3D-Aware Image Restoration: Leveraging Diffusion Models and Vision Mamba Techniques

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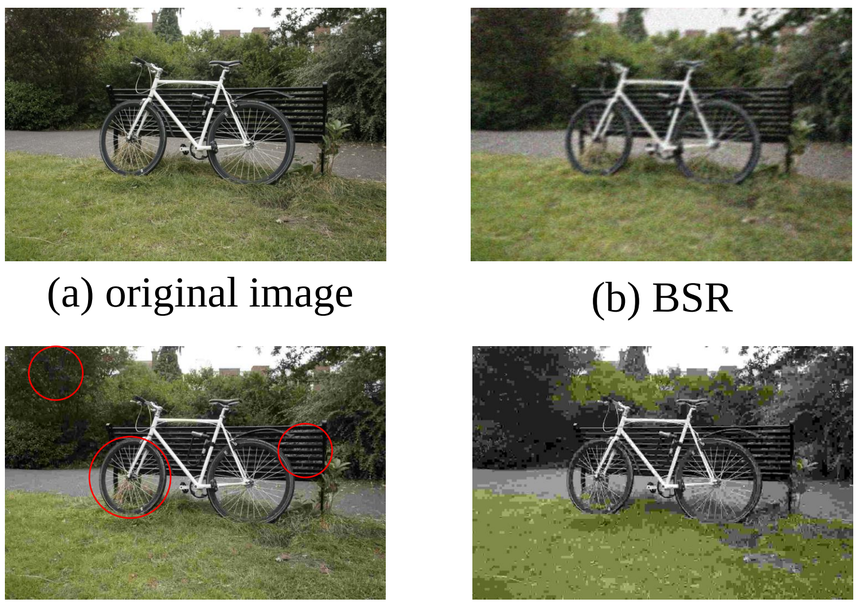
I. Introduction

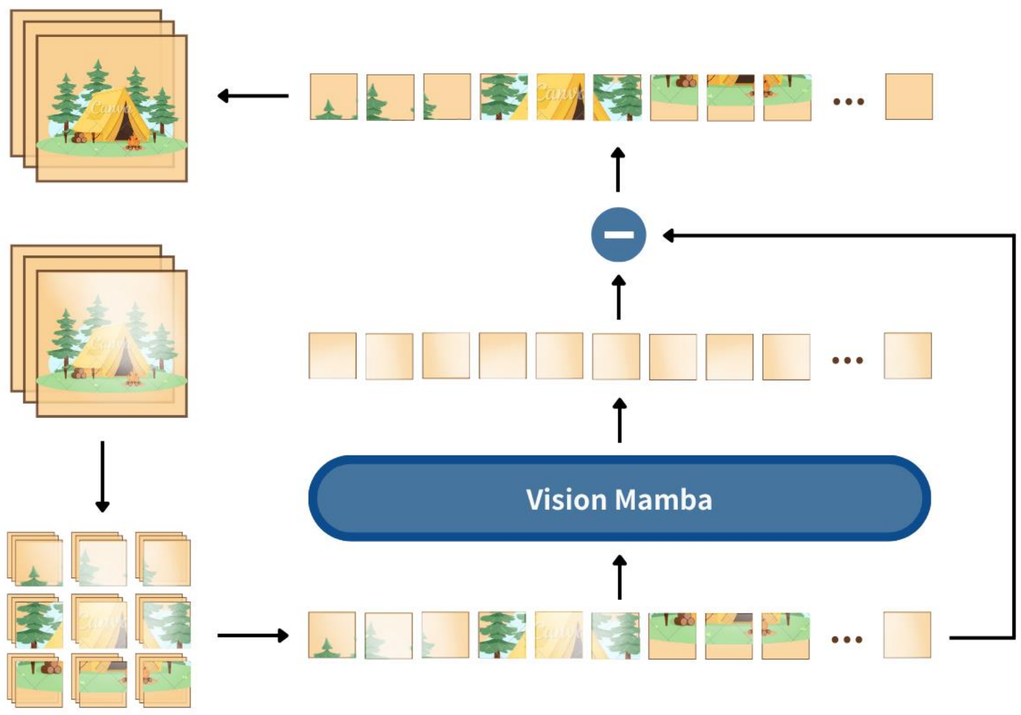
In natural images, various artifacts, such as JPEG compression, motion blur, and sensor noise, often degrade visual quality. These artifacts can significantly impact the performance of techniques like NeRF and 3DGS in novel-view synthesis tasks. To address this issue, we simulate two scenarios: the first involves the degradation method proposed by BSRGAN, and the second focuses on high-compression JPEG artifacts. We then experimented with different networks, including a pretrained Restormer, a diffusion model fine-tuned with DreamBooth and LoRA, and Vision Mamba, to restore the images. Our goal is to determine if these networks can effectively eliminate the artifacts and improve synthesis outcomes.



