

Restoration of Hand-Drawn Architectural Drawings using Latent Space Mapping with Degradation Generator

WED-PM-173

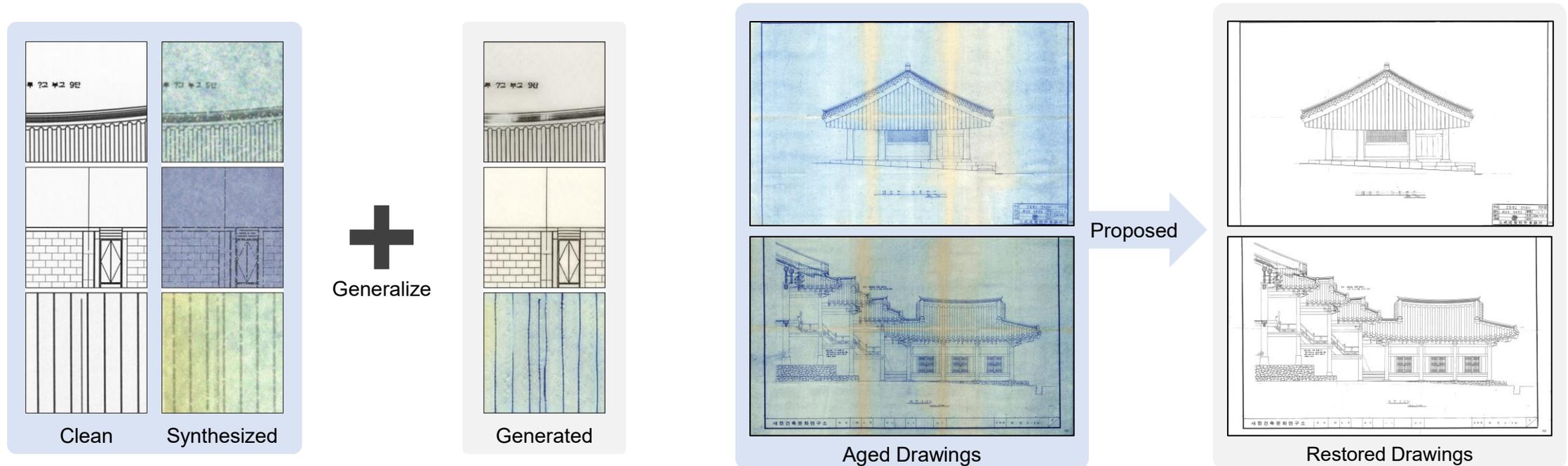
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Quick Preview

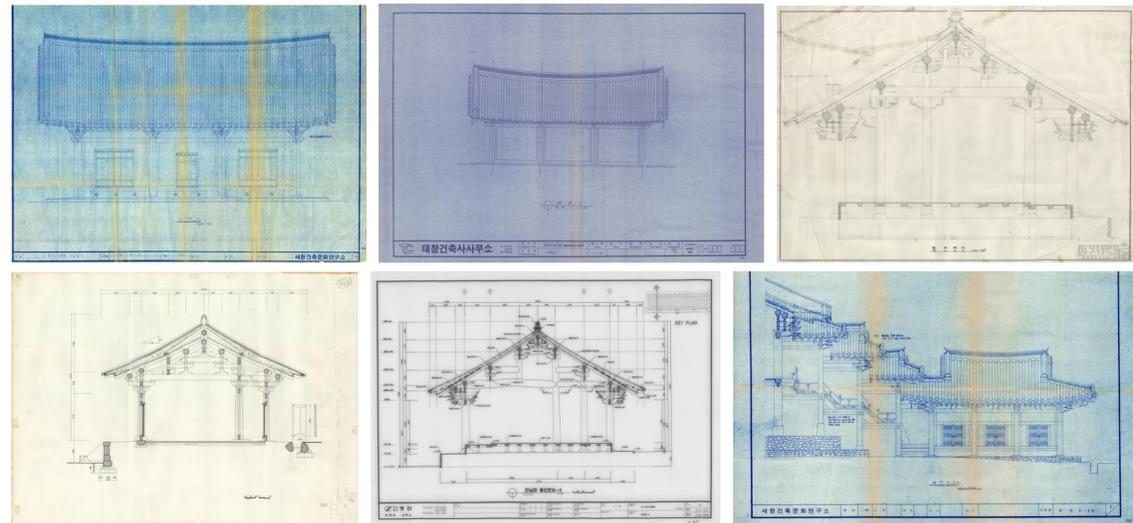
- We present restoration method of architectural drawings
 - Using unpaired clean-aged drawings and noisy drawings degraded by synthesis
 - We generate realistic aged drawings for generalizing synthesis domain to aged domain
 - Proposed method is based on VQGAN and is a 2-stage model.
- The proposed method reports meaningful gain in quantitative and qualitative results



Introduction

Motivation

- Drawings are essential for the systematic management of traditional buildings.
- The initial drawings of the building before the deformation occurs contain valuable information.
- In the initial drawing, information loss has occurred due to deterioration
 - Faded and deteriorated lines
 - Smearred and blurred complex parts
 - Background in faded color

