Recoding Color Transfer as A Color Homography (Supplementary Material)

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Abstract

In this supplementary material, we show the details of solving shading with a Laplacian smoothness constraint, the complete color transfer approximation evaluation table, and its corresponding color transfer approximation visual results. Please also check our supplementary video for video color grading extraction demonstrations.

1 Laplacian shading regularization

In this section, we describe how to minimize the cost function described in Equation 6 of the main paper. The Laplacian kernel K adopted in our method is defined as

$$K = \begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}. \tag{1}$$

The other choices for the Laplacian kernel can also produce satisfying results. The cost function can be reformulated as:

$$\min_{\underline{d}} \left\| I\underline{d} - \underline{d}_{\text{mapped}} \right\| + \lambda \left\| P\underline{d} \right\| \tag{2}$$

where $\underline{d}$ is the vector-form of the flattened 2D shading image I_D, $\underline{d}_{\text{mapped}}$ is the similar vector-form of the mapped per-pixel shadings, P is an $n \times n$ matrix that encodes the multiplicative factors for the convolution operation of each I_D pixel. P is filled with the Laplacian kernel weights. For instance, to calculate the j^{th} Laplacian shading pixel, we have:

$$\begin{cases} P_{o,j} = 1 & o \in \{j \pm 1, j \pm n_{\text{row}}\} \\ P_{j,j} = -4 \end{cases} \tag{3}$$

where n_{row} is the number of image matrix row. The other elements in P is filled with 0. The border pixels of the Laplacian shading image are also filled with the 0 (i.e. omitted for minimization). Finally, $\underline{d}$ is solved by regularized least square regression as follows:

$$\underline{d} = (I + \lambda P^{\intercal} P)^{-1} \underline{d}_{\text{mapped}}. \tag{4}$$

Empirically, we find $\lambda = 1000/(\sum_j \|P_{*,j}\|^2/n)$ suitable for most of our applications.

2 Quantitative evaluation of color transfer approximation

Table 1 shows the complete per-method PSNR errors corresponding to Table 1 in the main paper.

3 Color transfer approximation visual results

The following 4 figures contain the color transfer approximation results based on 7 classic source and target image pairs and four popular color transfer methods [1, 3, 4, 5]. These visual results correspond to the quantitative evaluation results shown in Table 1.

	3D Affine [2]				Shading Homography				Mapped Shading Homography			
Method	[1]	[3]	[4]	[5]	[1]	[3]	[4]	[5]	[1]	[3]	[4]	[5]
Pair 1	27.80	27.42	29.83	25.42	28.54	30.27	36.26	30.48	25.98	26.69	30.83	26.85
Pair 2	25.37	24.14	24.78	31.97	30.00	29.13	33.61	32.43	27.88	27.32	29.16	30.45
Pair 3	23.22	21.74	22.64	30.45	34.16	29.59	34.09	32.95	28.82	27.15	27.18	27.79
Pair 4	27.11	26.68	25.12	30.07	38.93	35.69	36.96	43.24	30.44	30.81	30.39	32.51
Pair 5	31.68	30.49	31.54	26.10	27.93	29.34	34.83	35.32	27.14	27.97	32.47	32.65
Pair 6	26.25	26.73	28.73	28.36	24.98	28.62	36.06	30.79	23.73	27.81	34.72	30.30
Pair 7	26.54	25.05	25.76	27.09	36.05	34.79	44.07	43.17	30.37	29.36	37.13	37.74

Table 1: PSNR error between the original color transfer result and its approximation.

