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Person Image Synthesis via Denoising Diffusion Model

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汇报人：李雅超

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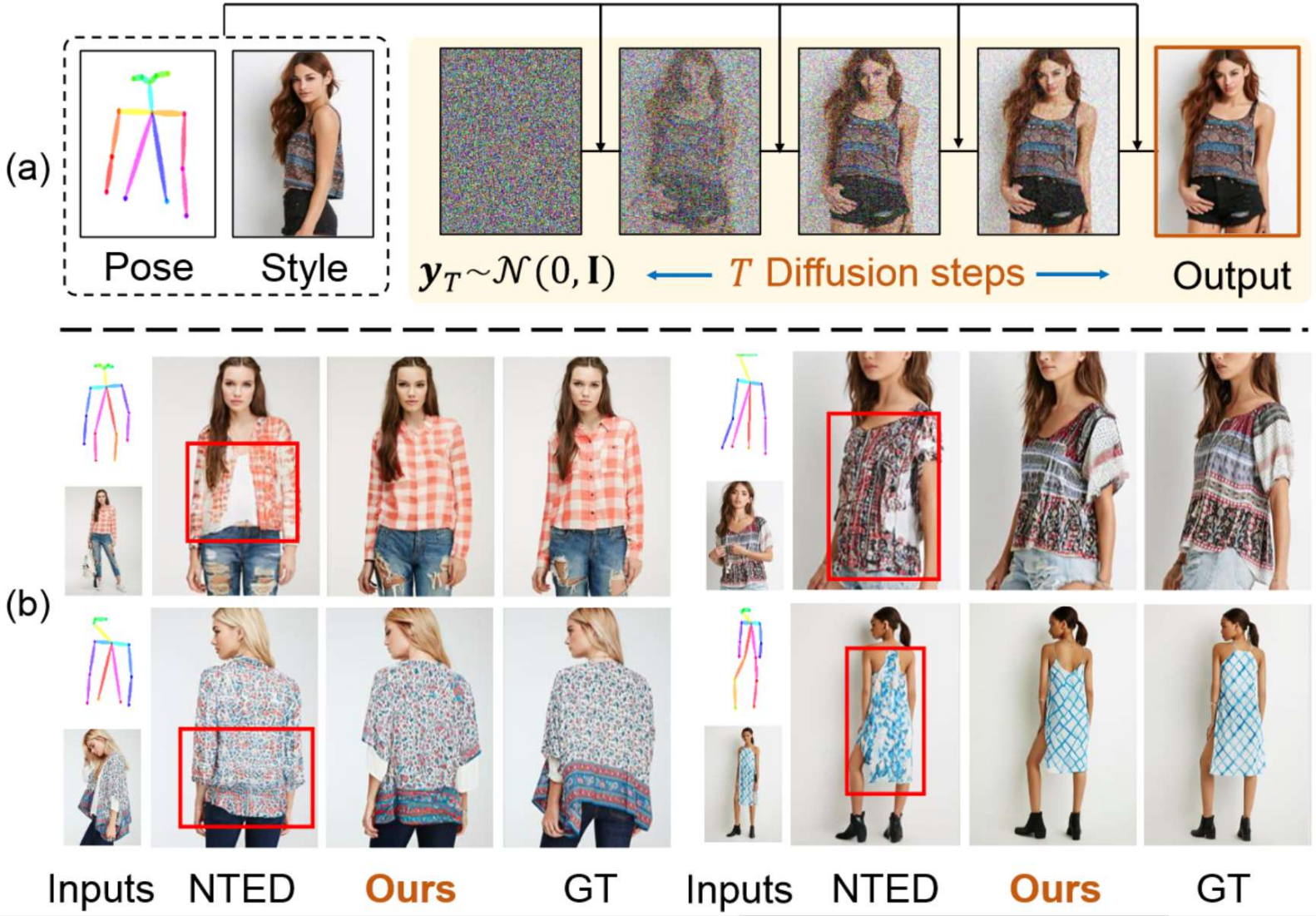

