High Resolution Face Age Editing

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https://github.com/InterDigitalInc/HRFAE
Motivation: Face retouching in film post-production

- Goal: Photo-realistic results on high resolution images

- Challenges:
  - Small artifacts easy to be perceived by human eyes
  - Consistent & continuous face age manipulation

- Solution:
  - Age Progression/Regression by Conditional Adversarial Autoencoder, Zhang et al., 2017
  - Face Aging with Identity-Preserved Conditional Generative Adversarial Networks, Wang et al., 2018
  - Learning face age progression: A pyramid architecture of gans, Yang et al., 2019

De-aging in film post-production – Martin Scorsese’s “The Irishman”
Our results

- **Input**: image in yellow frame
- **Output**: image of the same person at any required target age in the range \( \{20, \ldots, 69\} \) at resolution 1024x1024.
Age Transformer Network

\[ \mathcal{L}_{\text{recon}} = \mathbb{E}_{x_0 \sim p(x)}[\|G(x_0, \alpha_0) - x_0\|_1] \]

\[ \mathcal{L}_{\text{GAN}}(G) = \mathbb{E}_{x_0 \sim p(x)} \mathbb{E}_{\alpha_1 \sim q(\alpha|\alpha_0)} \left[ \left(D(G(x_0, \alpha_0)) - 1 \right)^2 \right] \]

\[ \mathcal{L}_{\text{GAN}}(D) = \mathbb{E}_{x_0 \sim p(x)} \mathbb{E}_{\alpha_1 \sim q(\alpha|\alpha_0)} \left[ \left(D(G(x_0, \alpha_0)) \right)^2 \right] + \mathbb{E}_{y \sim p(x)} \left[ D(y) - 1 \right]^2 \]

\[ \mathcal{L}_{\text{class}} = \mathbb{E}_{x_0 \sim p(x)} \mathbb{E}_{\alpha_1 \sim q(\alpha|\alpha_0)} \left[ \ell_{CE}(\alpha_1, V(G(x_0, \alpha_1))) \right] \]
Contribution

- A simple architecture
  - Use a single network for both aging and de-aging.

- Continuous age transitions
  - Feature modulation layer acts directly on the latent space and allows for continuous age transitions.

- Photorealistic results
  - Achieve artifact-free, sharp and photorealistic results on high-resolution face images.
Qualitative Results

- Age editing results on 1024x1024 images of FFHQ dataset.

- On each row, the yellow frame indicates the original image. Each column corresponds to a target age of 25, 35, 45, 55, 65.
Target age: 25
Target age: 35
Target age: 45
Target age: 55
Target age: 65
Continuous face age editing

✓ Little artifacts on high resolution images
✓ Continuous aging effects
× Fail to generate gray hair for old target age
Comparison

Age editing results on CACD dataset.

IPCGAN: Face Aging with Identity-Preserved Conditional Generative Adversarial Networks, Wang et al., 2018
Comparison

Age editing results on CACD dataset.

PAGGAN: Learning face age progression: A pyramid architecture of gans, Yang et al., 2019
Comparison

- Face aging results on CelebA-HQ dataset.
- Target age: 51-60
- Dataset not viewed at training time.
Conclusion

- Age transformer enabling continuous face age editing with a single network.

- The first to achieve face aging/de-aging task on high resolution images (1024x1024).

- Photorealistic, artifact-free results.

- Given the performance achieved, this design can be potentially useful for other face attribute manipulation tasks.