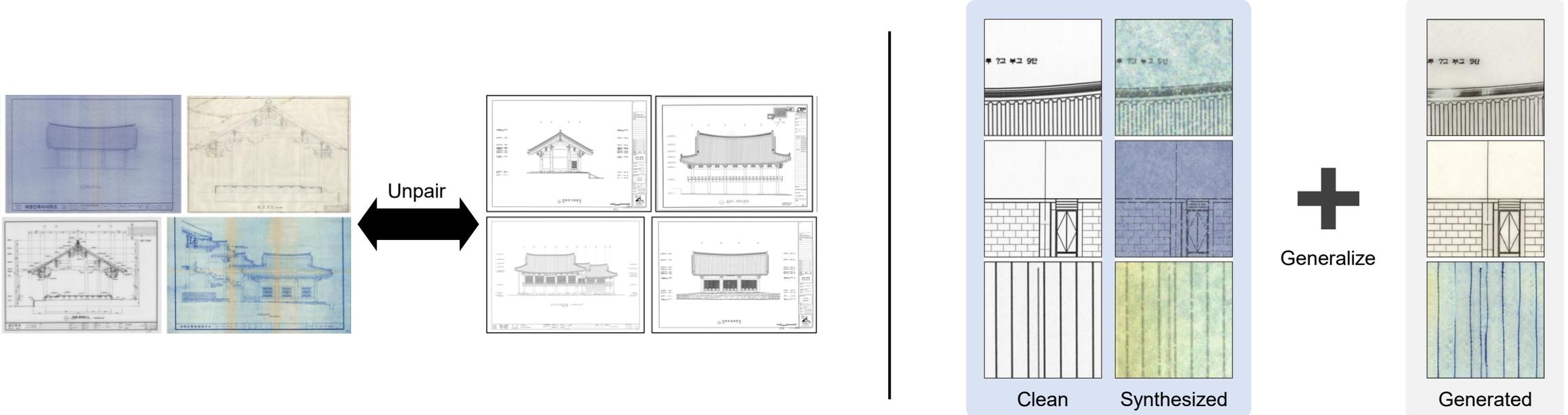


Aged Drawings

Introduction

Motivation

- The archived clean and aged drawings are unpaired.
- As prior approach [1], we construct paired datasets by synthesizing noise into clean drawings.
- This synthesized dataset showed performance degradation for aged drawings.
- Proposal generate realistic aged drawings with augmented drawings to restore aged drawings

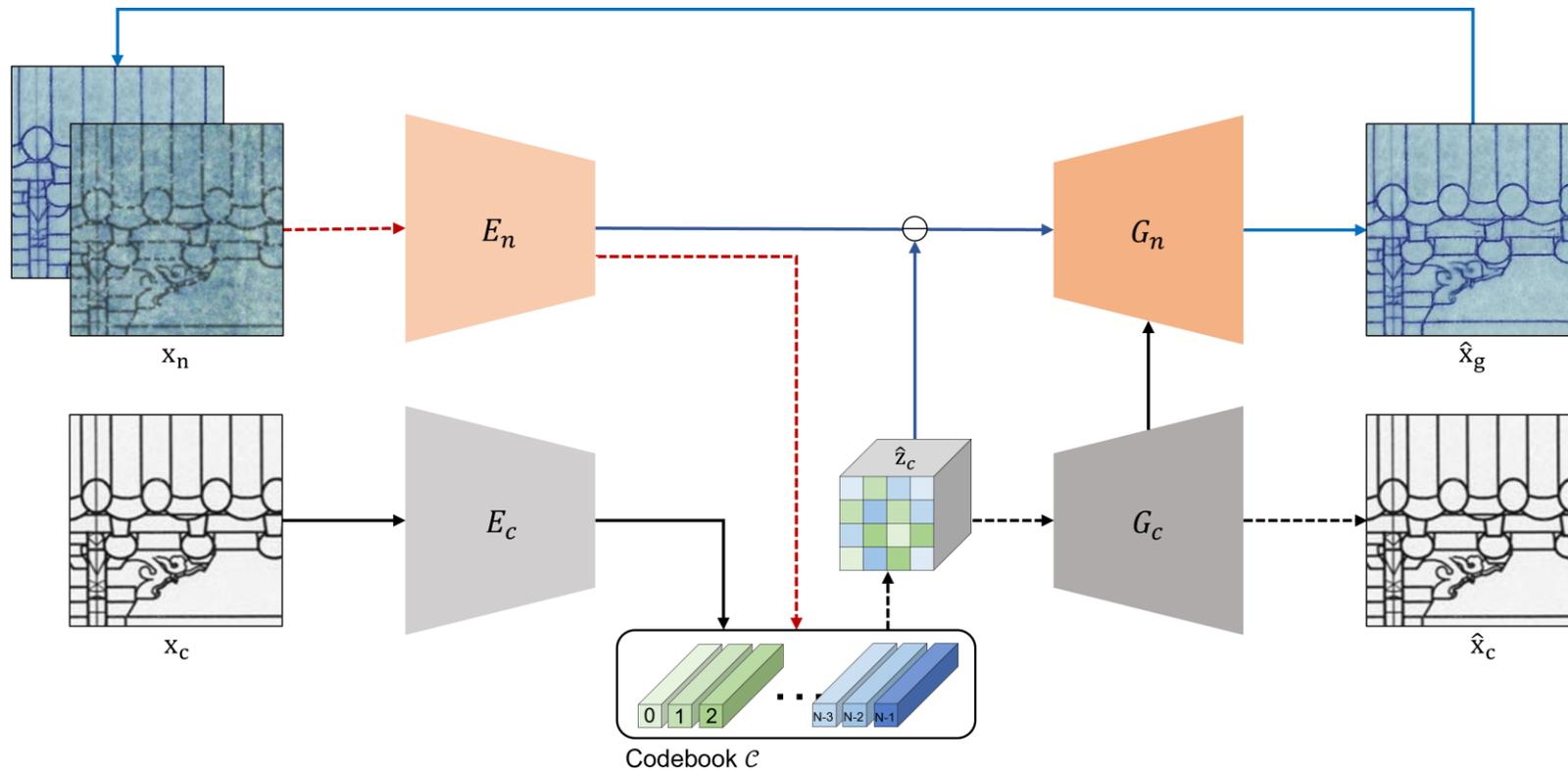


[1] Sasaki, K., Iizuka, S., Simo-Serra, E., & Ishikawa, H. (2018). Learning to restore deteriorated line drawing. *The Visual Computer*, 34(6), 1077-1085.