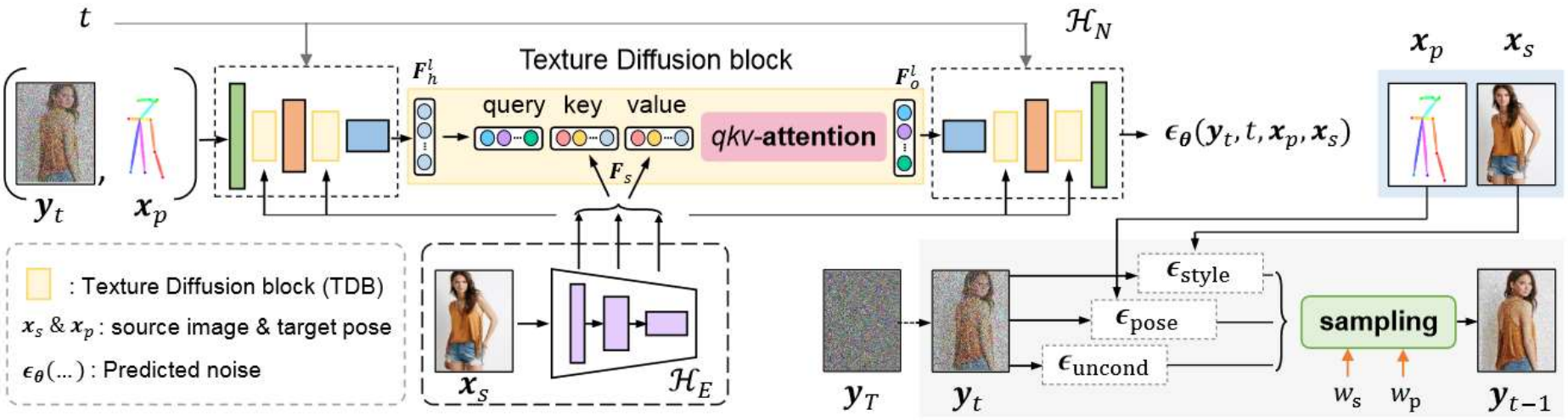

(a) Overview of our proposed PIDM architecture

(b) Disentangled Guidance based DDPM sampling

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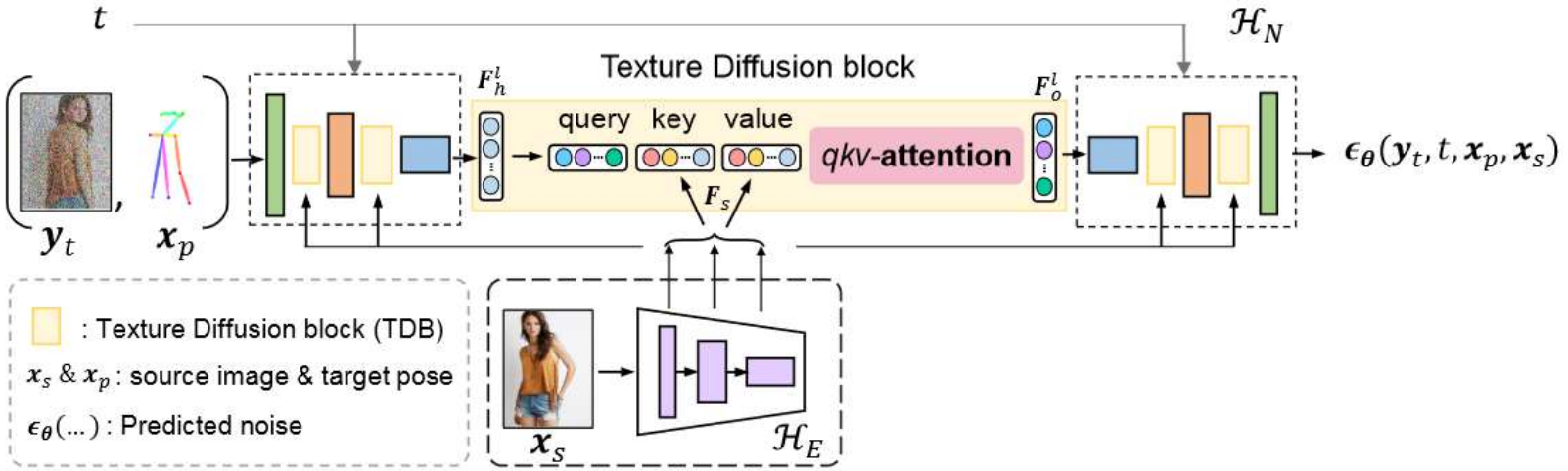
Texture-Conditioned Diffusion Model



