UniFlow: A Unified Pixel Flow Tokenizer for Visual Understanding and Generation

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Challenges in Complex Video Stylization

Existing tokenizers face a fundamental performance trade-off:

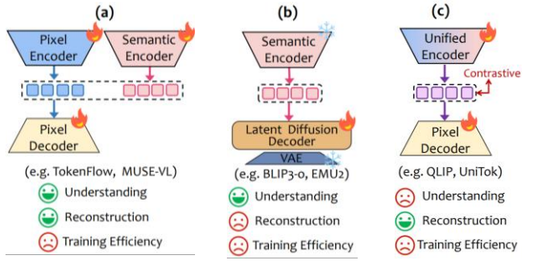
- High-level semantic abstraction (Understanding)
- Low-level pixel reconstruction (Generation)

Prior Approaches:

(1) Dual Encoders;

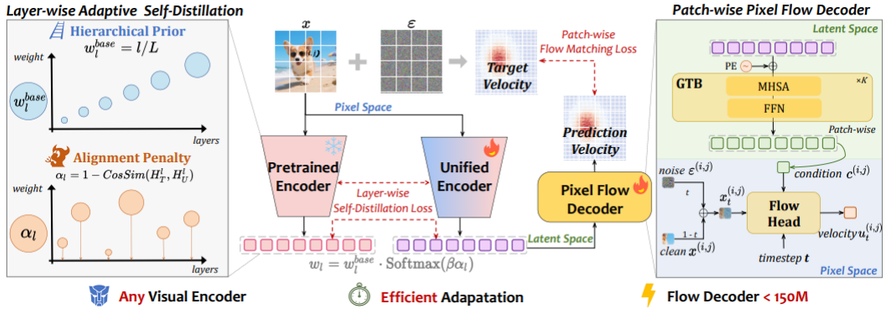
(2) Frozen Semantic + Diffusion;

(3) Unified + Pixel Decoder;



*How can we efficiently unify visual representations within a single tokenizer to achieve both **powerful semantic understanding** and **high-fidelity reconstruction**?*

UniFlow Framwork



Two Core Designs:

(1) LAYER-WISE ADAPTIVE SELF-DISTILLATION

Dynamic weight for each layer:

◇Deep layers: Strong semantic preservation

◇Shallow layers: Flexible detail adaptation

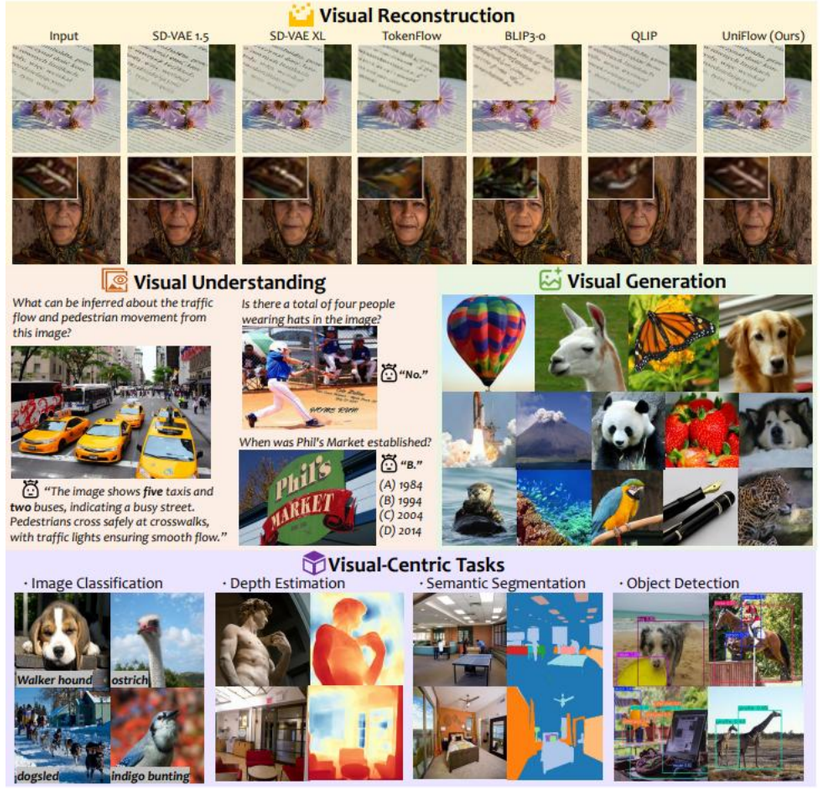
(2) PATCH-WISE PIXEL FLOW DECODER

Flow Matching in pixel space (not latent)

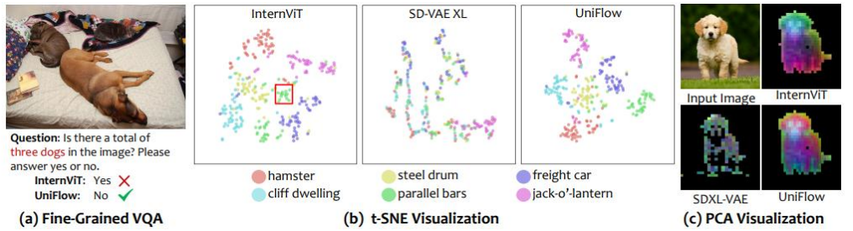
◇Global Transformer Blocks eliminates grid artifacts

◇Single-step Euler inference

Downstream Task Comparison



What Does UniFlow Learn?



Quantitative Results

Table 1: **Comparison of reconstruction quality on the 256 × 256 ImageNet-1K and MS-COCO 2017 validation sets.** "Ratio" denotes downsampling ratio; "Type" indicates tokenizer traits (VQ usage and decoder type). UniFlow achieves state-of-the-art (SOTA) performance in unified tokenizers while also being competitive with the best generative tokenizers. See Appendix B.1 for data details.

