

Self-Supervised **S**elective-Guided **D**iffusion Model for Old-Photo Face Restoration

Wenjie Li¹, Xiangyi Wang¹, Heng Guo¹, Guangwei Gao², Zhanyu Ma¹

December 2025 @ NeurIPS 2025

Presenter: *Wenjie Li*

Challenges

- ◆ It is difficult to construct paired datasets for training.

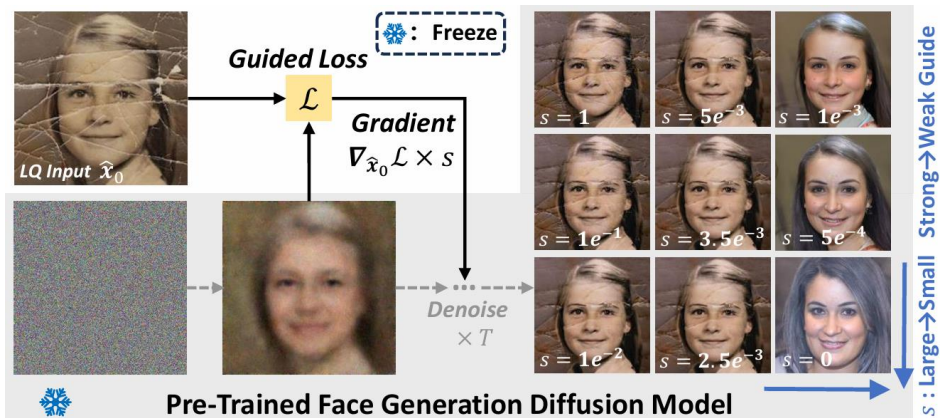


- ◆ Robust restoration of damaged, faded, or blurred images.



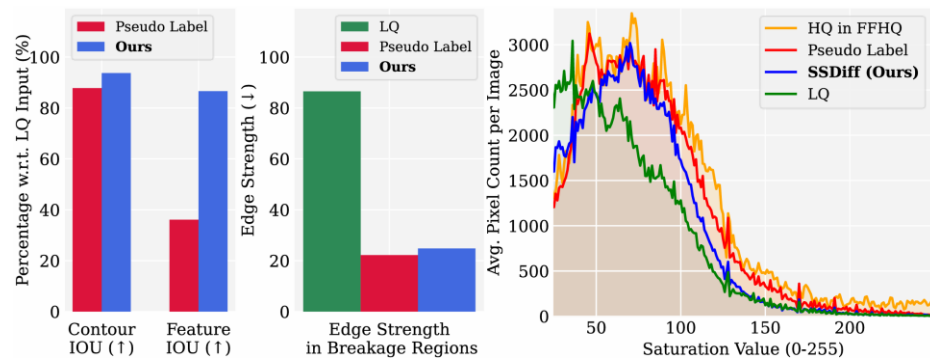
Insight

◆ Pseudo-label inspiration



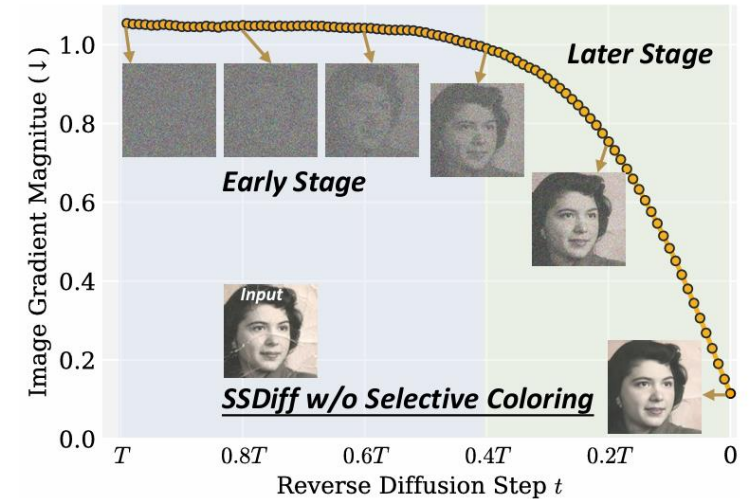
- Different levels of guidance yield facial images of varying quality.

◆ Statistical Analysis



- Statistical analysis show Pseudo-labels are suitable for reference guidance.

