Qualcomm

FlashControl

One-Step Controllable Generator via Distillation-Friendly Single-Branch Teachers

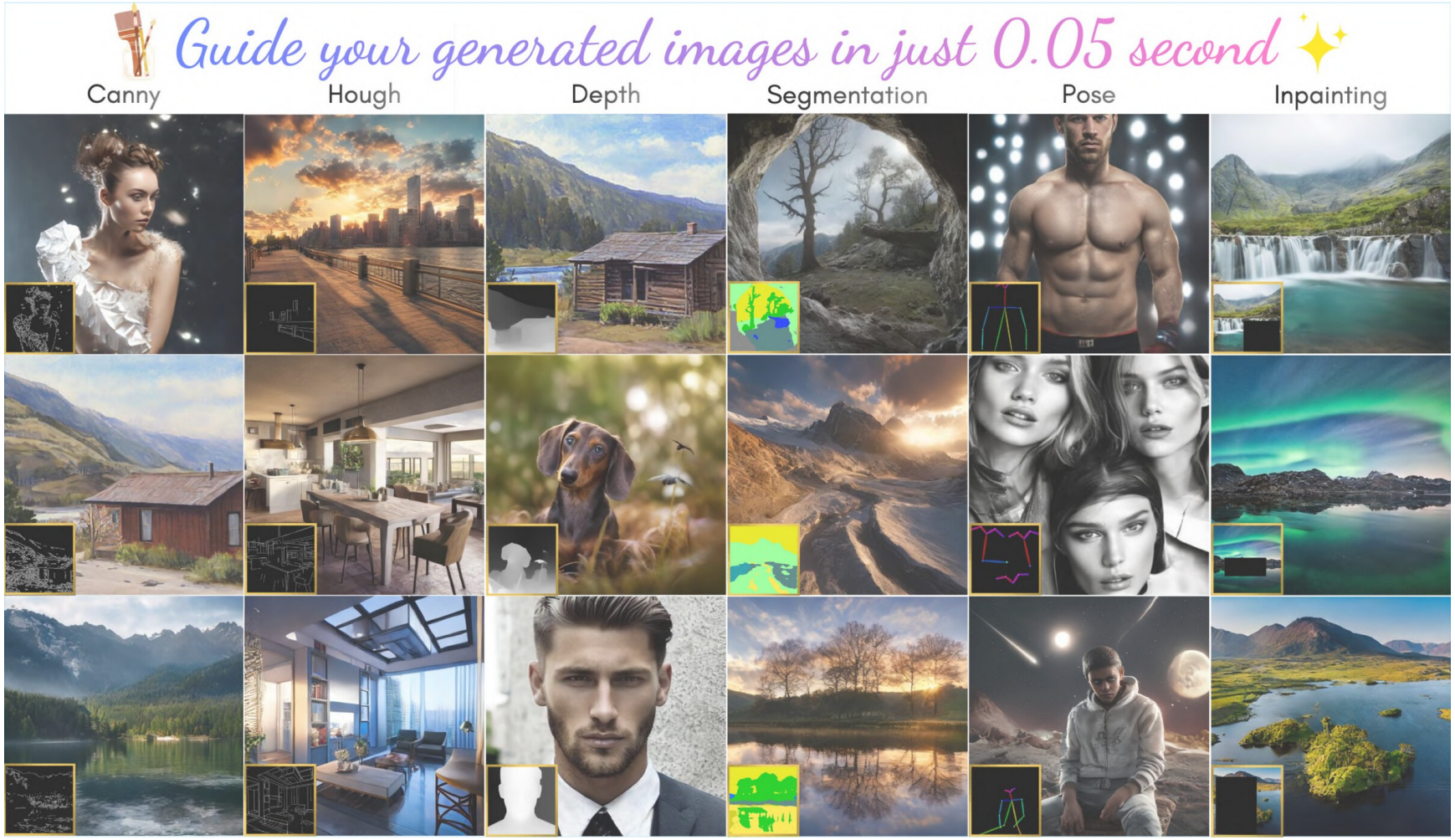
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Goal: controllable generation in one step



One FlashControl model, six control types, one step each.