Method	Type	Training Data	Ratio	ImageNet-1K			MS-COCO 2017		
				PSNR ↑	SSIM ↑	rFID ↓	PSNR ↑	SSIM ↑	rFID ↓
Generative Only Tokenizer									
Cosmos-DI (Agarwal et al., 2025)	Discrete-Pixel	–	16	19.98	0.54	4.40	19.22	0.48	11.97
LlamaGen (Sun et al., 2024a)	Discrete-Pixel	MS+IN-1K	16	20.65	0.54	2.47	20.28	0.55	8.40
Open-MAGVIT2 (Luo et al., 2024)	Discrete-Pixel	Mixed100M	16	22.70	0.64	1.67	22.31	0.65	6.76
BSQ-ViT (Yang et al., 2021)	Discrete-Pixel	IN-1K	16	28.14	0.81	0.45	–	–	–
SD-VAE 1.x (Rombach et al., 2022)	Continuous-Pixel	OImg	8	23.54	0.68	1.22	23.21	0.69	5.94
SD-VAE 2.x (Rombach et al., 2022)	Continuous-Pixel	OImg+LAae	8	23.54	0.68	1.22	26.62	0.77	4.26
OmniTokenizer (Wang et al., 2024a)	Continuous-Pixel	IN-1K+K600	8	26.74	0.82	1.02	26.44	0.83	4.69
SD-VAE XL (Podell et al., 2023)	Continuous-Pixel	OImg+LAae++	8	27.37	0.78	0.67	27.08	0.80	3.93
Qwen-Image (Wu et al., 2025a)	Continuous-Pixel	–	8	32.18	0.90	1.459	32.01	0.91	4.62
SD-VAE 3 (Esser et al., 2024)	Continuous-Pixel	–	8	31.29	0.87	0.20	31.18	0.89	1.67
Wan2.1 (Wan et al., 2025a)	Continuous-Pixel	–	8	31.34	0.89	0.95	31.19	0.90	3.45
FLUX-VAE (Labs, 2024)	Continuous-Pixel	–	8	**32.74**	**0.92**	**0.18**	**32.32**	**0.93**	**1.35**
Cosmos-CI (Agarwal et al., 2025)	Continuous-Pixel	–	16	25.07	0.70	0.96	24.74	0.71	5.06
VA-VAE (Yao et al., 2025)	Continuous-Pixel	IN-1K	16	27.96	0.79	0.28	27.50	0.81	2.71
Wan2.2 (Wan et al., 2025b)	Continuous-Pixel	–	16	31.25	0.88	0.749	31.10	0.89	3.28
SelfTok (Luo et al., 2024)	Discrete-Diffusion	IN-1K	–	24.14	0.71	0.70	–	–	–
FlowMo-Hi (Shaulov et al., 2025)	Discrete-Diffusion	IN-1K	–	26.93	0.79	0.56	–	–	–
l-DeTok (Yang et al., 2025a)	Continuous-Diffusion	IN-1K	16	–	–	0.68	–	–	–
Unified Tokenizer									
Show-o (Xie et al., 2024b)	Discrete-Pixel	-	16	21.34	0.59	3.50	20.90	0.59	9.26
QLIP-B (Zhao et al., 2025b)	Discrete-Pixel	DC-1B	16	23.16	0.63	3.21	–	–	–
VILA-U (Wu et al., 2024b)	Discrete-Pixel	WL-10B+CY-1B	16	–	–	1.80	–	–	–
Tokenflow (Qu et al., 2025)	Discrete-Pixel	LA+CY	16	21.41	0.69	1.37	–	–	–
DualViTok (Huang et al., 2025)	Discrete-Pixel	Mixed-63M	16	22.53	0.74	1.37	–	–	–
DualToken (Song et al., 2025)	Discrete-Pixel	CC12M	16	23.56	0.74	0.54	–	–	–
MUSE-VL (Xie et al., 2024c)	Discrete-Pixel	IN-1K+CC12M	16	20.14	0.646	2.26	–	–	–
SemHiTok (Chen et al., 2025i)	Discrete-Pixel	CY-50M	16	–	–	1.16	–	–	–
UniTok (Ma et al., 2025)	Discrete-Pixel	DC-1B	16	27.28	0.77	0.41	–	–	–
SeTok (Wu et al., 2025d)	Discrete-Pixel	IN-1K+OImg	–	–	–	2.07	–	–	–
UniLIP (Tang et al., 2025)	Continuous-Pixel	BP-32M	32	22.99	0.747	0.79	–	–	–
EMU2 (Sun et al., 2024b)	Continuous-Diffusion	LA-CO+LAae	14	13.49	0.42	3.27	–	–	–
BLIP3-o (Chen et al., 2025f)	Continuous-Diffusion	BP-32M	16	14.71	0.58	3.18	–	–	–
UniFlow(*CLIP*)	Continuous-Diffusion	IN-1K	14	28.66	0.91	0.67	29.61	0.92	3.69
UniFlow(*SigLIP2*)	Continuous-Diffusion	IN-1K	16	29.38	0.93	0.62	26.38	0.86	3.44
UniFlow(*DINOv2*)	Continuous-Diffusion	IN-1K	14	31.01	0.94	0.54	30.66	0.94	2.81
UniFlow(*InternViT*)	Continuous-Diffusion	IN-1K	14	**33.23**	**0.96**	**0.26**	**32.48**	**0.95**	**1.88**

Ablation Study

Key Findings: • Understanding Enhancement • Adaptive distillation (β=2) >> Uniform • GTB eliminates grid artifacts