前向扩散分布:

$$q(\boldsymbol{y}_t|\boldsymbol{y}_{t-1}) = \mathcal{N}(\boldsymbol{y}_t; \sqrt{1-\beta_t}\boldsymbol{y}_{t-1}, \beta_t\mathbf{I}). \quad (1)$$

逆向去噪分布:

$$p_\theta(\boldsymbol{y}_{t-1}|\boldsymbol{y}_t, \boldsymbol{x}_p, \boldsymbol{x}_s) = \mathcal{N}(\boldsymbol{y}_{t-1}; \mu_\theta(\boldsymbol{y}_t, t, \boldsymbol{x}_p, \boldsymbol{x}_s), \Sigma_\theta(\boldsymbol{y}_t, t, \boldsymbol{x}_p, \boldsymbol{x}_s)). \quad (2)$$

损失函数:

$$L_{\text{mse}} = \mathbb{E}_{t\sim[1,T],\boldsymbol{y}_0\sim q(\boldsymbol{y}_0),\epsilon} \|\epsilon - \epsilon_\theta(\boldsymbol{y}_t, t, \boldsymbol{x}_p, \boldsymbol{x}_s)\|^2. \quad (3)$$

$$L_{\text{hybrid}} = L_{\text{mse}} + L_{\text{vib}}. \quad (4)$$

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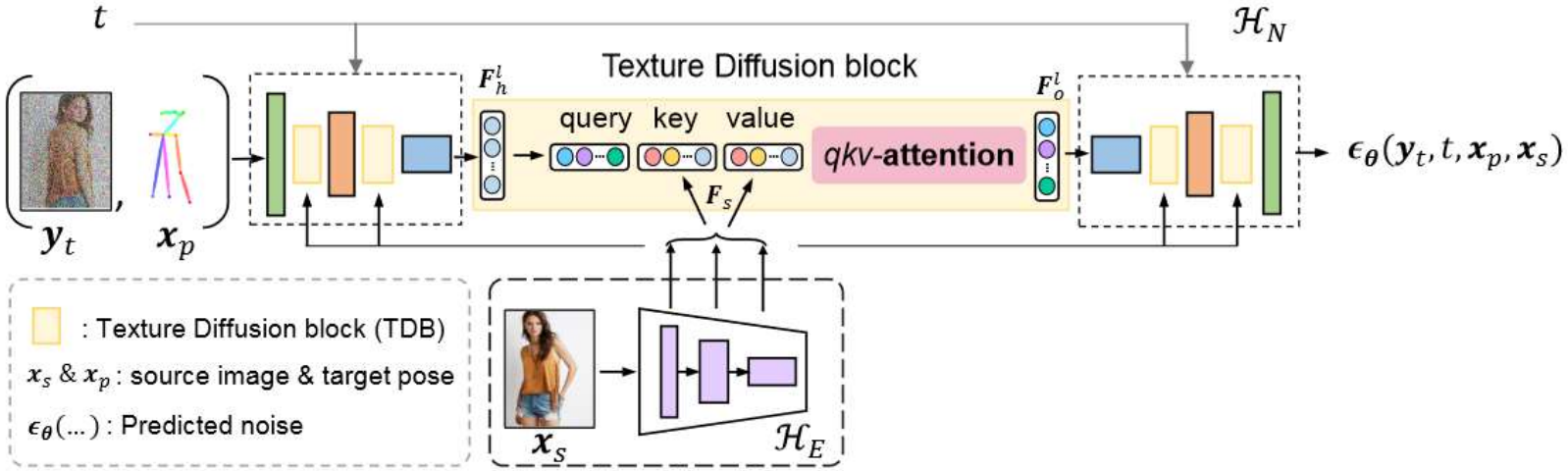
Texture Diffusion block



$$\boldsymbol{Q} = \phi_q^l(\boldsymbol{F}_h^l), \quad \boldsymbol{K} = \phi_k^l(\boldsymbol{F}_s), \quad \boldsymbol{V} = \phi_v^l(\boldsymbol{F}_s)$$

$$\boldsymbol{F}_{att}^l = \frac{\boldsymbol{Q}\boldsymbol{K}^T}{\sqrt{C}}, \quad \boldsymbol{F}_{\boldsymbol{o}}^{\boldsymbol{l}} = \boldsymbol{W}^{\boldsymbol{l}}\mathrm{softmax}(\boldsymbol{F}_{att}^l)\boldsymbol{V} + \boldsymbol{F}_h^l, \tag{5}$$