Time per image

ControlNet · 50 steps

2.17 s

FlashControl · 1 step

0.043 s

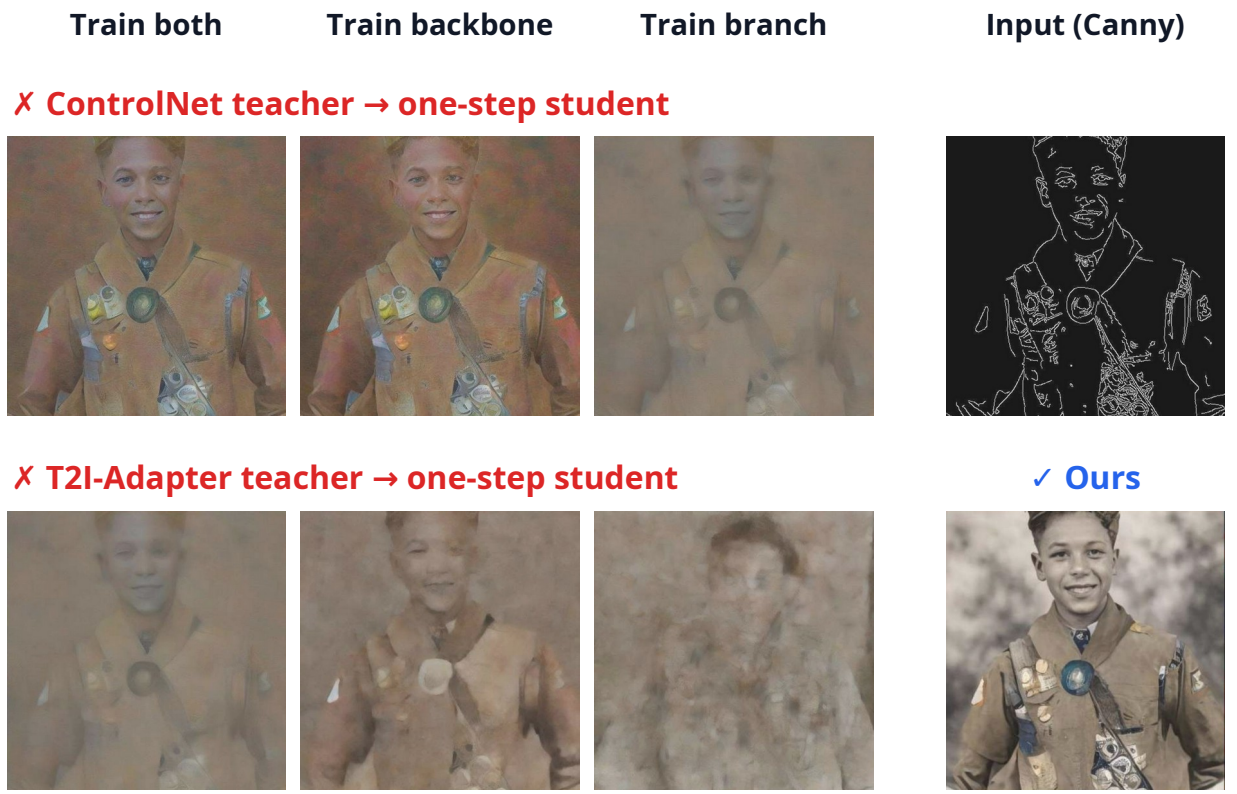
50×

faster inference

512^2 image, A100, bf16

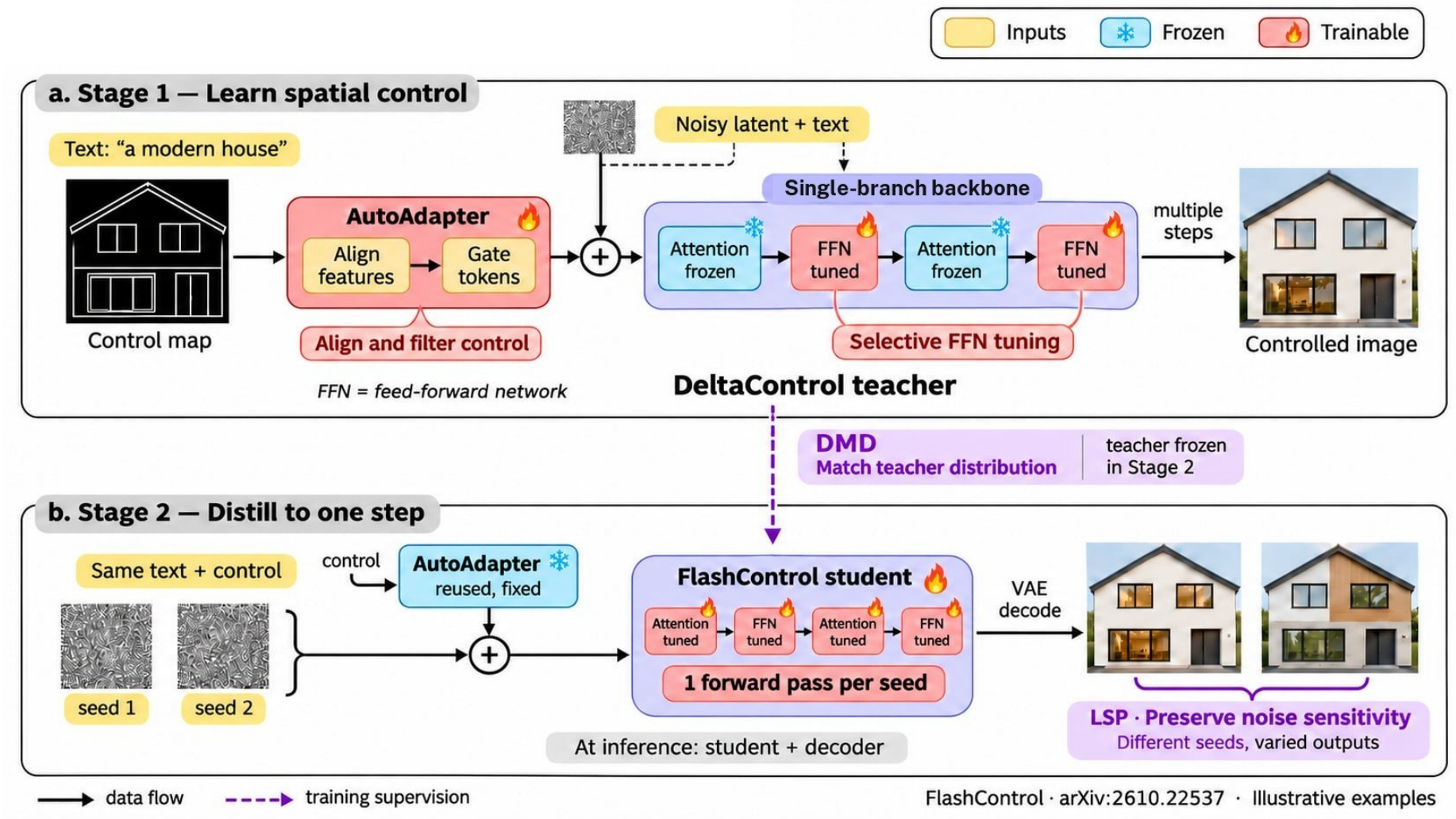
Why does one-step control fail?

- **Standard route:** distill a multi-step controllable model (the teacher) into a one-step student.
- Common control models are **dual-branch**: the base model plus a separate control branch (ControlNet, T2I-Adapter).
- Distilling them **fails**: the students are blurry and ignore the condition, whatever part we train or freeze.
- **Our fix:** put control inside a single-branch teacher.