Proposed Method

Overview

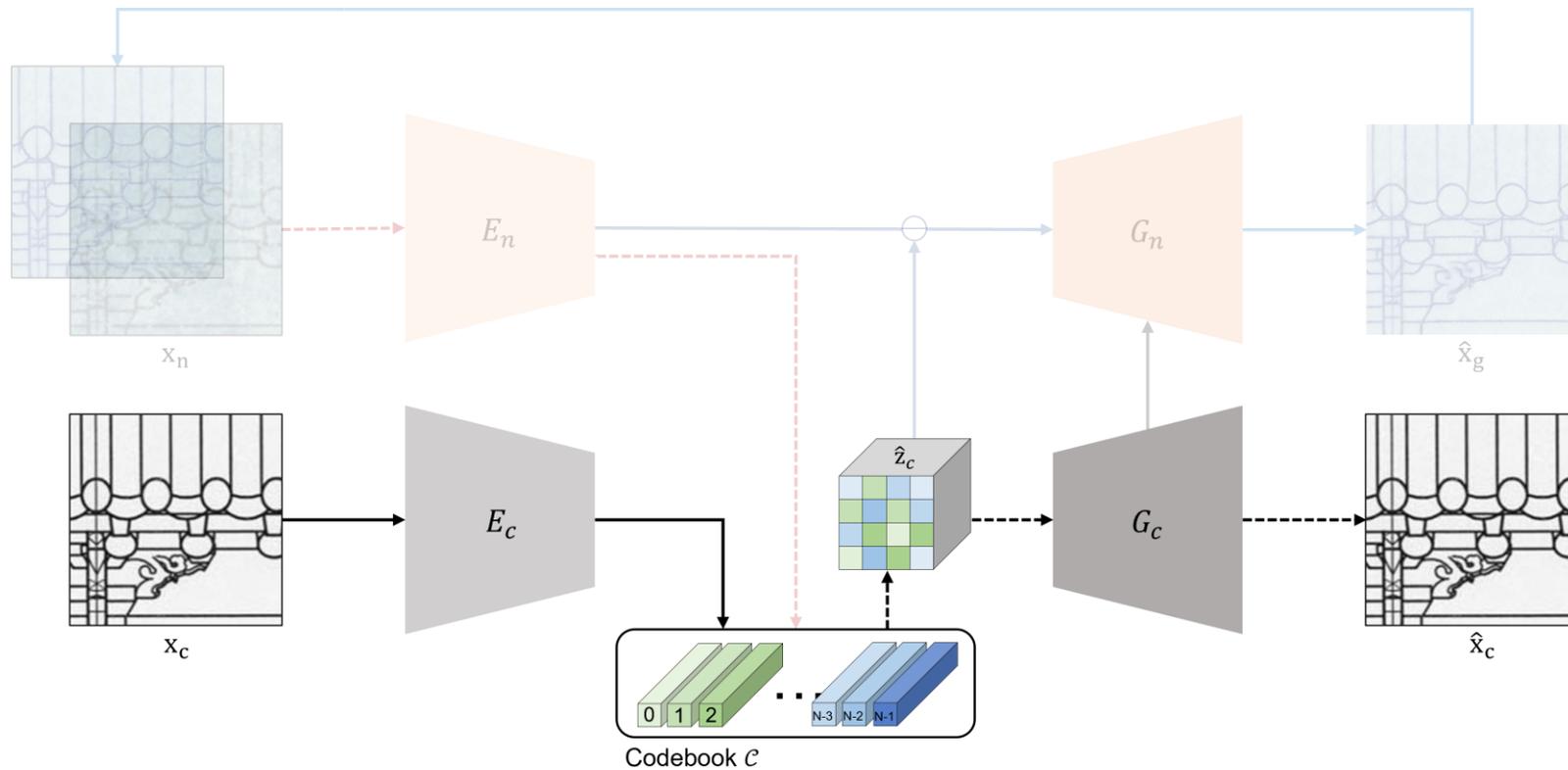
- The proposed method performs restoration based on VQGAN and consists of two stages.



Proposed Method

Stage 1

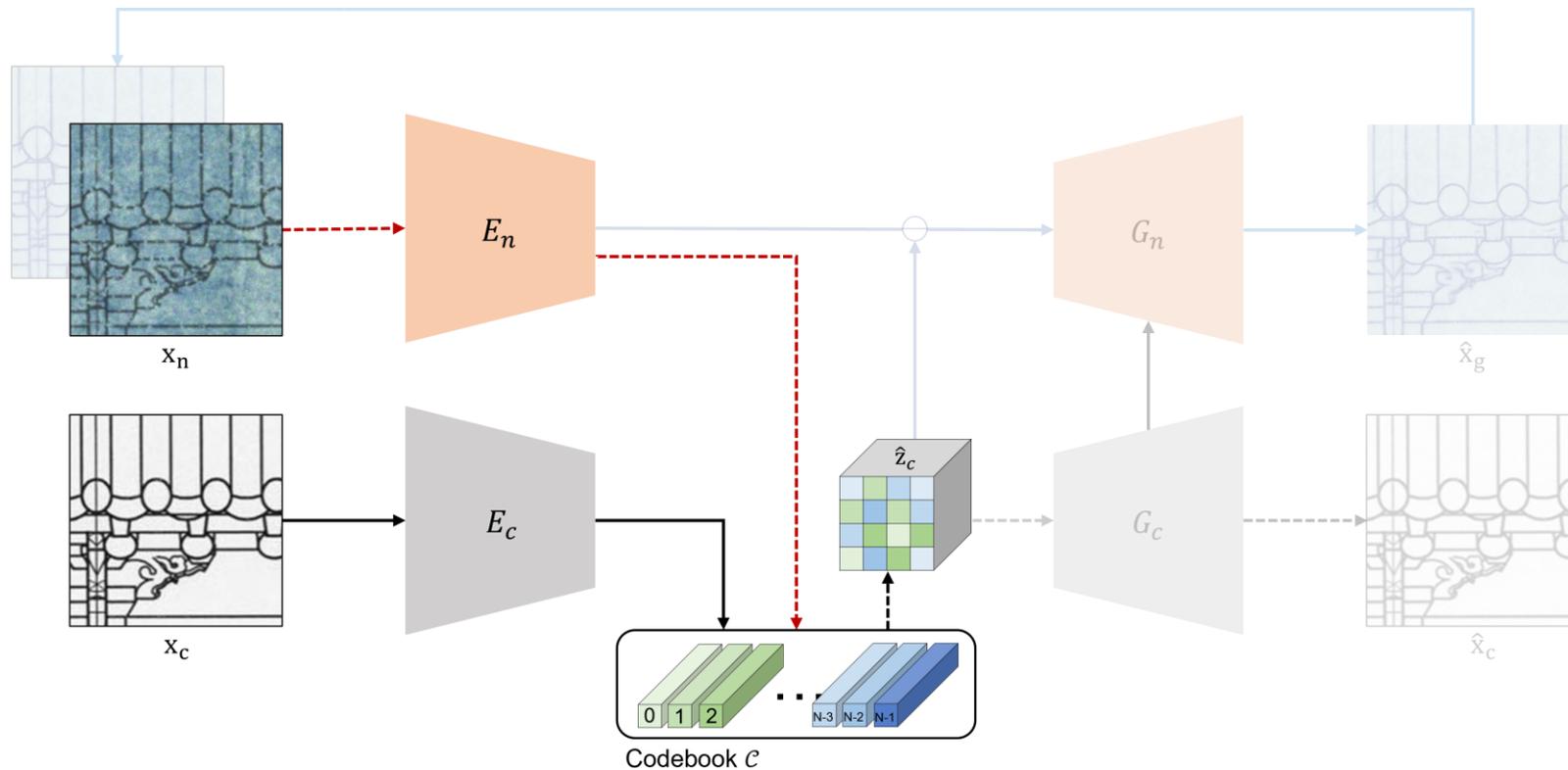
- Learning VQGAN for pre-training on clean drawing
- Codebook \mathcal{C} learn discrete latent variables for clean drawings.