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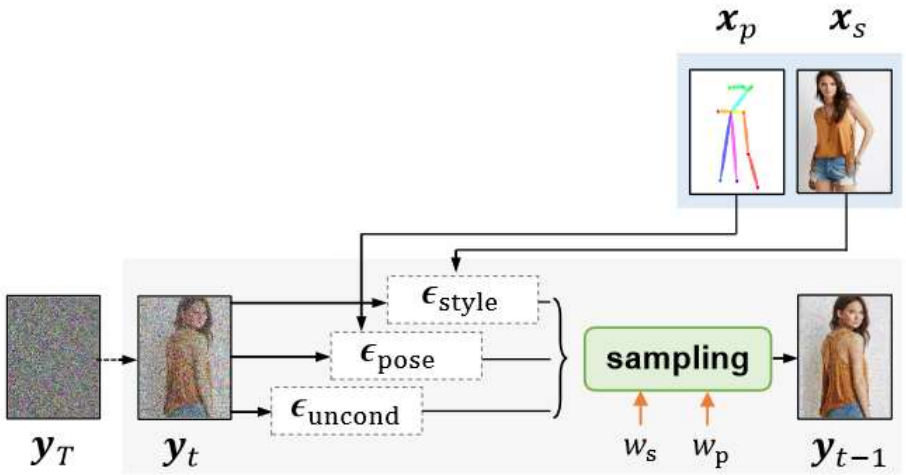
Disentangled Guidance based Sampling



$$\epsilon_{\text{uncond}} = \epsilon_\theta(\boldsymbol{y}_t, t, \emptyset, \emptyset)$$
$$\epsilon_{\text{pose}} = \epsilon_\theta(\boldsymbol{y}_t, t, \boldsymbol{x}_p, \emptyset) - \epsilon_{\text{uncond}}$$
$$\epsilon_{\text{style}} = \epsilon_\theta(\boldsymbol{y}_t, t, \emptyset, \boldsymbol{x}_s) - \epsilon_{\text{uncond}}$$

解耦的条件噪音:

$$\boldsymbol{\epsilon}_{\text{cond}} = \boldsymbol{\epsilon}_{\text{uncond}} + w_p \boldsymbol{\epsilon}_{\text{pose}} + w_s \boldsymbol{\epsilon}_{\text{style}}, \tag{6}$$

原始的无分类引导下的条件噪音:

$$\begin{aligned}\bar{\boldsymbol{\epsilon}}_\theta(\mathbf{x}_t, t, y) &= \boldsymbol{\epsilon}_\theta(\mathbf{x}_t, t, y) - \sqrt{1-\bar{\alpha}_t} w \nabla_{\mathbf{x}_t} \log p(y \mid \mathbf{x}_t) \\ &= \boldsymbol{\epsilon}_\theta(\mathbf{x}_t, t, y) + w(\boldsymbol{\epsilon}_\theta(\mathbf{x}_t, t, y) - \boldsymbol{\epsilon}_\theta(\mathbf{x}_t, t)) \\ &= (w+1)\boldsymbol{\epsilon}_\theta(\mathbf{x}_t, t, y) - w\boldsymbol{\epsilon}_\theta(\mathbf{x}_t, t)\end{aligned}$$