◆ Reverse diffusion

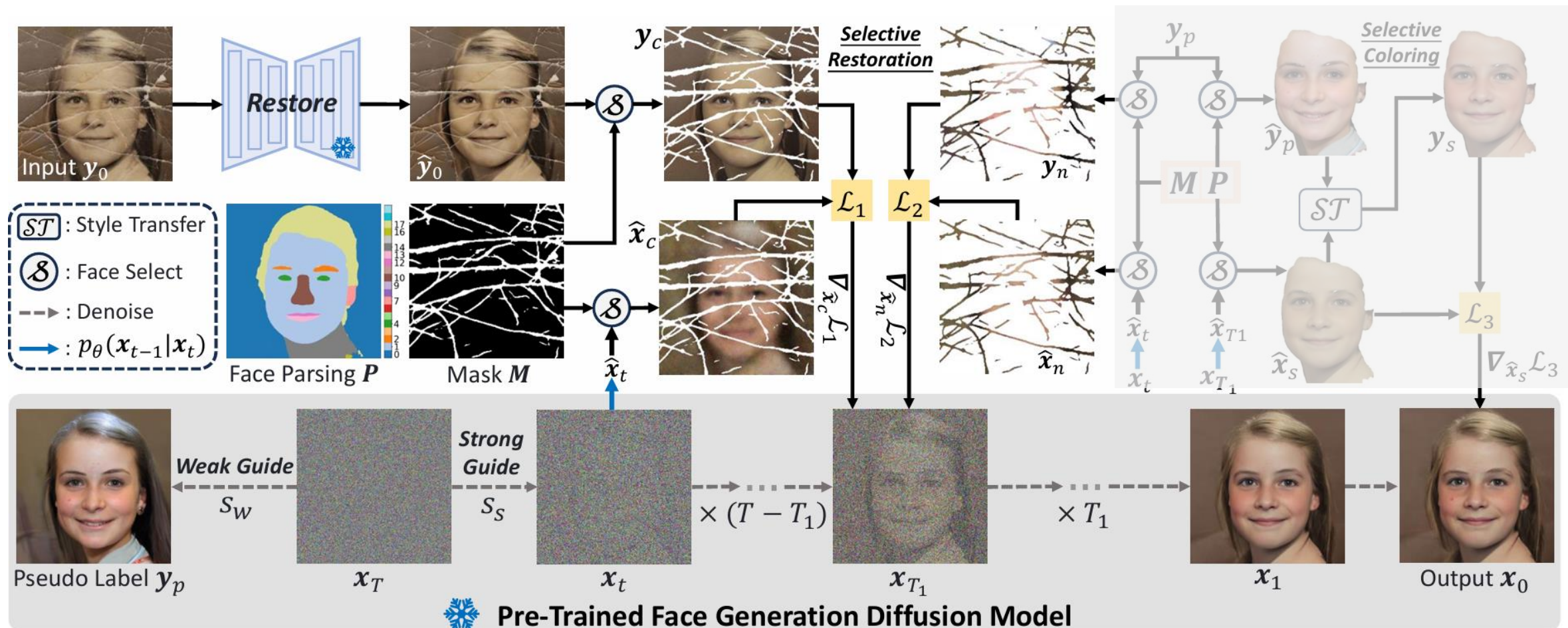


- Structure first, Details second;