Proposed Method

Stage 2: Mapping

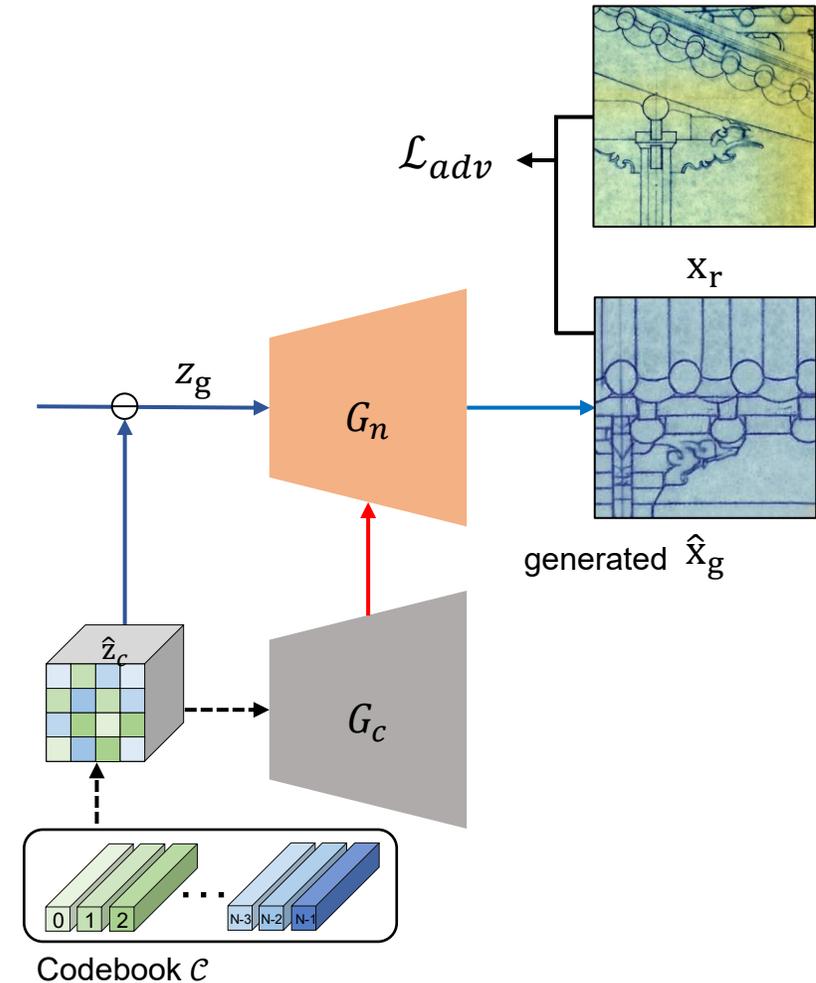
- Pre-trained parts in the first stage is frozen in the second stage.
- Mapping latent variables of encoded noisy drawings to encoded clean drawings



Proposed Method

Stage 2: Degradation Generator (DG)