定量实验结果

Dataset	Methods	FID(↓)	SSIM(↑)	LPIPS(↓)
DeepFashion [11] (256 × 176)	Def-GAN [20]	18.457	0.6786	0.2330
	PATN [30]	20.751	0.6709	0.2562
	ADGAN [14]	14.458	0.6721	0.2283
	PISE [23]	13.610	0.6629	0.2059
	GFLA [19]	10.573	0.7074	0.2341
	DPTN [24]	11.387	0.7112	0.1931
	CASD [28]	11.373	0.7248	0.1936
	NTED [18]	8.6838	0.7182	0.1752
	PIDM (Ours)	**6.3671**	**0.7312**	**0.1678**
DeepFashion [11] (512 × 352)	CocosNet2 [29]	13.325	0.7236	0.2265
	NTED [18]	7.7821	0.7376	0.1980
	PIDM (Ours)	**5.8365**	**0.7419**	**0.1768**
Market-1501 [27] (128 × 64)	Def-GAN [20]	25.364	0.2683	0.2994
	PTN [30]	22.657	0.2821	0.3196
	GFLA [19]	19.751	0.2883	0.2817
	DPTN [24]	18.995	0.2854	0.2711
	PIDM (Ours)	**14.451**	**0.3054**	**0.2415**

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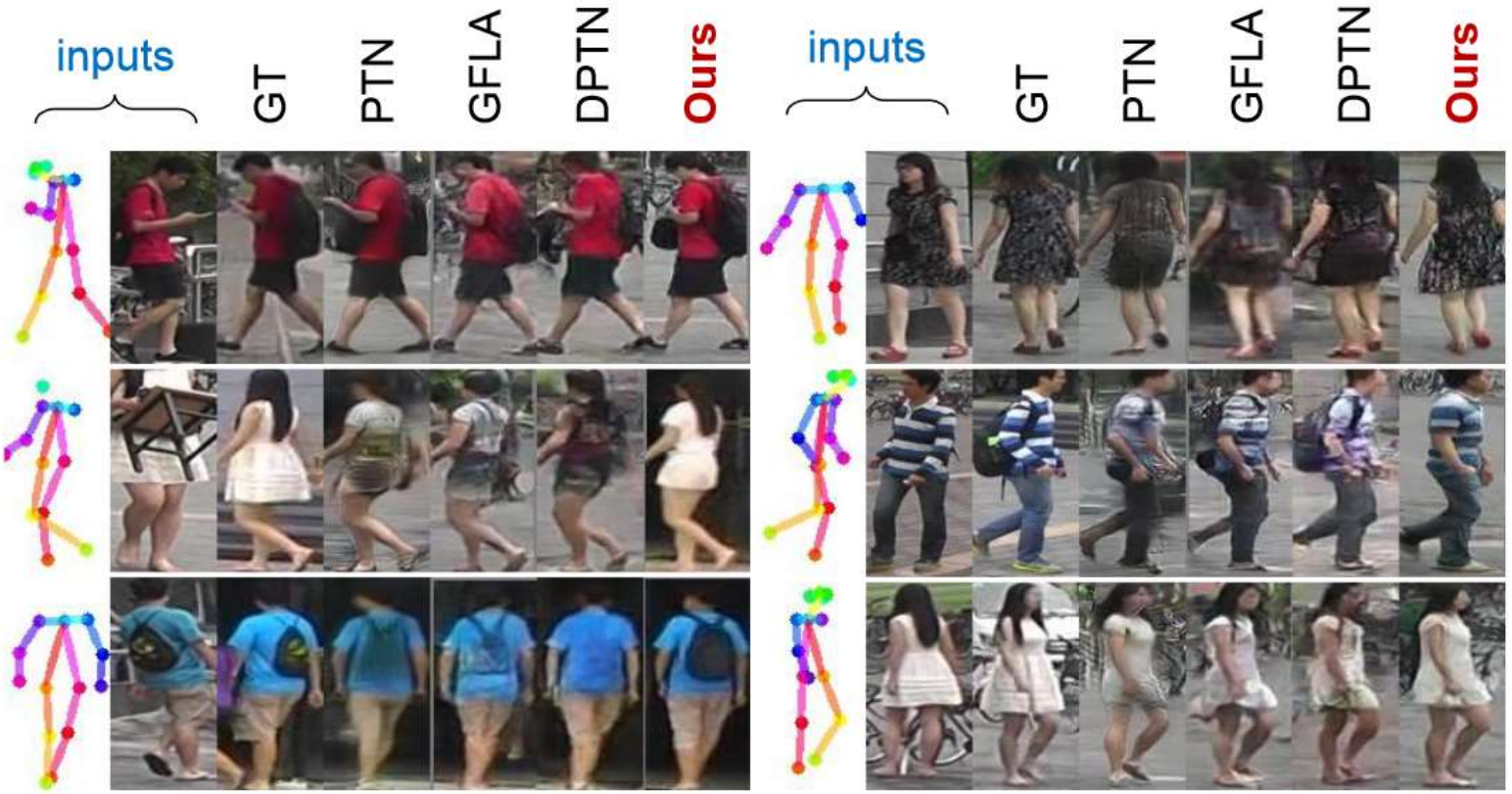
可视化对比结果




