Supplementary Materials: Foreground Harmonization and Shadow Generation for Composite Image

In this supplementary document, we first provide a detailed structure of our IH-SGDiffusion network to ensure better understanding and reproducibility. In addition, we will provide more visual comparison results of different methods on IH-SG dataset.

1 NETWORK STRUCTURE

The detailed structure of our IH-SG diffusion network is shown in Table 1. Symbols of the operators are listed as follows:

- `Conv(cin, cout, k, s, p)`: a convolution operation with cin input channels, cout output channels, kernel size of k, stride size of s, and padding p.
- `ConvT(cin, cout, k, s, p)`: a transposed convolution operation with cin input channels, cout output channels, kernel size of k, stride size of s, and padding p.
- `BN`: Batch Normalization.
- `ReLU`: Rectified Linear Unit, a widely used activation function in neural networks.
- `Concat`: a concatenation operation in the channel dimension.

Overall, the Background Extraction module can be seen as a U-shaped network with two shared encoders, so it is not listed repeatedly. For the shadow generation module, it consists of two identical encoders and a decoder, as well as a channel space cross attention mechanism.

Table 1: The structure of background extraction module.

	Layer name(s)
1	Conv(4, 64, 7, 2, 3) + BN + ReLU + Avgpool
D1	Resblock + Avgpool
D2	Resblock + Avgpool
D3	Resblock + Avgpool
D4	Resblock + Avgpool
M1	Conv(512, 1024, 3, 1, 1)
C1	ConvT(1024, 512, 3, 2, 1)
U1	Concat(D4, C1) + Conv + BN + ReLU
C2	ConvT(512, 256, 3, 2, 1)
U2	Concat(D3, C2) + Conv + BN + ReLU
C3	ConvT(256, 128, 3, 2, 1)
U3	Concat(D2, C3) + Conv + BN + ReLU
C4	ConvT(128, 64, 3, 2, 1)
U4	Concat(D1, C4) + Conv + BN + ReLU
out	Conv(64, 2, 3, 1, 1)

2 QUALITATIVE ANALYSIS

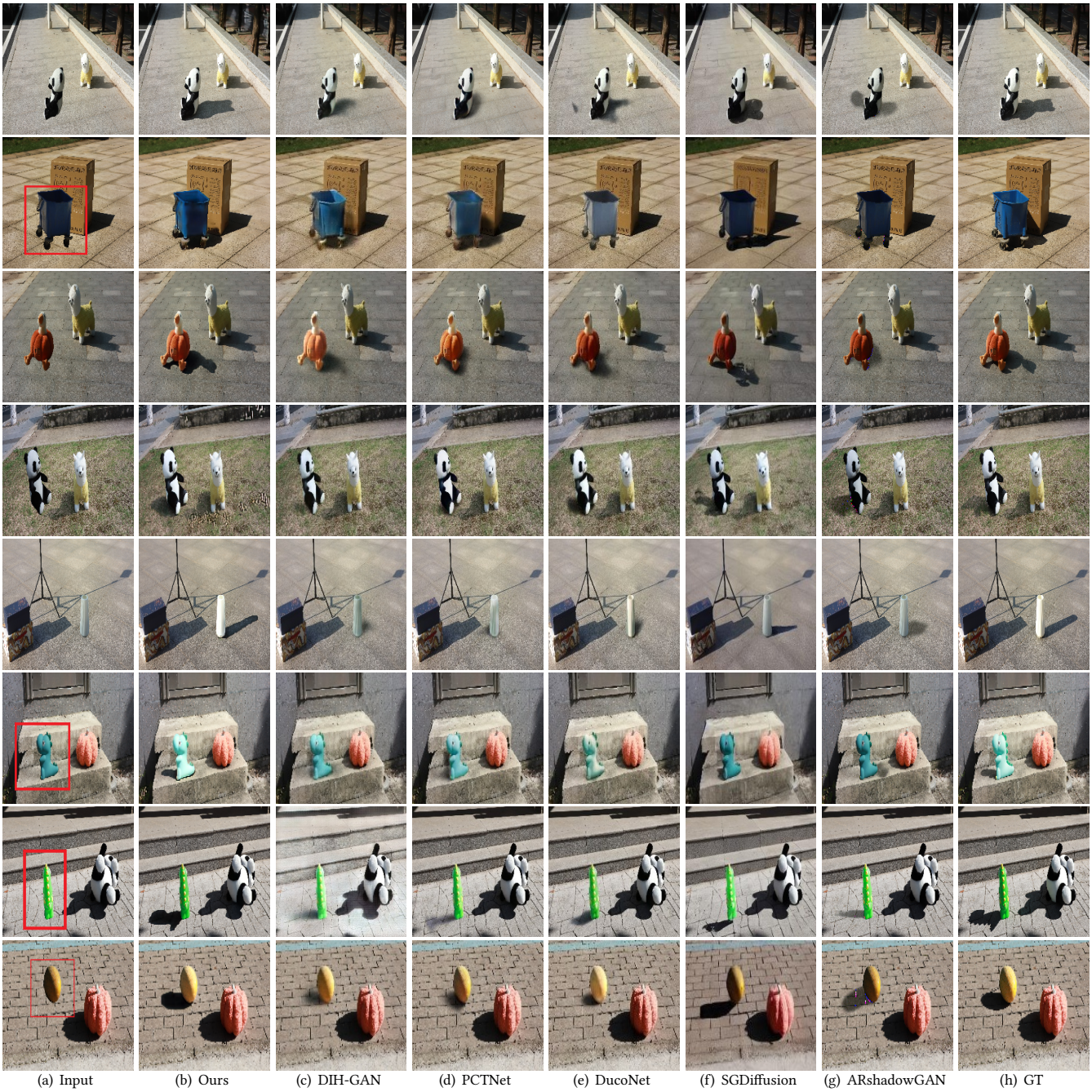
We have demonstrated more methods and the light and shadow editing results of IH-SG Diffusion. As shown in Figure 1. Compared with other methods, our results are more reasonable, harmonious, and visually closer to real images.