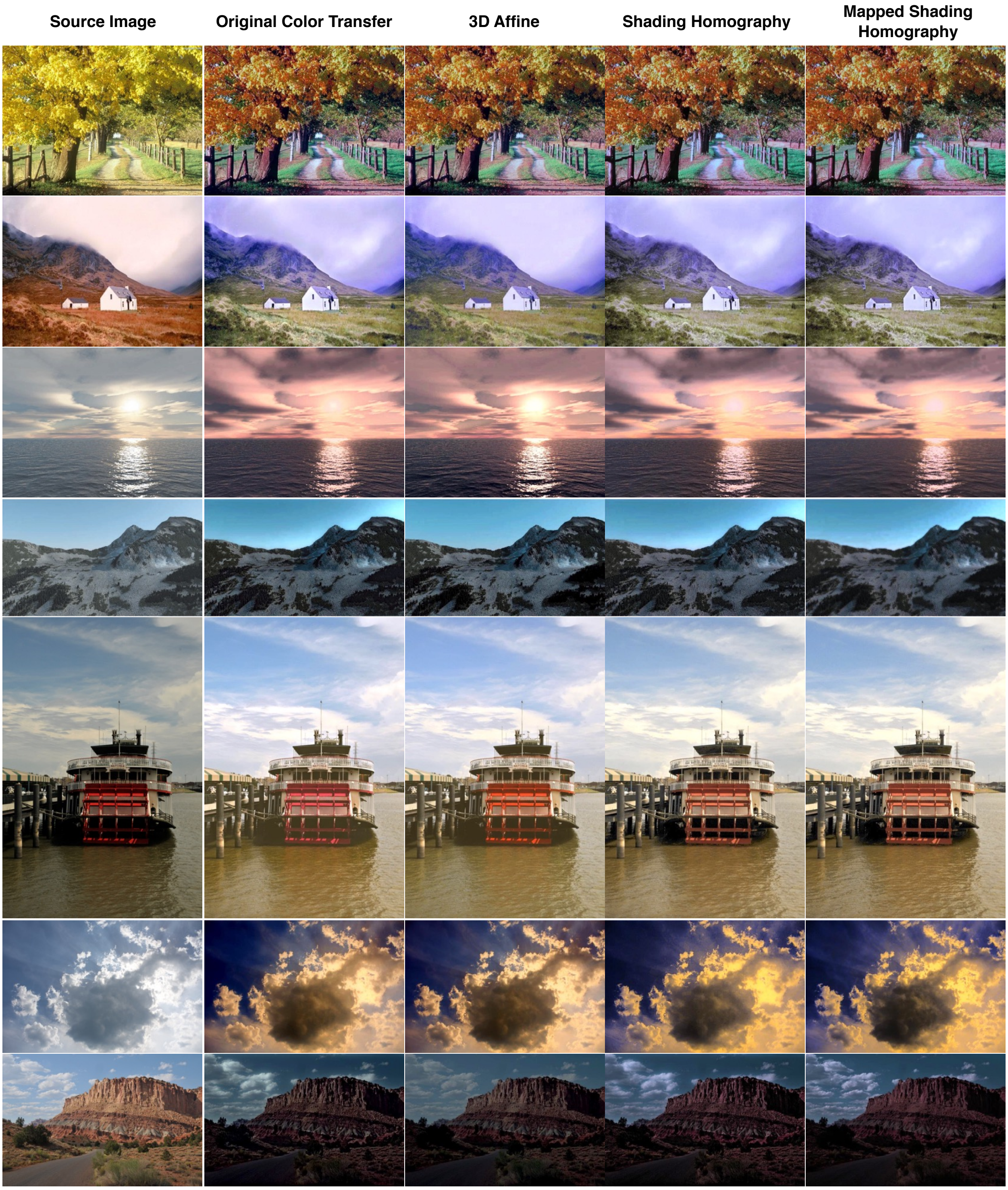

Figure 1: Visual comparisons. Original color transfer results of [1] and its approximations.