inputs
GT
ADGAN
PISE
GFLA
DPTN
CASD
NTED
Ours
inputs
GT
ADGAN
PISE
GFLA
DPTN
CASD
NTED
Ours
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)

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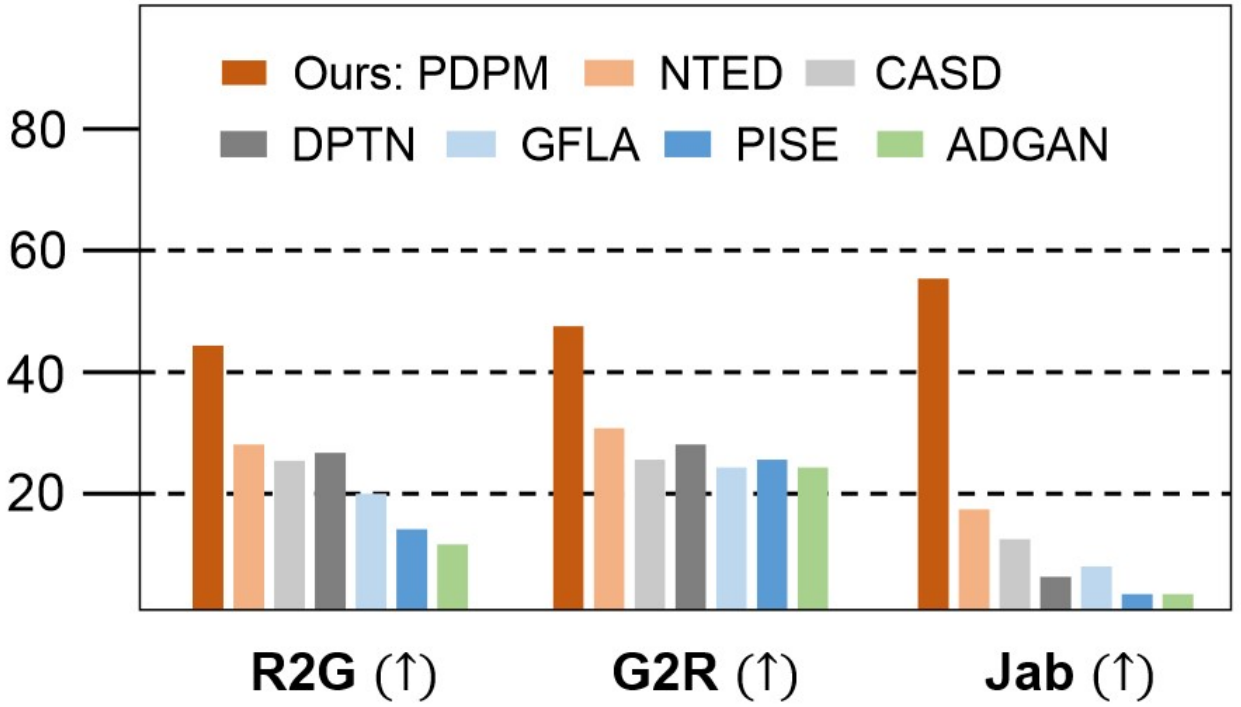
User Study结果