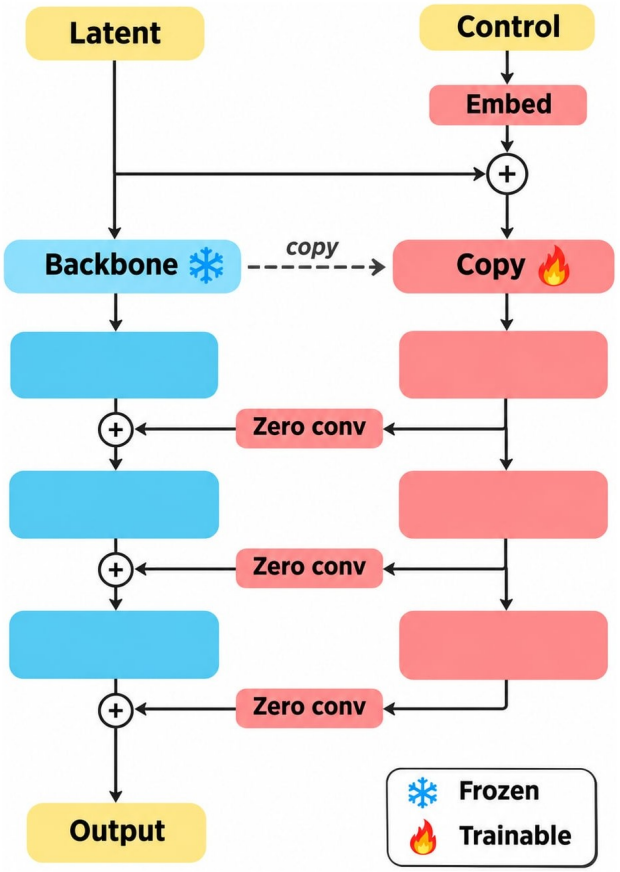


Every image comes from a one-step student distilled with DMD. Columns: which parts of the student are trained.

