Face Aging via Diffusion-Based Editing
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Introduction
- Existing GAN-based methods rely solely on face image datasets. Limited scale and bias of the dataset leads to poor performance on rare cases (extreme age, facial accessories, etc.).
- Recently proposed Diffusion Models exhibit superior generation quality compared to GANs, but no previous work on extending them to specific image-editing tasks.

Method (1/2): Specialization stage
Repurpose the pre-trained text-to-image diffusion model for face-aging task
- For every face image \( x \) with estimated age \( \alpha \), perform fine-tuning with text-image pair \( \{ x, \text{"photo of a } [\alpha] \text{ year old person"} \} \)
- Double-prompt scheme: add another age-agnostic prompt "photo of a person". Better disentanglement of age information from age-irrelevant features

Training loss:
\[
L_{DM} = \mathbb{E}_{\alpha \sim \mathcal{L}(\alpha, \alpha', \alpha'')} \left[ \| \epsilon - c_0(\alpha, t, \mathcal{P}) \|^2_2 + \| \epsilon' - c_0(\alpha', t, \mathcal{P}) \|^2_2 \right]
\]

Method (2/2): Age editing stage
Image Inversion
- Invert input image with its estimated age to initial noise and optimized null-text embedding

Cross attention control
- Cross attention maps contain rich semantic relations between spatial layout and age information in text prompt
- Replace estimated age with target age to guide the new diffusion process while swapping attention maps

Experiments and results
- First work to extend large-scale diffusion models for face aging.
- Successfully leverage attention mechanism for age manipulation and disentanglement
- Qualitatively and quantitatively demonstrate the superiority over state-of-the-art methods in terms of aging accuracy, attribute preservation, aging quality and generalization.
- Code available at https://github.com/MunchkinChen/FADING

Conclusion
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