◆ Our Design

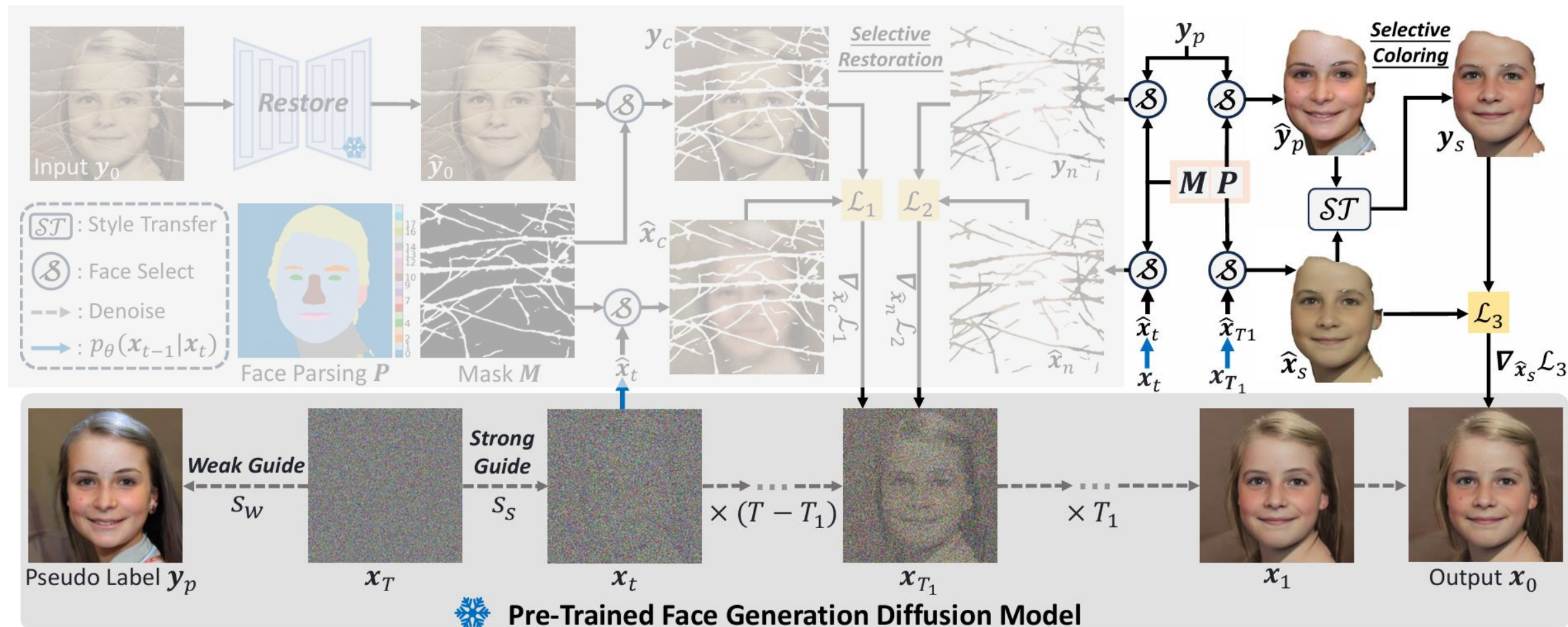
- Constructing the pseudo-labeled facial data for guidance purposes.
- Employing guided diffusion to achieve train-free restoration of old photo faces.

Network Architecture



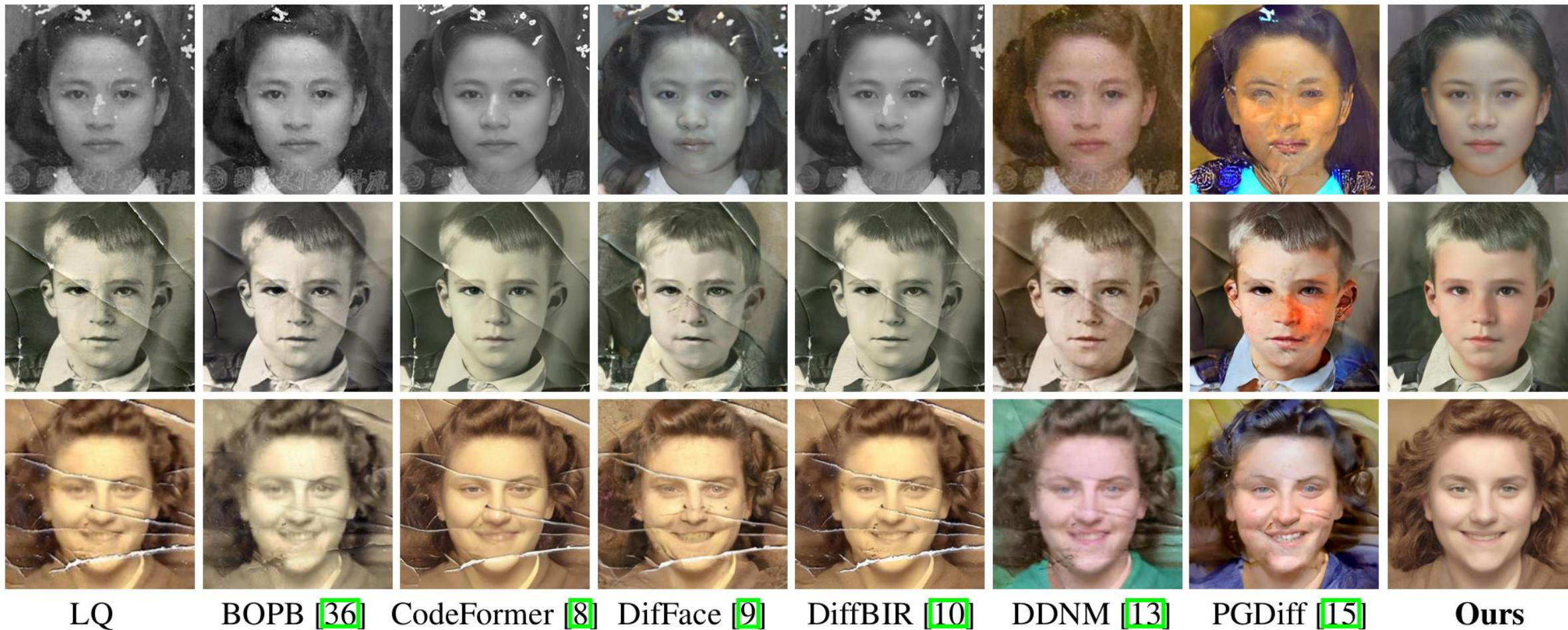
□ **Optimization:** $\mathcal{L} = \arg \min \left(\mathbb{E} \|y_c(s_w^*) - \hat{x}_c(s_s^*)\|_2^2 + \mathbb{E} \|y_n(s_w^*) - \hat{x}_n(s_s^*)\|_2^2 + \mathbb{E} \|y_s(s_w^*) - \hat{x}_s(s_s^*)\|_2^2 \right)$

