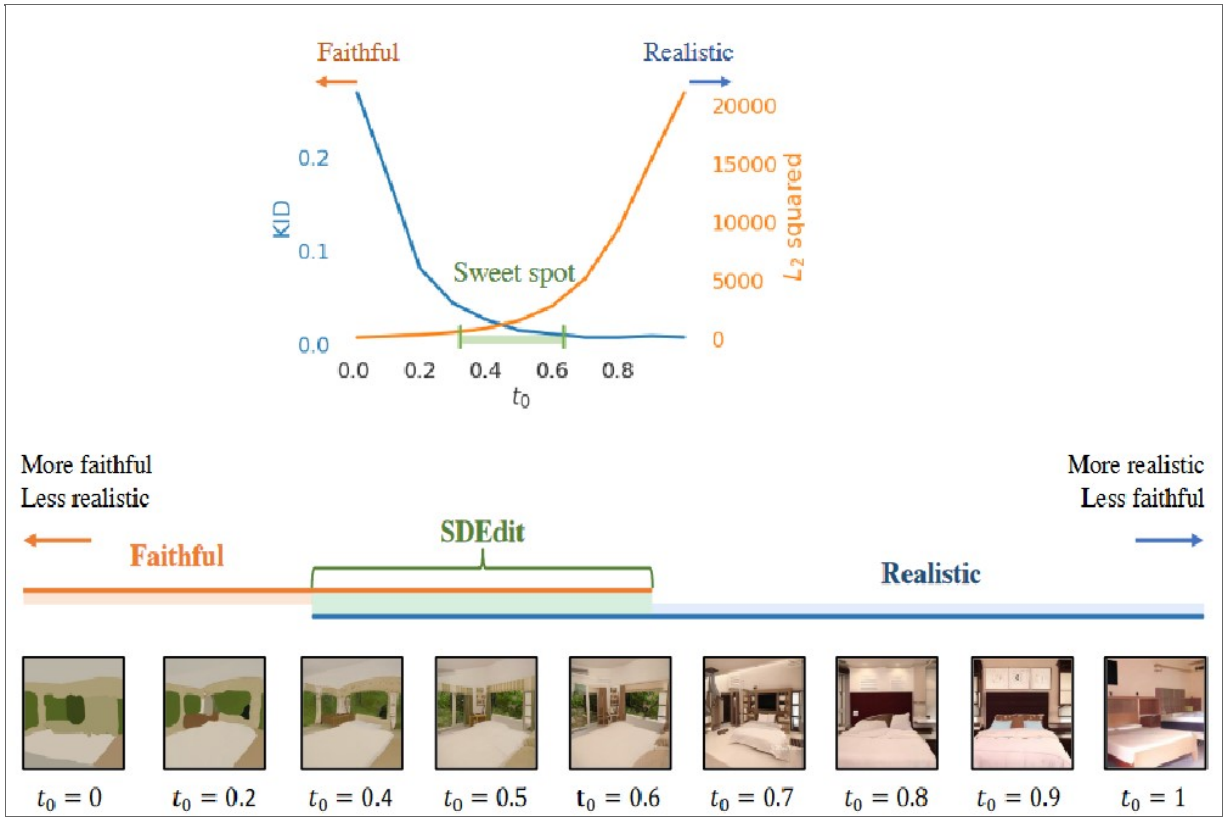


Figure 2: Synthesizing images from strokes with SDEdit. The blue dots illustrate the editing process of our method. The green and blue contour plots represent the distributions of images and stroke paintings, respectively. Given a stroke painting, we first perturb it with Gaussian noise and progressively remove the noise by simulating the reverse SDE. This process gradually projects an unrealistic stroke painting to the manifold of natural images.

image.png

Realism vs. Faithfulness



sdeditrealvsfaith.png

Depends on noise

Proposition 1. *Assume that* $\|s_\theta(\mathbf{x}, t)\|_2^2 \leq C$ *for all* $\mathbf{x} \in \mathcal{X}$ *and* $t \in [0, 1]$. *Then for all* $\delta \in (0, 1$ *with probability at least* $(1 - \delta)$,

$$\left\|\mathbf{x}^{(g)} - \text{SDEdit}(\mathbf{x}^{(g)}; t_0, \theta)\right\|_2^2 \leq \sigma^2(t_0)(C\sigma^2(t_0) + d + 2\sqrt{-d \cdot \log \delta} - 2\log \delta) \quad (5$$

where d *is the number of dimensions of* $\mathbf{x}^{(g)}$.

We provide the proof in Appendix A.

sdedit_prop.png

Pay special attention to $\sigma^2(t_0)$, the while rightside increases as this value increases. The right side comes from the gaussian noise, and the noise related to our score function that we use during sampling. All of these increase as $\sigma^2(t_0)$ increases. $\sigma^2(t_0)$ increasesthe closer t_0 is to T and is minimized at 0.

Proof in Appendix A.

Algorithm

Algorithm 1 Guided image synthesis and editing with SDEdit (VE-SDE)

Require: $\mathbf{x}^{(g)}$ (guide), t_0 (SDE hyper-parameter), N (total denoising steps)

$\Delta t \leftarrow \frac{t_0}{N}$
$\mathbf{z} \sim \mathcal{N}(\mathbf{0}, \boldsymbol{I})$
$\mathbf{x} \leftarrow \mathbf{x} + \sigma(t_0)\mathbf{z}$
for $n \leftarrow N$ **to** 1 **do**
  $t \leftarrow t_0 \frac{n}{N}$
  $\mathbf{z} \sim \mathcal{N}(\mathbf{0}, \boldsymbol{I})$
  $\epsilon \leftarrow \sqrt{\sigma^2(t) - \sigma^2(t - \Delta t)}$
  $\mathbf{x} \leftarrow \mathbf{x} + \epsilon^2 \boldsymbol{s_\theta}(\mathbf{x}, t) + \epsilon \mathbf{z}$
end for
Return $\mathbf{x}$

sdedit_algorithm.png

- ϵ is a distance
- Δt is our step, t_0 is chosen
- $t \leftarrow t_0 \frac{N}{N}$ and $t \leftarrow t_0 \frac{1}{N} = \Delta t$

Any questions?

- In equation 4 why isnt z's in front of imaginary?

  Equation 4:
  $$x(t) = x(t + \Delta t) + (\sigma^2(t) - \sigma^2(t + \Delta t))s_\theta(x(t), t) + \sqrt{\sigma^2(t) - \sigma^2(t + \Delta t)}z$$

Error ×