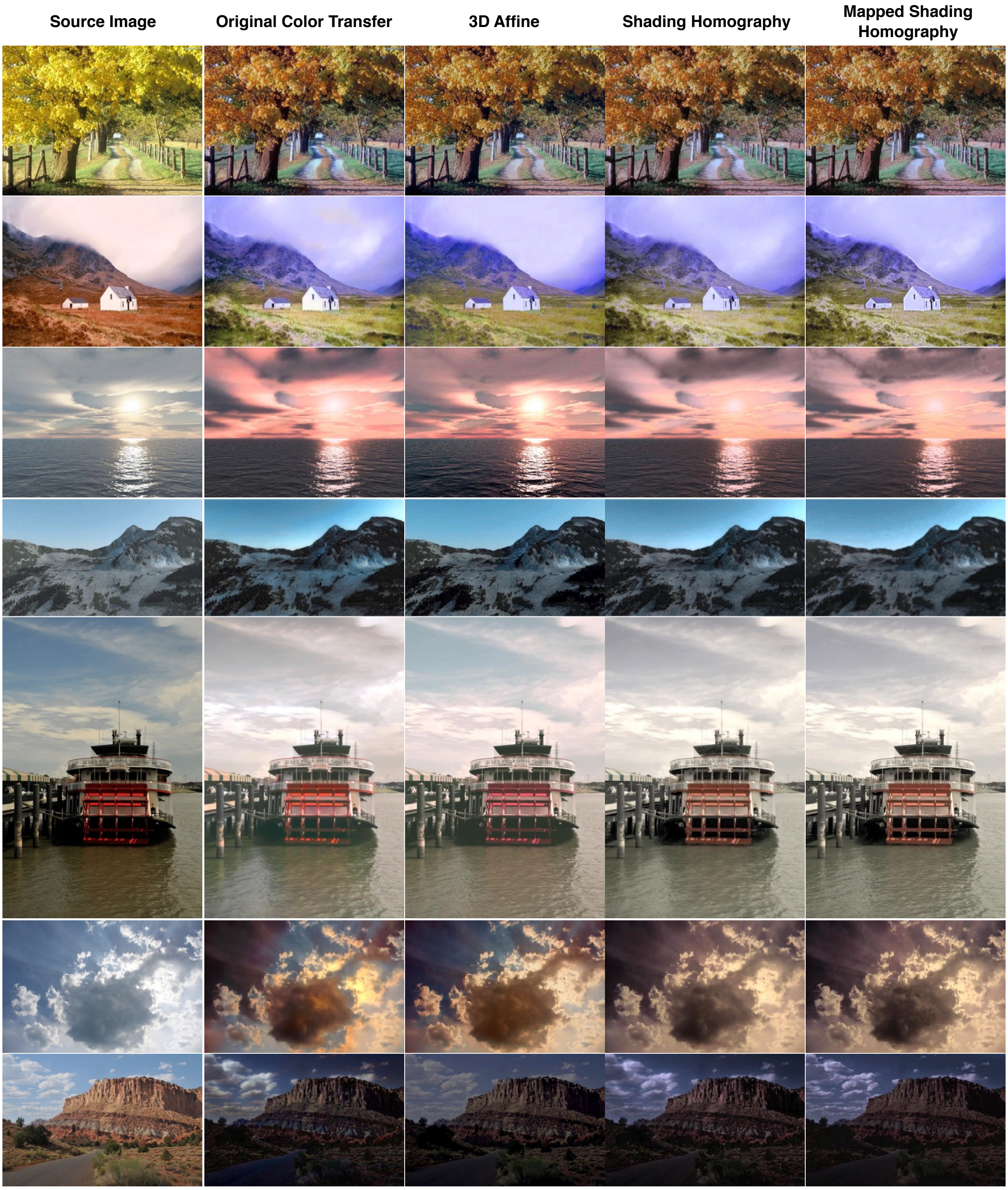

Figure 2: Visual comparisons. Original color transfer results of [3] and its approximations.