Network Architecture



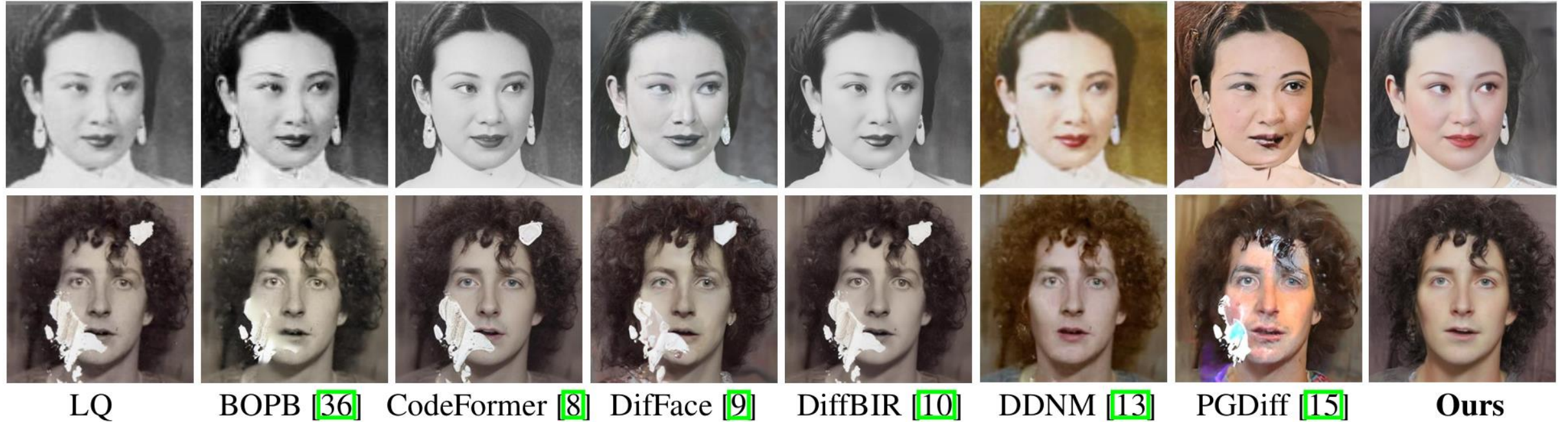
□ **Optimization:** $\mathcal{L} = \arg \min \left(\mathbb{E} \|y_c(s_w^*) - \hat{x}_c(s_s^*)\|_2^2 + \mathbb{E} \|y_n(s_w^*) - \hat{x}_n(s_s^*)\|_2^2 + \mathbb{E} \|y_s(s_w^*) - \hat{x}_s(s_s^*)\|_2^2 \right)$