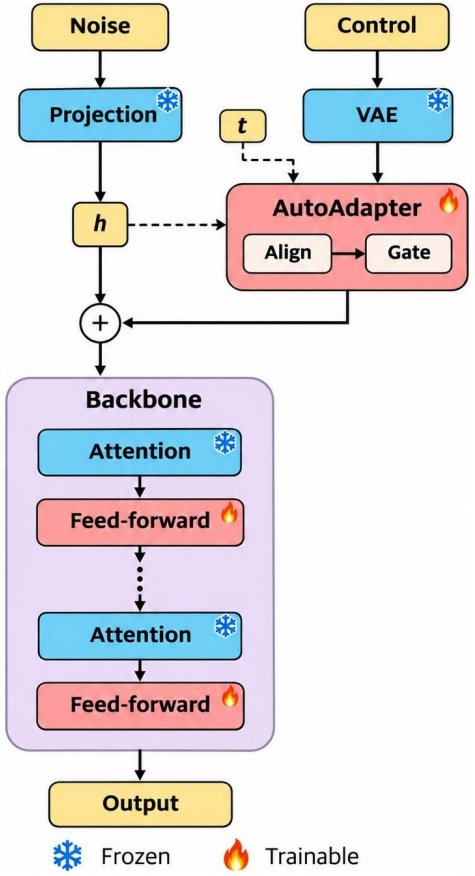
FlashControl: two stages



Stage 1 · DeltaControl: a single-branch teacher

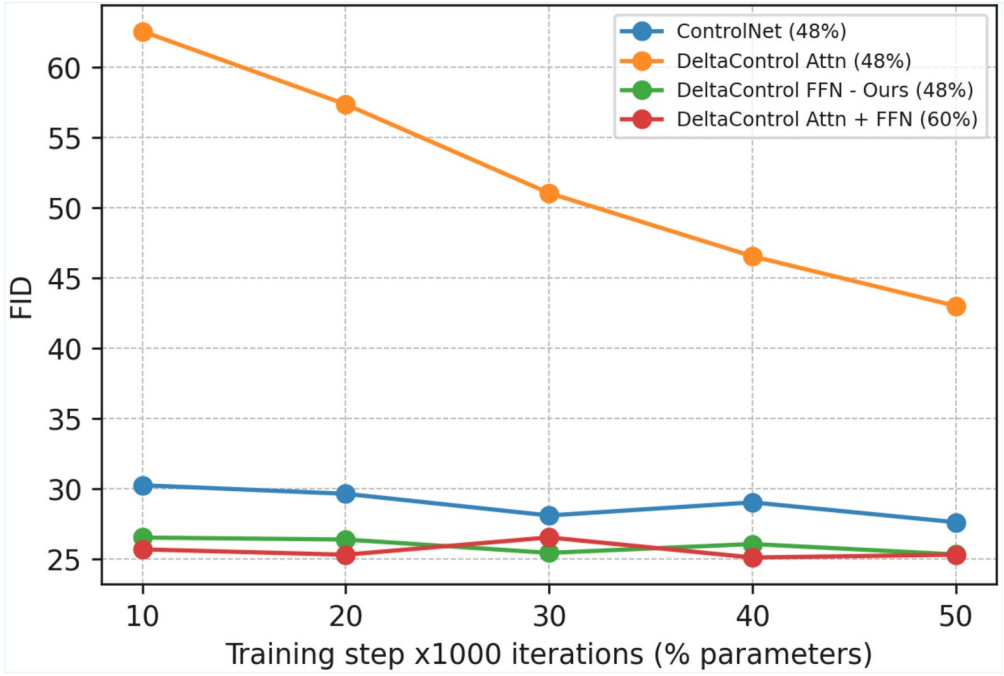


ControlNet: two branches



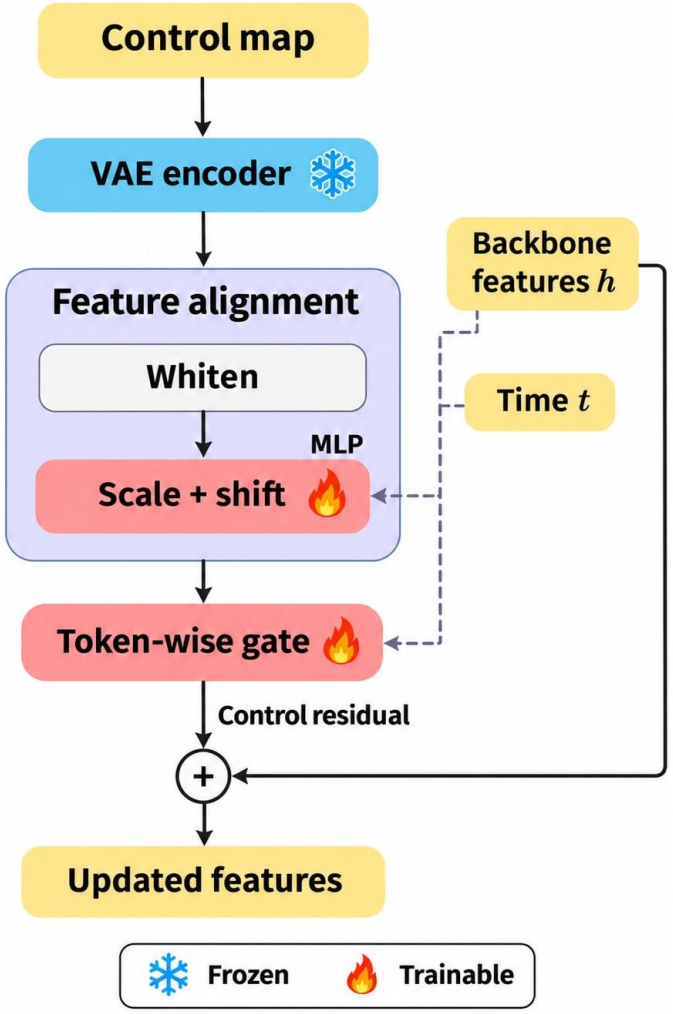
DeltaControl: one branch

- ControlNet trains a **copy** of the backbone.
- DeltaControl has **no copy**: it fine-tunes only the **feed-forward** layers; attention stays frozen.