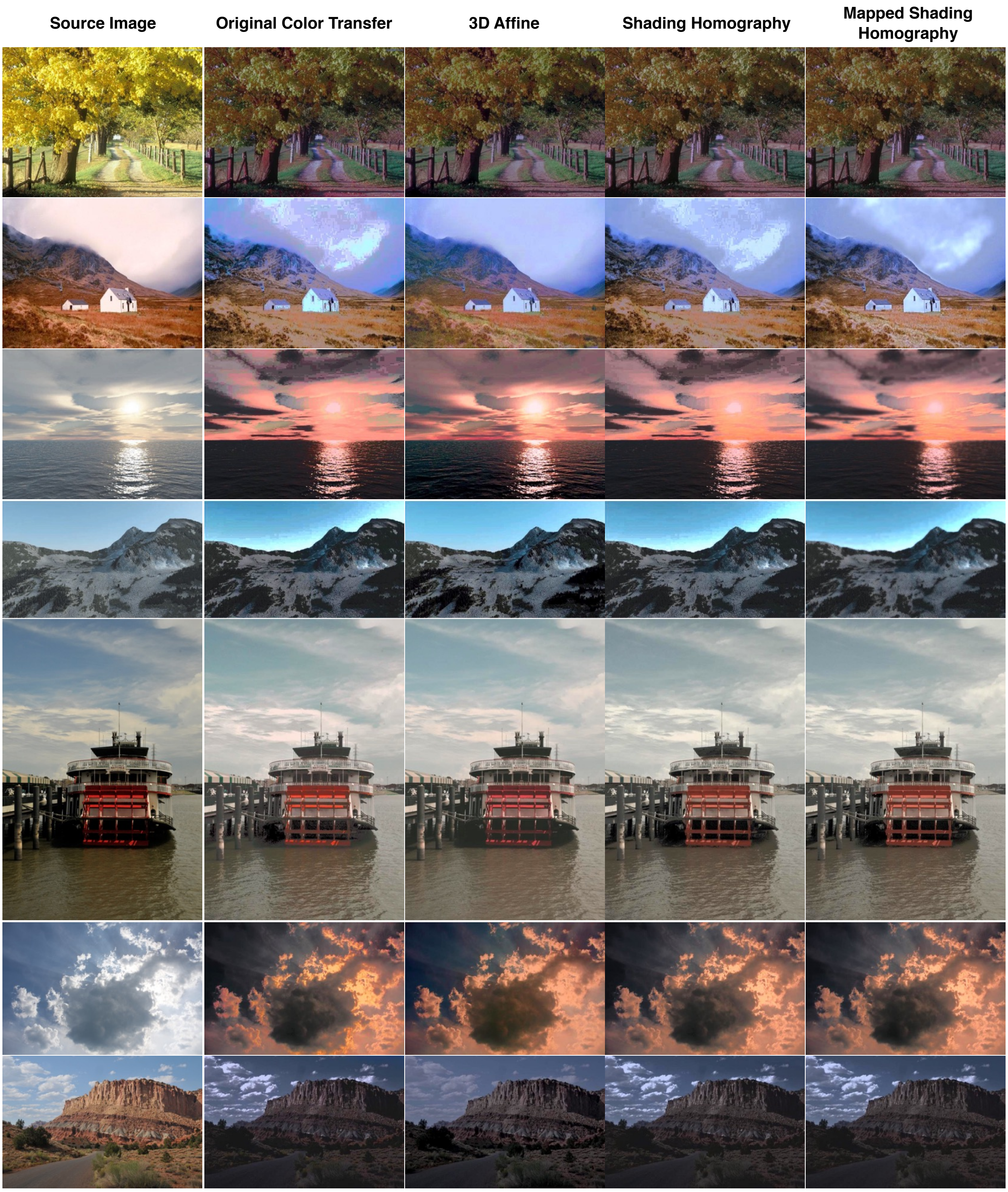

Figure 3: Visual comparisons. Original color transfer results of [4] and its approximations.