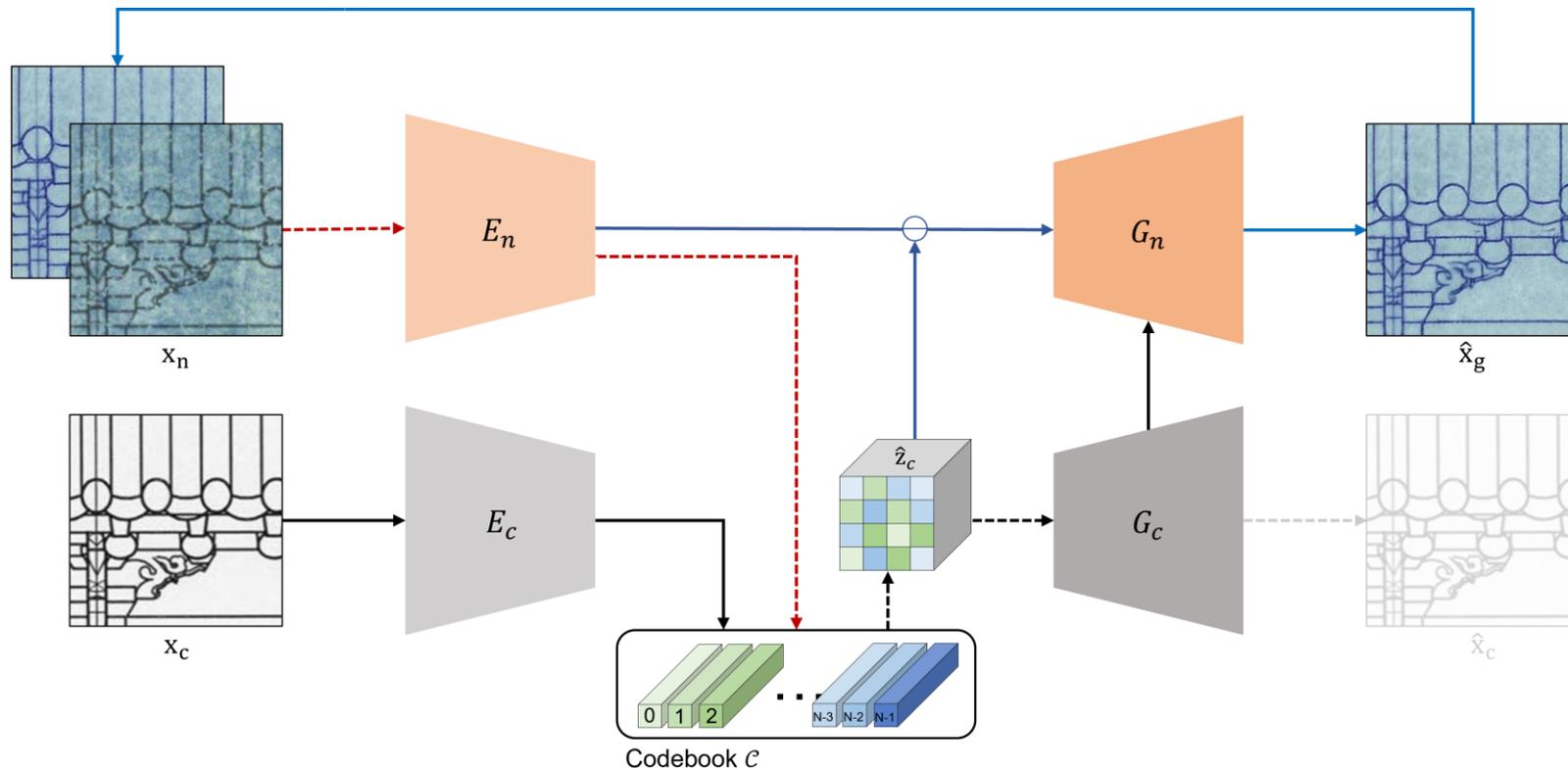
- Producing augmented version of noisy drawings from clean drawings
- Feeding intermediate activation of the G_c to G_n in order to keep up the drawings
- Concatenating activation and using deformable convolution for drawing degradation
- Generator G_n is trained adversarially on aged drawings x_r



Proposed Method

Stage 2

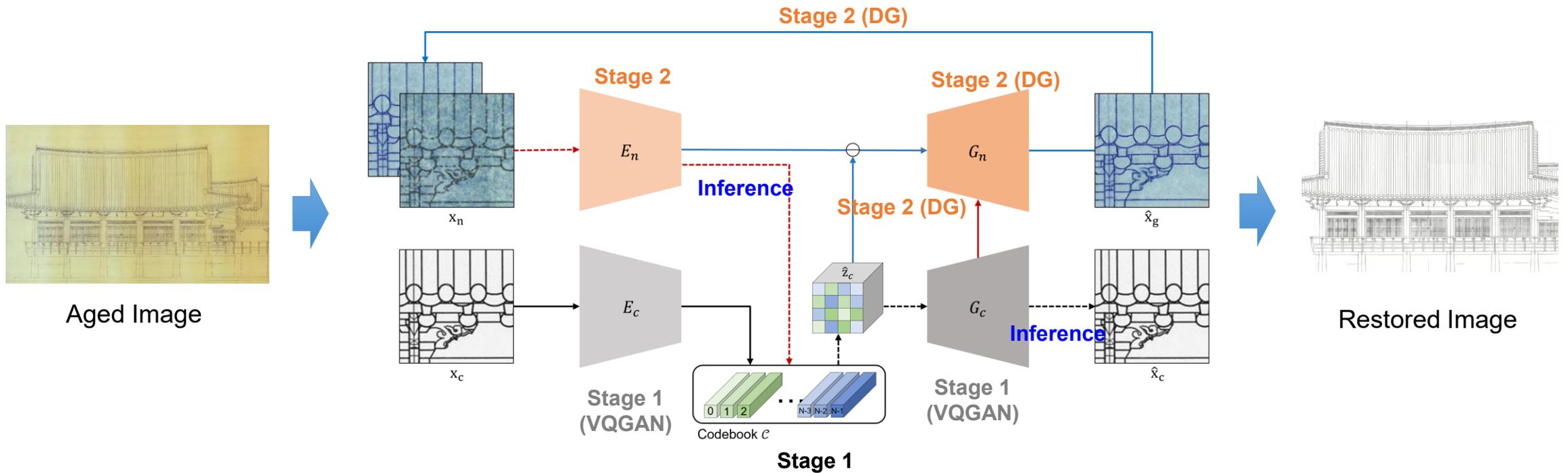
- Degraded drawing \hat{x}_g is used as augmented noisy drawing for mitigating generalize gap



Proposed Method

Inference

- We operate the model patch by patch, and restoration is performed through E_n , code, G_c .