Same parameter budget (PixArt-α): FFN-only beats ControlNet.

AutoAdapter: inject the right amount of control



PROBLEM

Control features and backbone features have very different scales. Adding them directly is either ignored or breaks the image.

WHY AUTOADAPTER

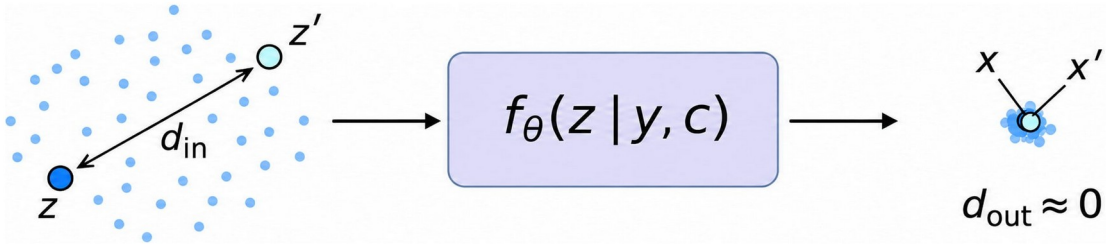
- **Align** the statistics, so control matches the backbone's scale.
- **Gate** each token, so the model trusts control only where it helps.
- Reused unchanged in the one-step student.

AutoAdapter (FID ↓)	Canny	Depth
none	28.15	31.11
w/o align	26.38	29.51
w/o gate	26.88	29.64
full	**26.03**	**29.24**

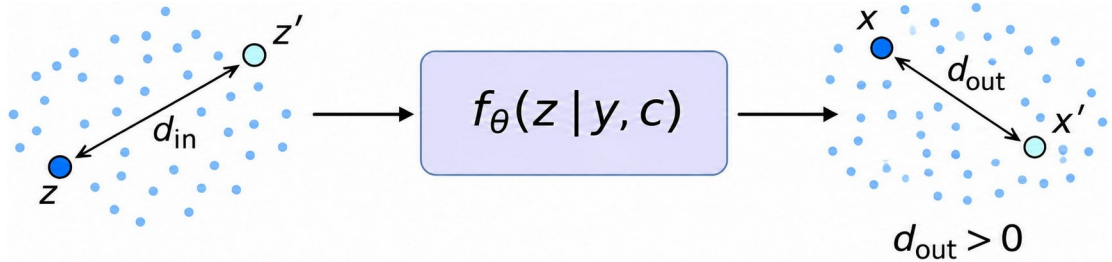
Stage 2 · Distillation with LSP

Late in distillation the student starts to ignore its input noise: different noises give almost the same image. Latent Sensitivity Preservation (LSP) keeps far-apart noises mapped to far-apart outputs.

Without LSP: outputs collapse



With LSP: outputs stay apart



$$\mathscr{L}_{\text{LSP}} = -\, d_{\text{out}} / (d_{\text{in}} + \varepsilon) \qquad \mathscr{L} = \mathscr{L}_{\text{DMD}} + \lambda \cdot \mathscr{L}_{\text{LSP}}$$

Pure DMD, no GAN loss. LSP keeps samples sharp and diverse.