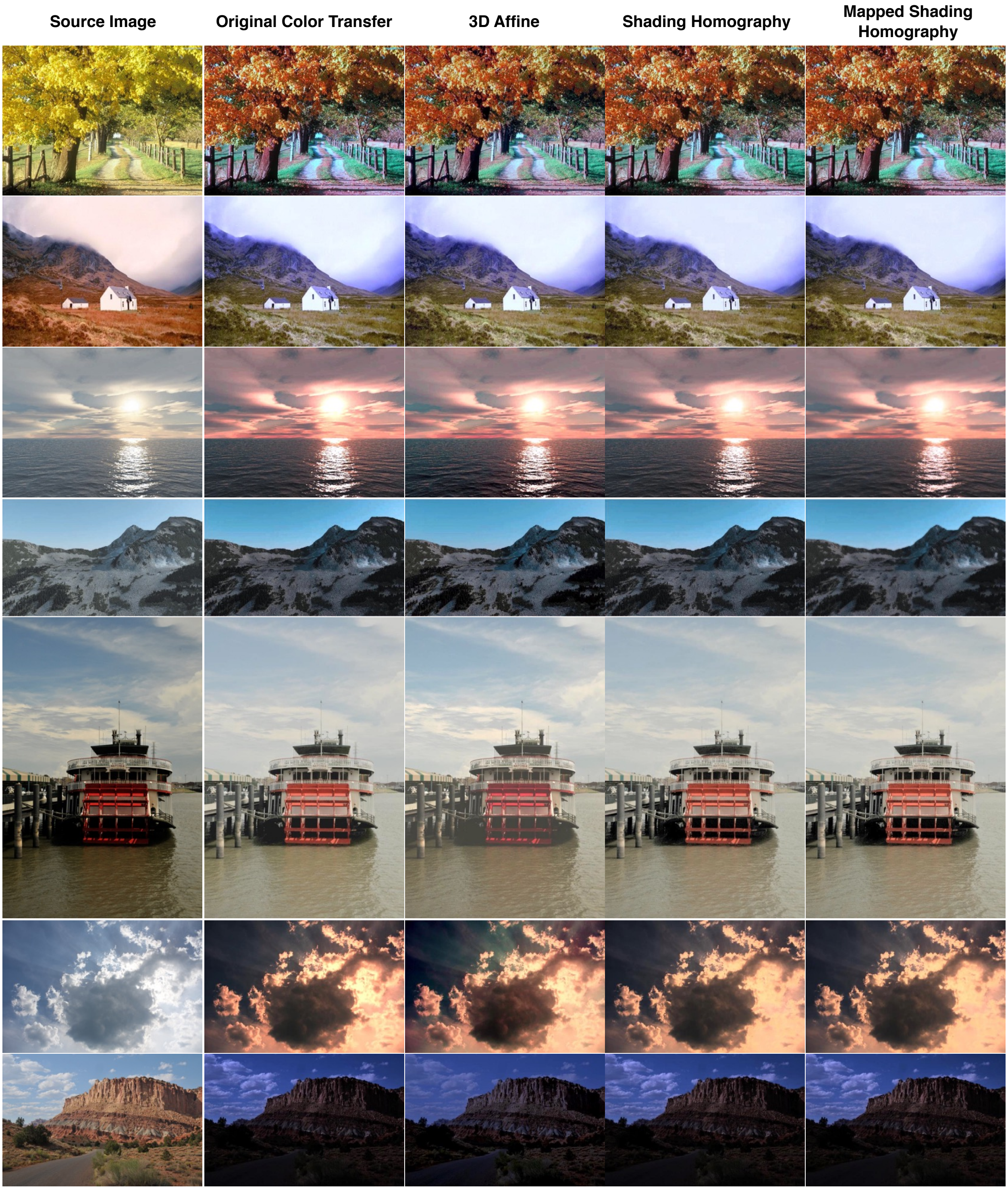

Figure 4: Visual comparisons. Original color transfer results of [5] and its approximations.

References

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