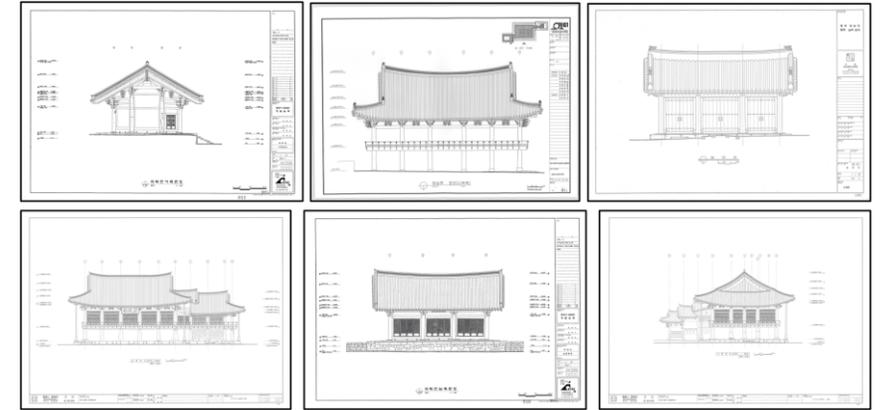
Experiments

Dataset

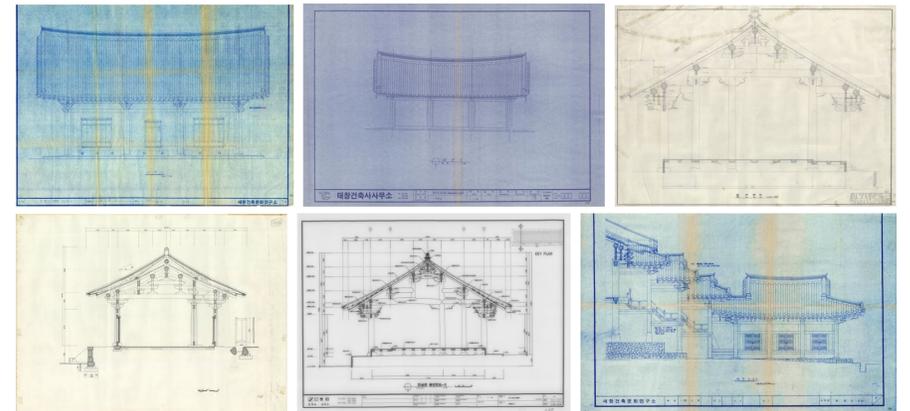
- Traditional wooden buildings drawings from Cultural Heritage Administration website¹
 - Drawings contain frontal elevations, side elevations and details
 - Drawn by 10 studios between the 1970s and 2000s.
 - National heritages: 12, Heritages: 43
 - Clean drawings: 330, Aged drawings: 350
- We randomly crop the drawings with 256x256 resolutions for training

Setup

- We consider two configurations.
- In the following notation, HVQ and RVQ stand for Hierarchical-VQ [2] and Residual-VQ [3], respectively.



Clean Drawings



Aged Drawings

¹<http://english.cha.go.kr/cha/idx/SubIndex.do?mn=EN>

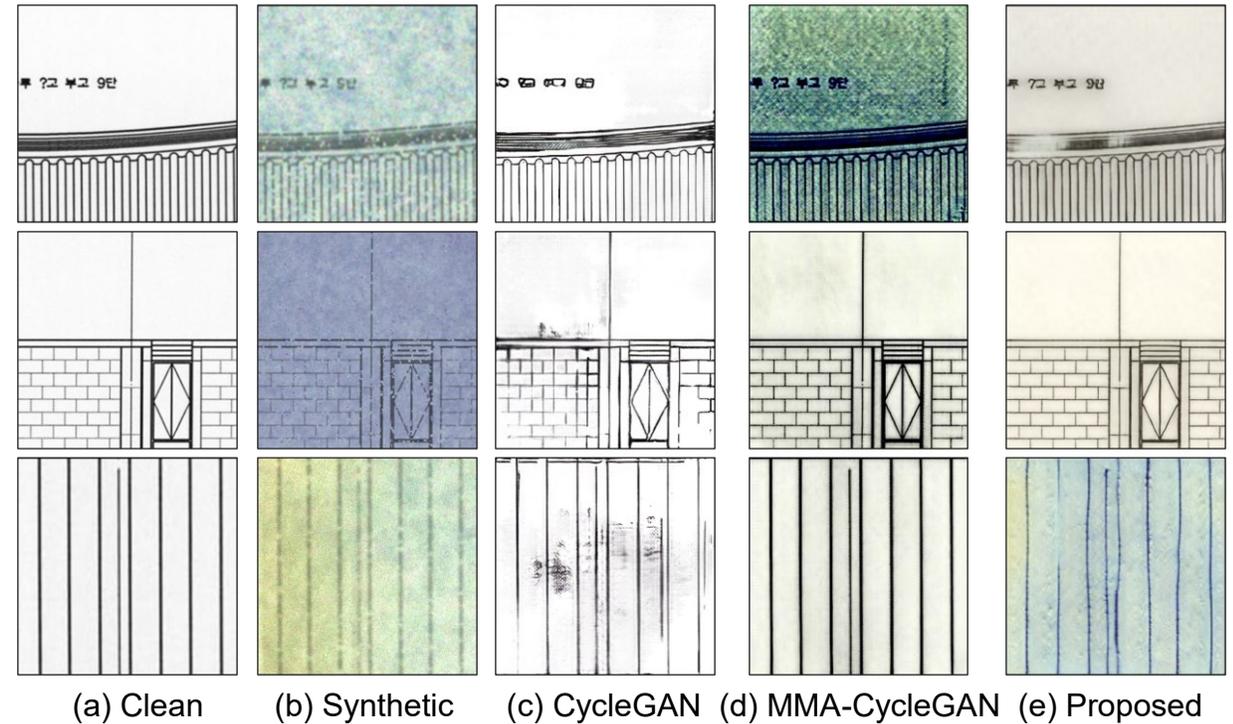
[2] Ali Razavi, Aaron van den Oord, and Oriol Vinyals. Generating diverse high-fidelity images with vq-vae-2, NeurIPS, 2019

[3] Doyup Lee, Chiheon Kim, Saehoon Kim, Minsu Cho, and Wook-Shin Han. Autoregressive image generation using residual quantization. CVPR, 2022.