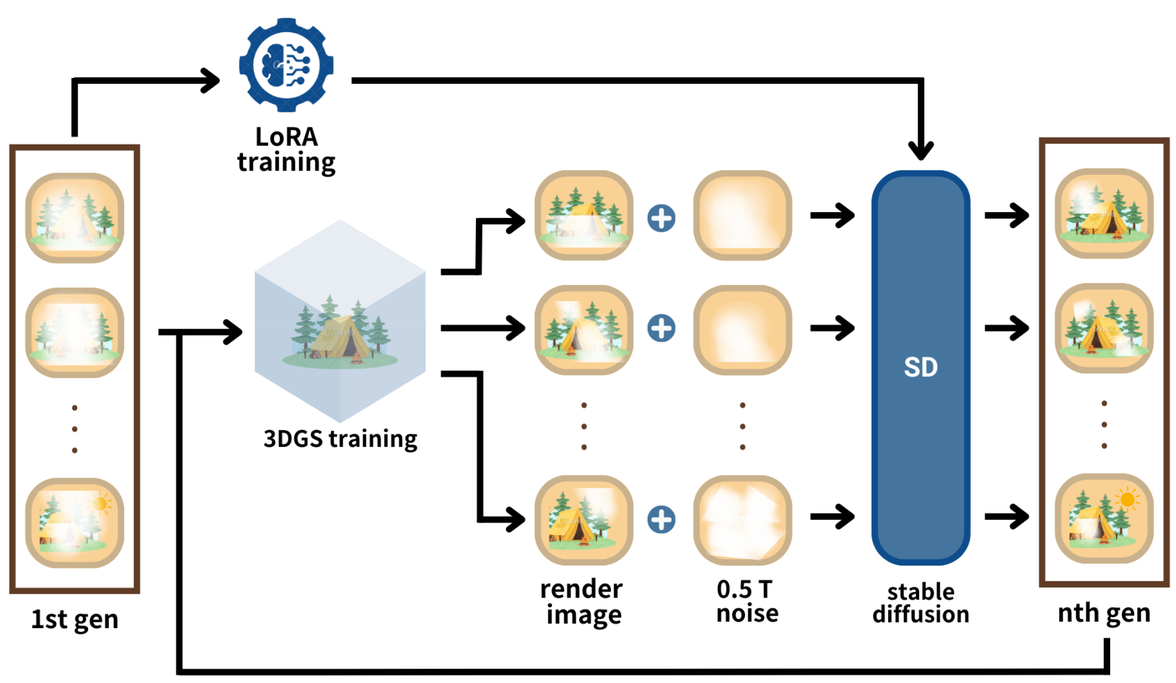
(a) original image (b) BSR (c) JPEG (Q=10) (d) JPEG (Q=3)

Fig. 1: Degraded images

II. Method



(a) Vision Mamba



(b) Stable Diffusion + LoRA + DreamBooth

Fig. 2: Network architecture

III. Experiment

	Vimeo90K			Mip-NeRF 360		
	PSNR ↑	SSIM ↑	LPIPS ↓	PSNR ↑	SSIM ↑	LPIPS ↓
Restormer	**21.180**	**0.556**	0.456	20.142	0.357	0.579
Stable Diffusion XL refiner	16.890	0.367	0.571	18.249	0.290	0.608
Stable Diffusion + DreamBooth + LoRA	14.824	0.275	0.595	18.156	0.306	**0.551**
Vision Mamba	19.315	0.536	**0.444**	**20.646**	**0.397**	0.581

