Improving Angular Parameterization for Compact Neural Materials

Zilin Xu[1,2], Yang Zhou[1], Yehonathan Litman[1], Ling-Qi Yan[2], Anton Michels[1]

[1]Meta Reality Labs Research [2]Mohamed bin Zayed University of Artificial Intelligence

Problem

We investigate the impact of different MLP input angular parameterizations on the quality of very compact neural materials.

We show that a suitable angular parameterization significantly improves visual quality, especially in cases with small MLP capacity.

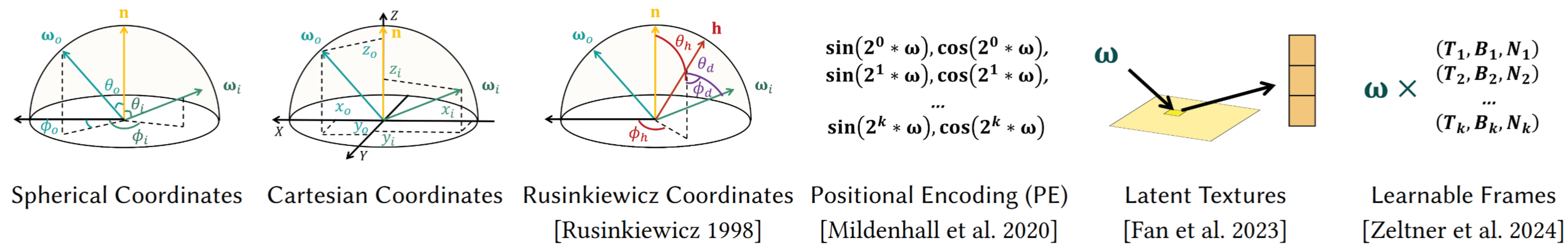

Fig. 1 Common angular parameterizations for neural materials.

We summarize the existing angular parameterizations above (Fig.1), and our goal is to answer the question:

Which angular parameterization is optimal for neural materials with tiny MLPs?

Experiment

We train MLPs with three 8 X 8 hidden layers and a 7-channel neural texture using different angular parameterizations (the angular input dim is limited to $D < 10$) from scratch on two representative measured materials:

1. Leather11, which has complex reflection, and
2. Fabric12, which has strong sheen mostly at the grazing angles.

On the right (Fig.2) we show the average test L_1 error over the entire dataset during training.

On the bottom (Fig.3), we visualize selected 2D slices of each material.