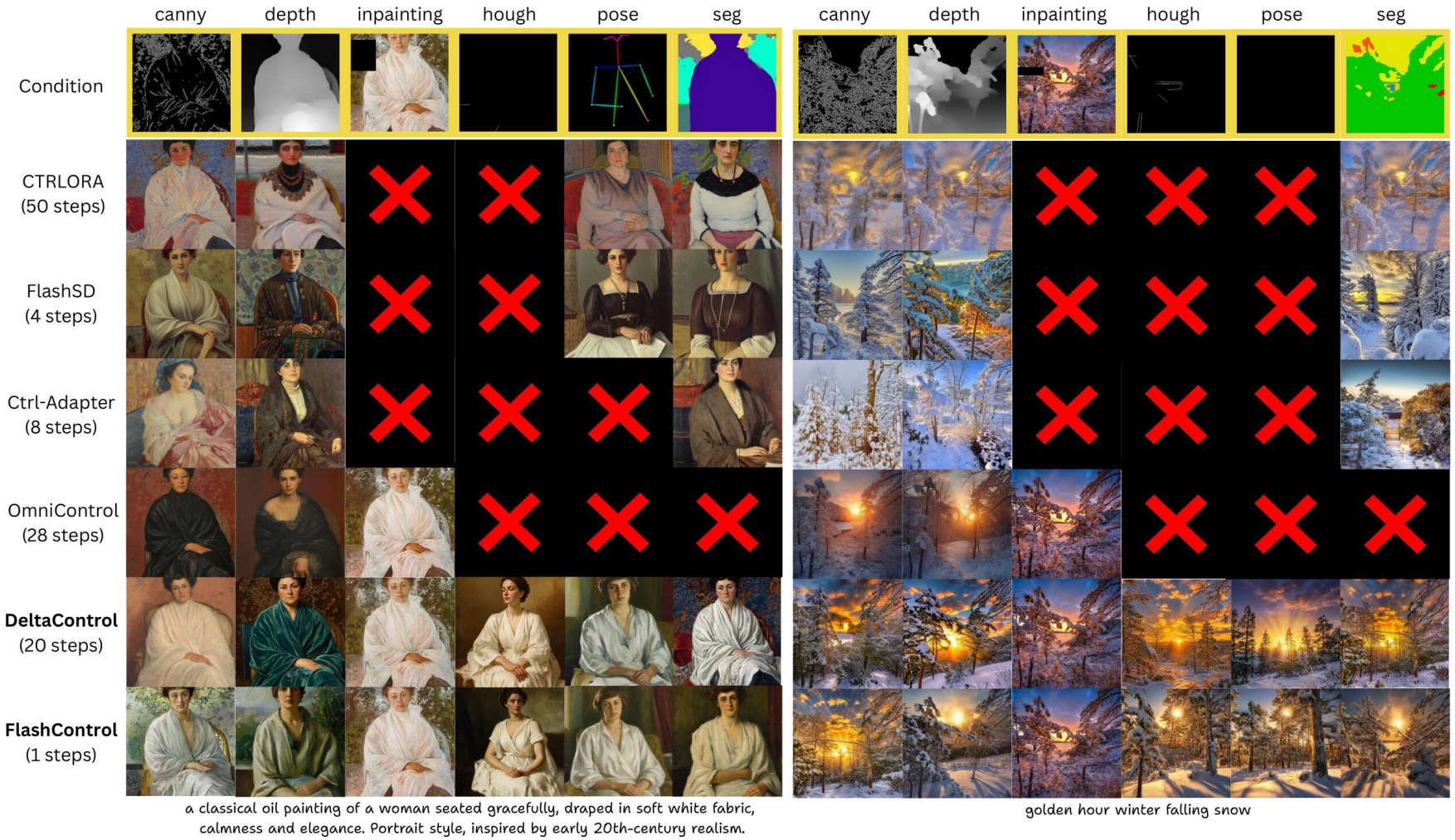
Results: one step matches multi-step models

FID ↓ on COCO-5k. Steps = network evaluations.