Table 2: The structure of shadow generation module.

	Layer name(s)
1	Conv(3, 64, 3, 1, 1) + ReLU
D1-1	Conv(64, 64, 3, 1, 1) + ReLU
D1-2	Conv(64, 64, 3, 1, 1) + ReLU + maxpool
D2-1	Conv(64, 128, 3, 1, 1) + ReLU
D2-2	Conv(128, 128, 3, 1, 1) + ReLU + maxpool
D3-1	Conv(128, 256, 3, 1, 1) + ReLU
D3-2	Conv(256, 256, 3, 1, 1) + ReLU + maxpool
D4-1	Conv(256, 512, 3, 1, 1) + ReLU
D4-2	Conv(512, 512, 3, 1, 1) + ReLU + maxpool
M1	Conv(512, 1024, 3, 1, 1)
M2	Conv(1024, 1024, 3, 1, 1)
U4-1	ConvT(1024, 512, 3, 2, 1)
C1	Concat(U4-1, D4-2)
U3-1	Conv(1024, 512, 3, 1, 1) + ReLU
U3-2	Conv(512, 512, 3, 1, 1) + ReLU
U3-3	ConvT(512 256, 3, 2, 1)
C2	Concat(U3-3, D3-2)
U2-1	Conv(512, 256, 3, 2, 1) + ReLU
U2-2	Conv(256, 256, 3, 1, 1) + ReLU
U2-3	ConvT(256 128, 3, 2, 1)
C3	Concat(U2-3, D2-2)
U1-1	Conv(256, 128, 3, 2, 1) + ReLU
U1-2	Conv(128, 128, 3, 1, 1) + ReLU
U1-3	ConvT(128, 64, 3, 2, 1)
C4	Concat(U1-3, D1-2)
U0-1	Conv(128, 64, 3, 1, 1) + ReLU
U0-2	Conv(64, 64, 3, 1, 1) + ReLU
out	Conv(64, 1, 3, 1, 1)

REFERENCES

[1] Zhongyun Bao, Chengjiang Long, Gang Fu, Daquan Liu, Yuanzhen Li, Jiaming Wu, and Chunxia Xiao. 2022. Deep Image-based Illumination Harmonization. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 18542–18551.



(a) Input (b) Ours (c) DIH-GAN (d) PCTNet (e) DucoNet (f) SGDiffusion (g) ARshadowGAN (h) GT

Figure 1: Three testing cases of diferent methods on IH-SG dataset. From left to right are composite images, the results of our results, DIH-GAN [1], PCTNet [2], DucoNet [5] and the SGDiffusion [4], ARshadowGAN [3] and ground truth, respectively.

[2] Julian Jorge Andrade Guerreiro, Mitsuru Nakazawa, and Björn Stenger. 2023. PCT-Net: Full Resolution Image Harmonization Using Pixel-Wise Color Transformations. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*. 5917–5926.

[3] Daquan Liu, Chengjiang Long, Hongpan Zhang, Hanning Yu, Xinzhi Dong, and Chunxia Xiao. 2020. Arshadowgan: Shadow generative adversarial network for augmented reality in single light scenes. In *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition*. 8139–8148.

[4] Qingyang Liu, Junqi You, Jianting Wang, Xinhao Tao, Bo Zhang, and Li Niu. 2024. Shadow Generation for Composite Image Using Diffusion model. *arXiv preprint arXiv:2403.15234* (2024).

[5] Linfeng Tan, Jiangtong Li, Li Niu, and Liqing Zhang. 2023. Deep Image Harmonization in Dual Color Spaces. In *Proceedings of the 31st ACM International Conference on Multimedia*. 2159–2167.