Results



- *Our SSDiff significantly outperforms existing methods.*

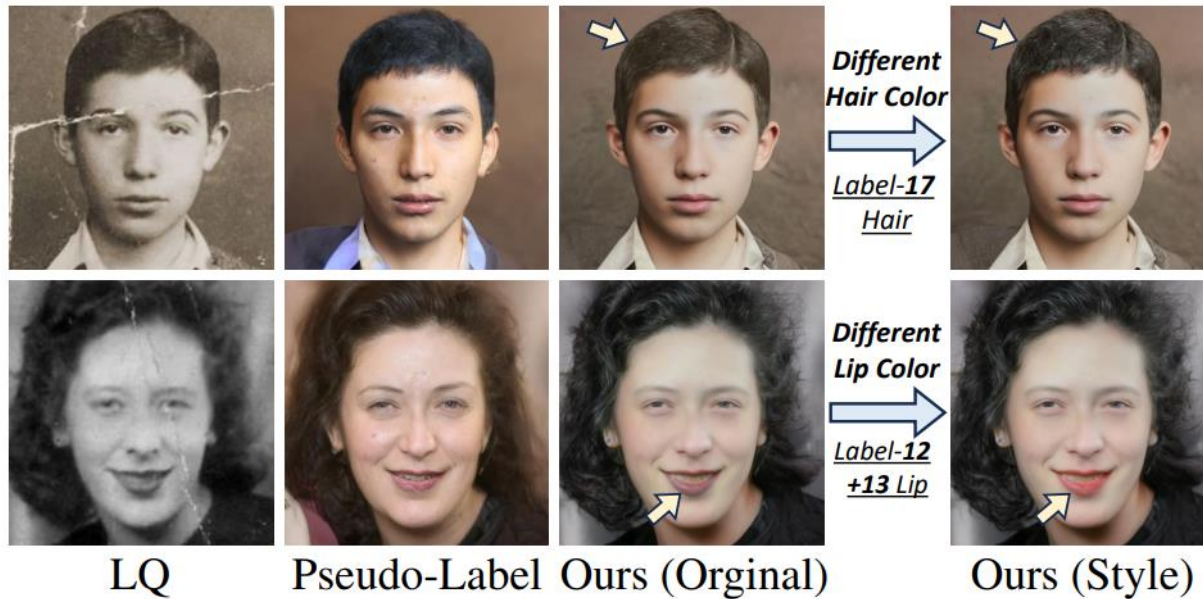
Results



- *When the input contains no breakage areas or significant breakages, our SSDiff also significantly outperforms existing methods.*

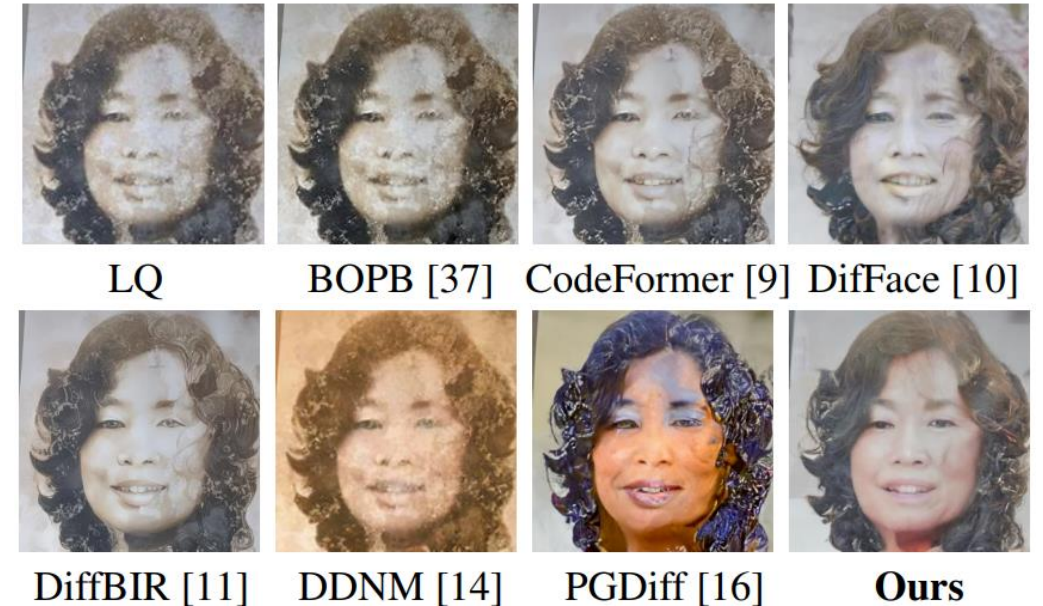
Results

□ Region-Specific Stylized Restoration



- *SSDiff allows stylized restoration of facial components specified by reference to pseudo-labels on inputs.*

□ Limitations



- *When large stains appear, it may lead to unnatural artifacts and distorted details.*

1



北京邮电大学

Beijing University of Posts and Telecommunications

2



南京理工大学

NANJING UNIVERSITY OF SCIENCE & TECHNOLOGY



Thank You !



Paper



Code



Homepage