Experiments

Generating degraded drawings

	KID↓	FID↓
CycleGAN [25]	0.035 ± 0.001	59.979 ± 0.08
MMA-CycleGAN [9]	0.033 ± 0.001	54.862 ± 0.15
Proposed (HVQ-DG)	0.015 ± 0.001	29.663 ± 0.05
Proposed (RVQ-DG)	0.023 ± 0.001	41.159 ± 0.06



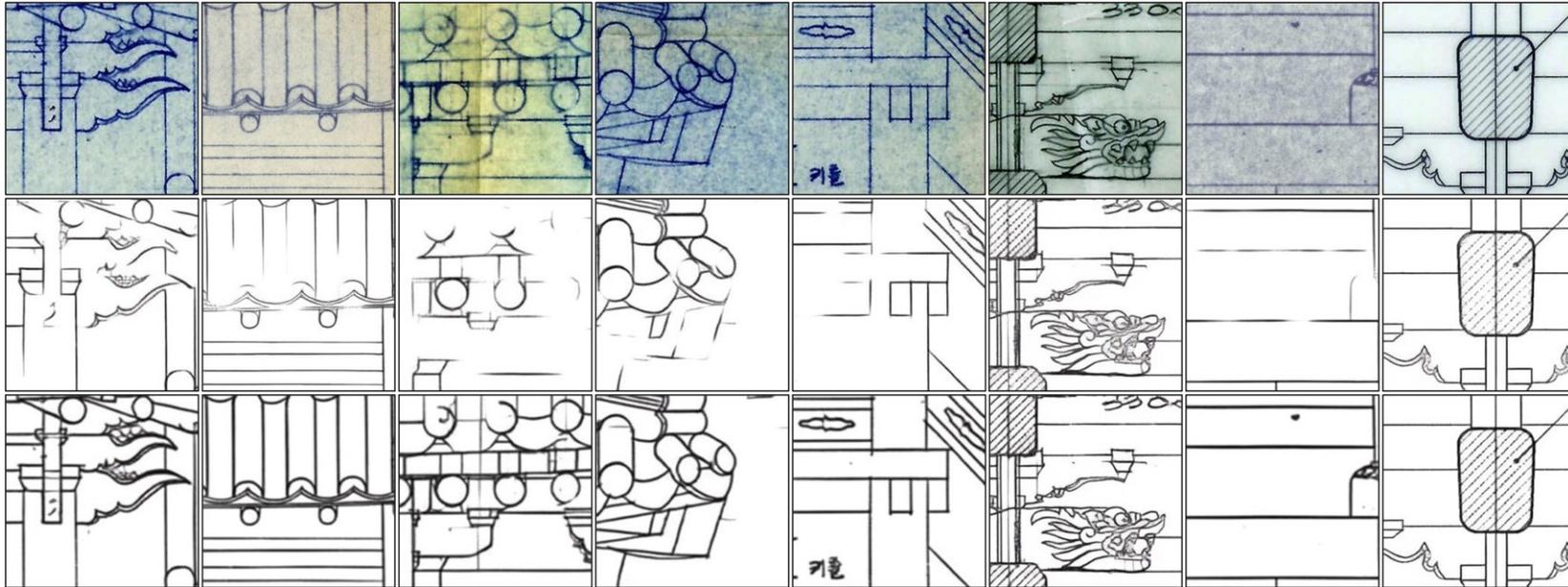
Experiments

Qualitative Results of Restoration

	SSIM↑	PSNR↑	LPIPS↓	FID↓
SASAKI <i>et al.</i> [16]	0.8870	21.32	0.1977	98.677
WAN <i>et al.</i> [19]	0.9548	22.73	0.0632	36.090
YUE <i>et al.</i> [20]	0.9534	23.83	0.0713	42.121
Guo <i>et al.</i> [21]	0.9616	24.78	0.0585	37.025
Proposed (HVQ)	0.9683	25.89	0.0559	36.812
Proposed (RVQ)	0.9613	24.96	0.0531	36.468
Proposed (HVQ-DG)	0.9673	25.82	0.0564	36.590
Proposed (RVQ-DG)	0.9576	24.51	0.0542	33.500

Experiments

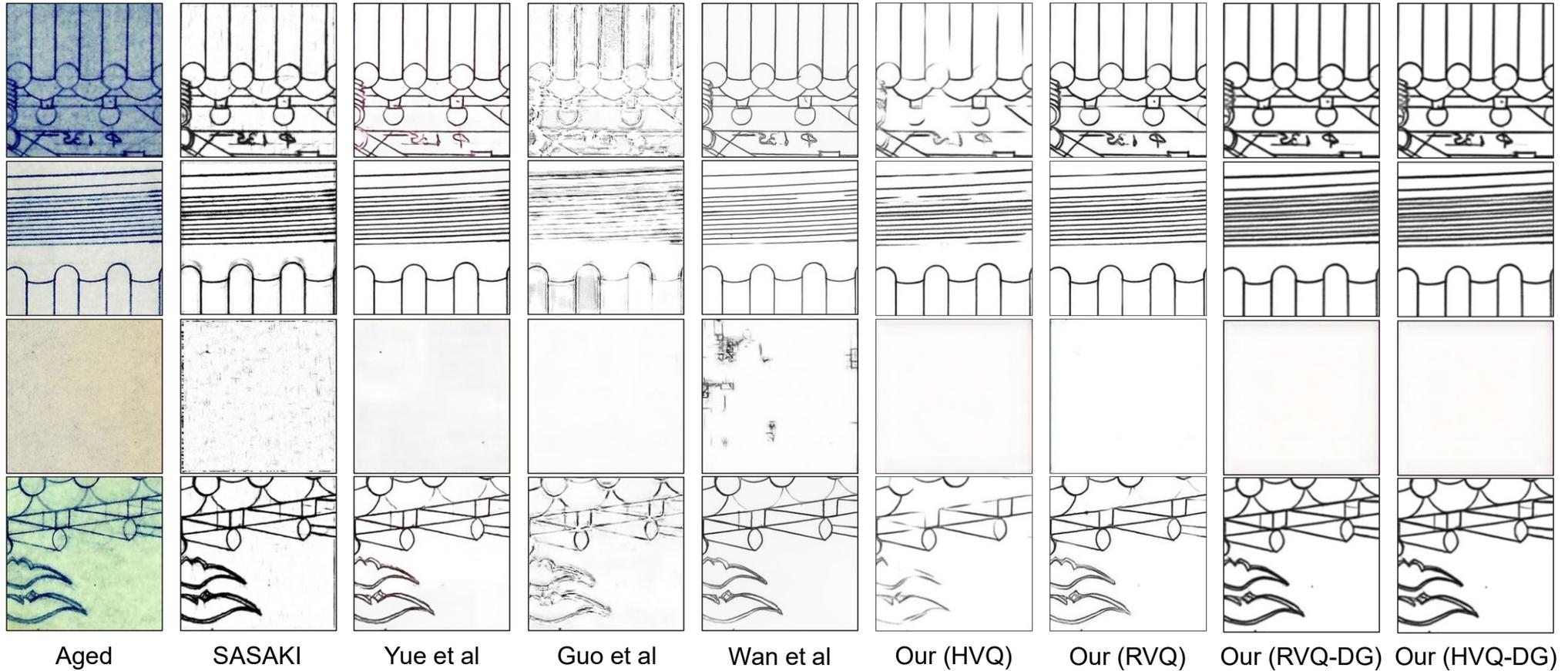
Ablation Study about Degradation Generator