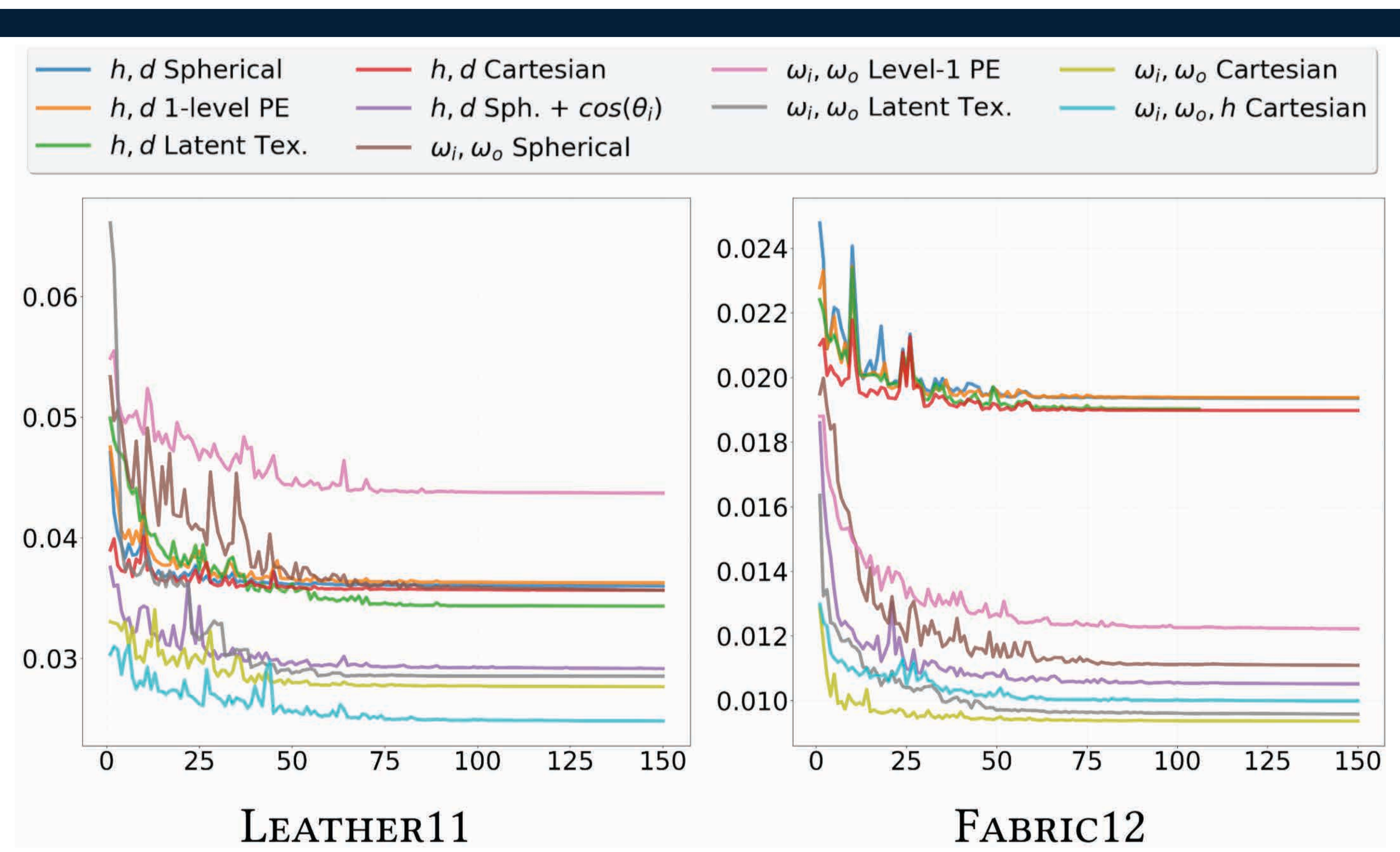

Fig. 2 The test L_1 error during training.

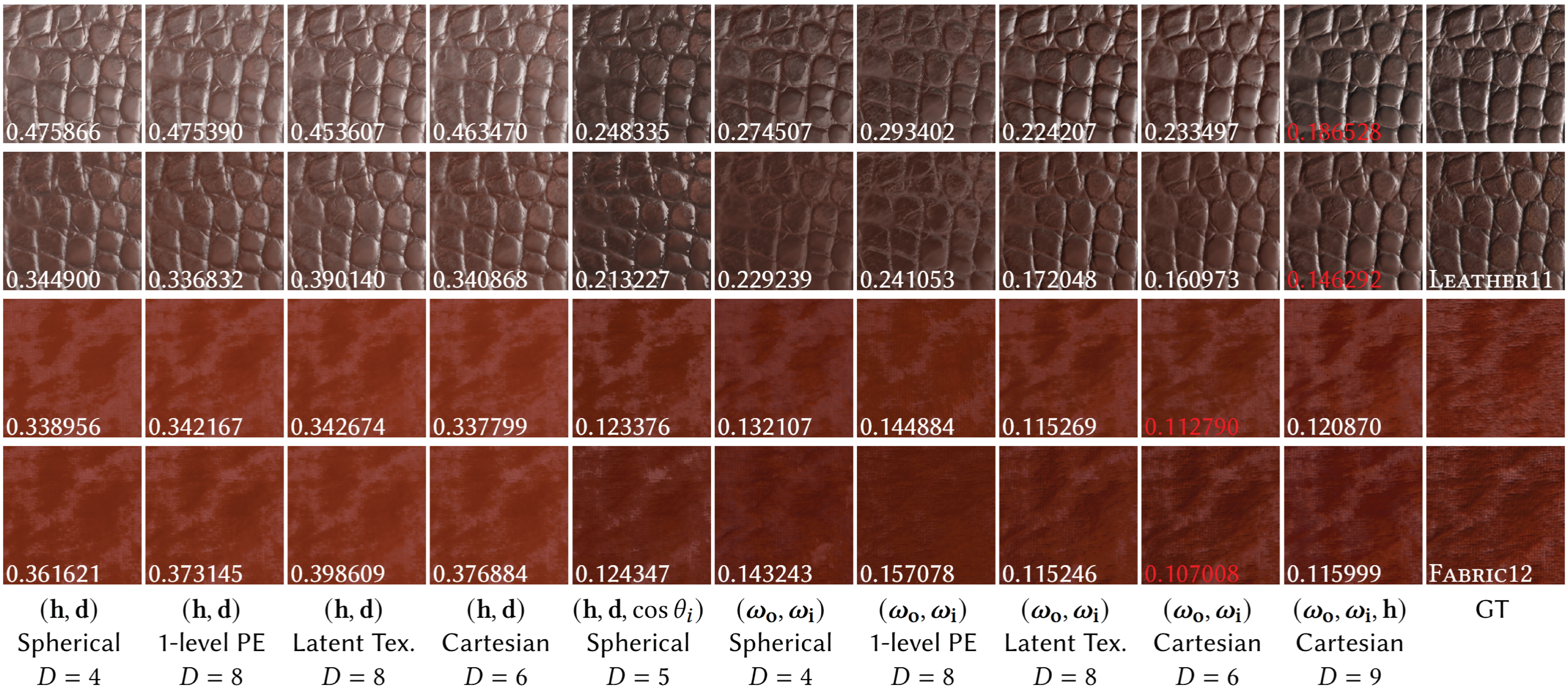

Fig.3 Each row shows the results under a different pair of input angles. Under limited input dim, sophisticated methods provide no additional benefits. Instead, providing the light falloff using $\cos(\theta_i)$ shows significant improvement. Parameterizations that include the light falloff, like using $\boldsymbol{\omega_o}, \boldsymbol{\omega_i}$ in Cartesian coordinates, consistently achieve the best quality.

Conclusion

In conclusion, we studied angular parameterizations for compact neural materials. With limited input dimensions, advanced methods fail to maintain accurate appearance, while straightforward Cartesian parameterizations achieve the best quality. Explicitly including the half vector $\mathbf{h}$ often leads to improved handling of specular reflections.