30 generated images

30 real-world images



R2G: real-world to generate

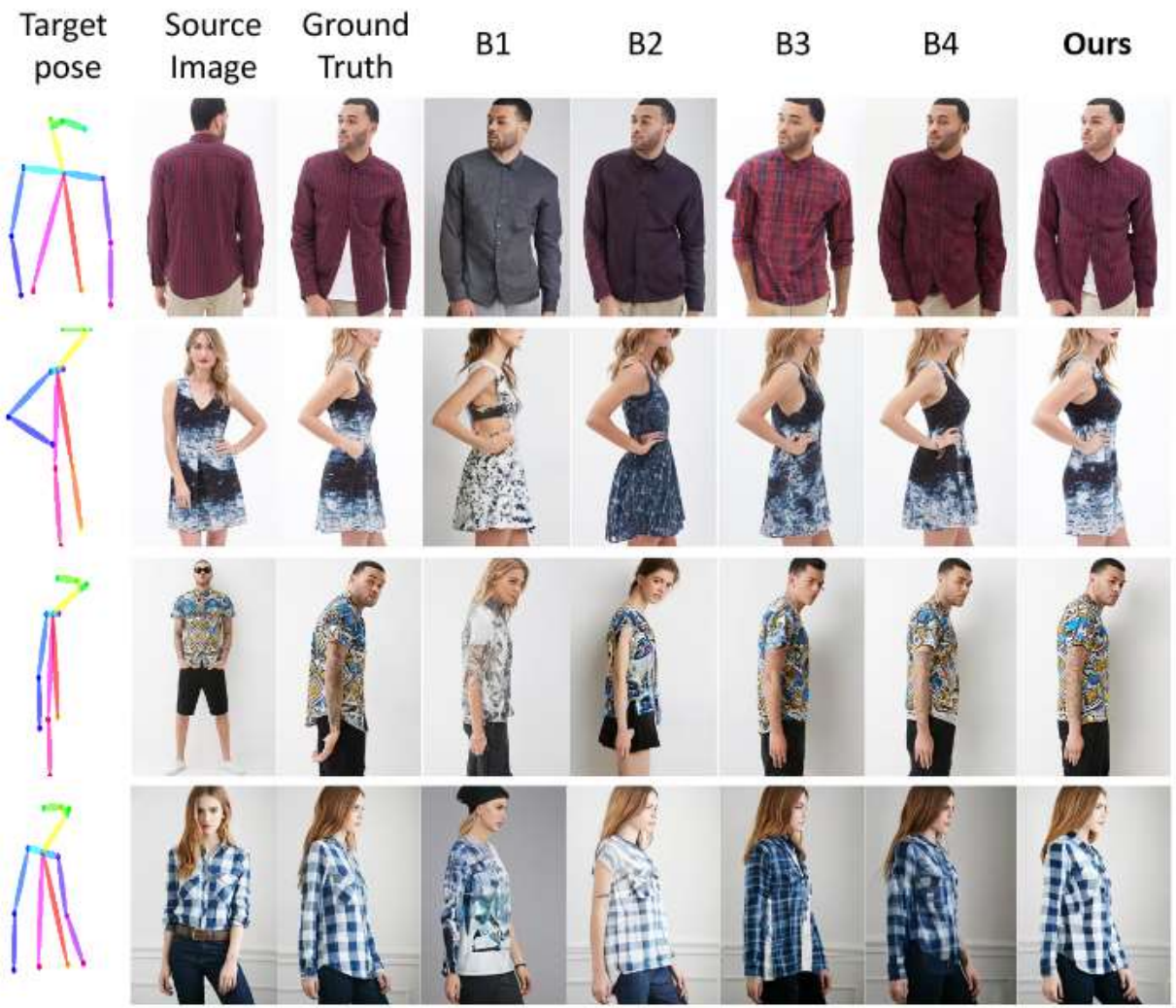
G2R: generate to real-world

Jab: the percentage of images considered the best among all models

消融实验

Methods	FID(↓)	SSIM(↑)	LPIPS(↓)
B1: `Baseline`† (concat)	10.813	0.6911	0.2112
B2: `Baseline`	9.8510	0.7005	0.1983
B3: `Baseline + TDB`	7.5133	0.7178	0.1870
B4: `Baseline + TDB + CF-guidance`	6.8176	0.7195	0.1769
Ours: Baseline + TDB + DCF-guidance	**6.3671**	**0.7312**	**0.1676**

消融实验



Appearance Control and Editing