Top: Aged Drawings. Middle: without DG. Bottom: with DG.

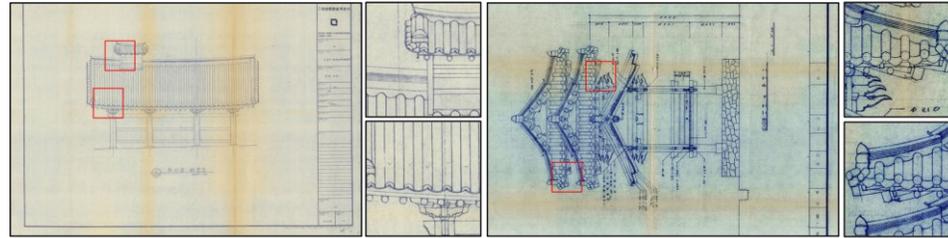
Experiments

Quantitative Results in Aged Drawings

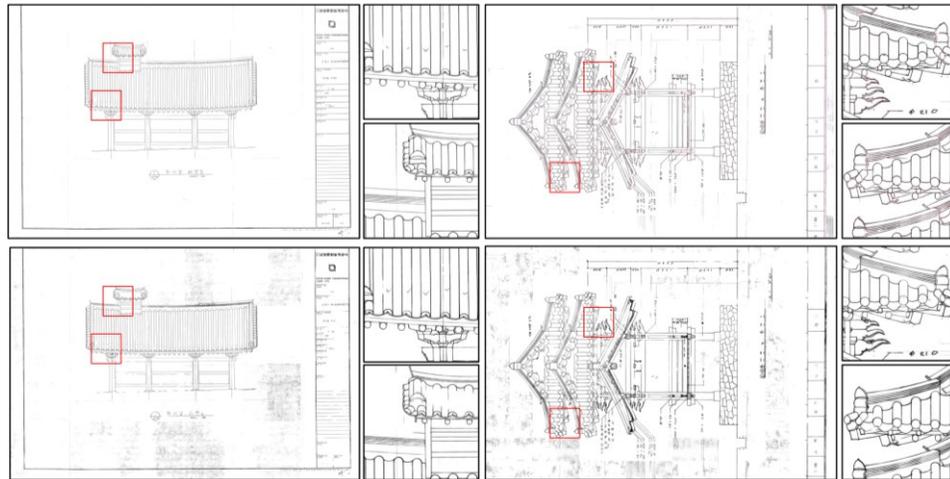


Experiments

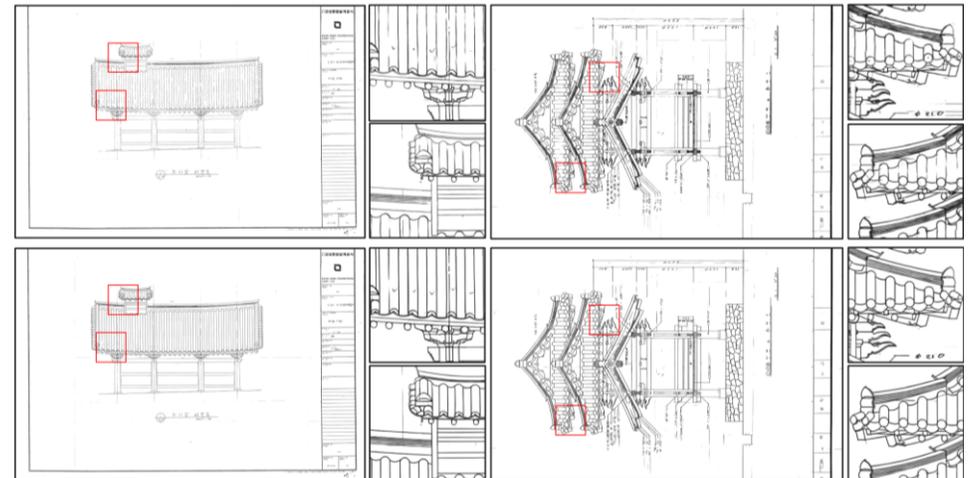
Quantitative Results in Aged Drawings



Aged drawings



Top: Yue et al. Bottom: Wan et al.



Top: proposed (HVQ-DG). Bottom: proposed (RVQ-DG).

Conclusion

- We propose VQGAN-based restoration method for aged architectural drawings
- We propose the degradation generator to generalize the model to aged drawings
- We report a meaningful gain in quantitative and qualitative results