Method	Backbone	Steps	Canny	Depth	Seg	Pose	Hough	Inpaint
JDM	SD2.1	1	20.62	25.06	24.95	32.84	30.65	20.73
OminiControl	FLUX.2-Klein-4B	28	20.63	22.02	23.83	31.63	27.30	15.92
RepControlNet	PixArt-α	50	16.02	20.50	22.84	28.62	26.67	15.50
FlashControl (ours)	**SD2.1**	**1**	**17.82**	**22.10**	**22.81**	**29.41**	**26.63**	**17.60**
FlashControl (ours)	**PixArt-α**	**1**	**16.82**	**18.29**	**20.83**	**25.62**	**26.84**	**17.68**
DeltaControl (our teacher)	FLUX.2-Klein-4B	28	12.87	16.57	16.56	22.23	20.34	10.16
FlashControl (ours)	**FLUX.2-Klein-4B**	**1**	**13.64**	**16.77**	**17.83**	**23.68**	**21.21**	**12.18**

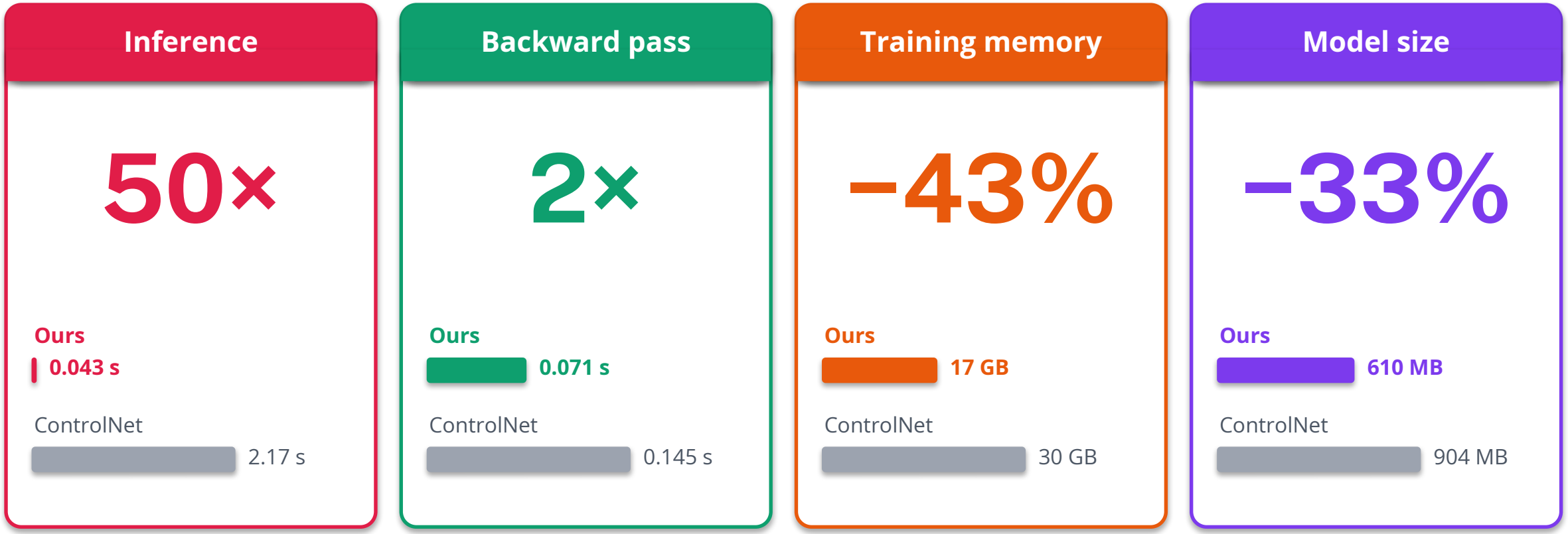
- 1-step FlashControl on FLUX.2 stays close to its 28-step teacher.
- It beats multi-step baselines such as OminiControl (28 steps) on all six tasks.

Qualitative comparison



Red crosses: the method does not support that control.

Fast to train, fast to run



Ours = 1-step FlashControl for inference (ControlNet: 50 steps), DeltaControl teacher for training (SD2.1, same protocol). Inference: 512^2 image, A100, bf16.

Takeaway

The **teacher architecture** decides whether one-step control works.

1. **DeltaControl** — single-branch teacher: tune feed-forward layers
2. **AutoAdapter** — aligned, gated control injection
3. **LSP** — keeps the one-step student sensitive to noise

One model · six controls · one step · arXiv:2610.22537