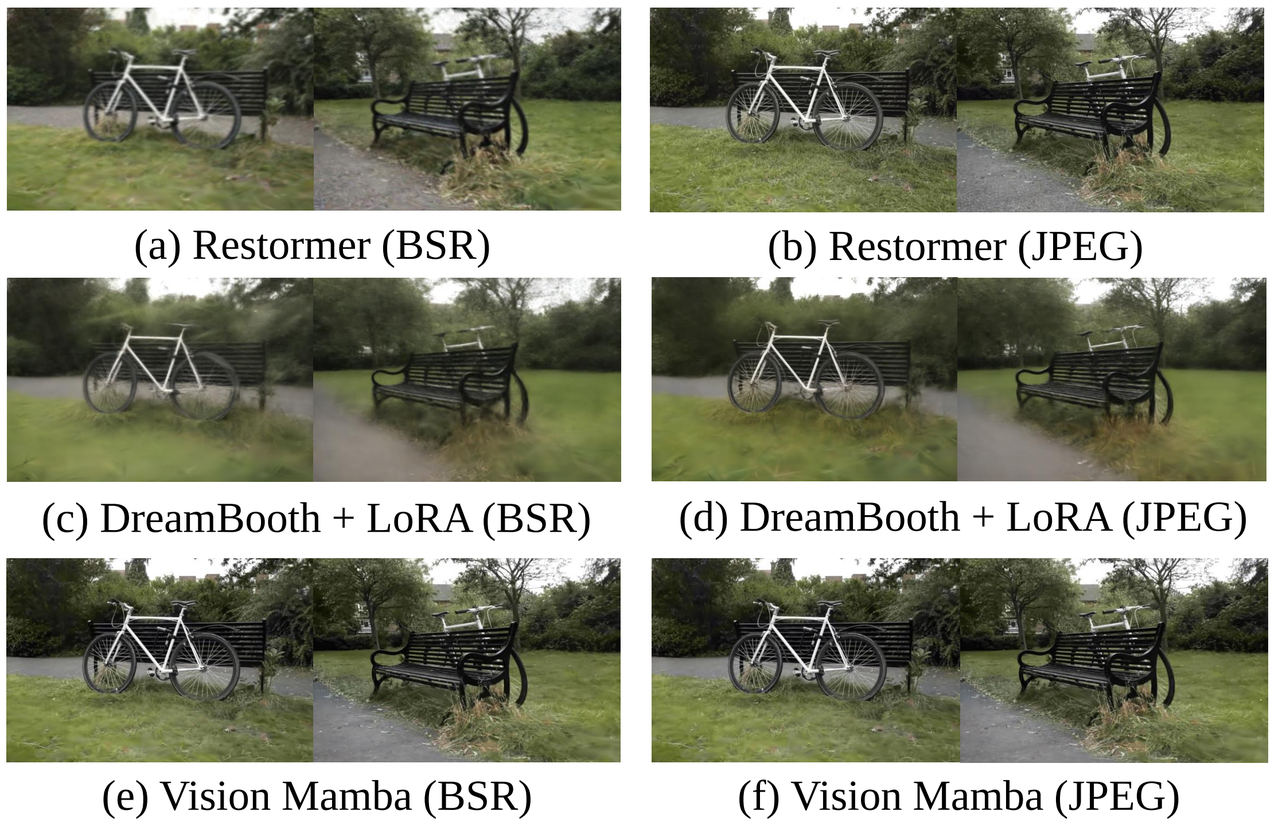
Table. 1: The comparison results on BSR degraded data.

	Vimeo90K			Mip-NeRF 360		
	PSNR ↑	SSIM ↑	LPIPS ↓	PSNR ↑	SSIM ↑	LPIPS ↓
Restormer	19.358	0.596	**0.303**	**25.772**	**0.728**	0.381
Stable Diffusion XL refiner	19.361	0.550	0.430	18.703	0.370	0.468
Stable Diffusion + DreamBooth + LoRA	15.168	0.353	0.506	18.087	0.343	0.489
Vision Mamba	**20.586**	**0.608**	0.358	25.525	0.703	**0.372**

Table. 2: The comparison results on JPEG compression data.

IV. Conclusion

In our two architectures, Vision Mamba outperformed Restormer in certain situations and produced visually superior results after using 3DGS for training on the restored images, making it a highly promising model. On the other hand, although the Stable Diffusion model is powerful, we struggled to effectively limit its diversity, even after applying DreamBooth and LoRA. This limitation led to suboptimal performance. However, if the diversity of the diffusion model can be successfully controlled, we believe it could also become a promising model.



(a) Restormer (BSR) (b) Restormer (JPEG) (c) DreamBooth + LoRA (BSR) (d) DreamBooth + LoRA (JPEG) (e) Vision Mamba (BSR) (f) Vision Mamba (JPEG)

Fig. 3: Visual comparisons after applying 3DGS.