SPECTRAL PROGRESSIVE PATH TRACING

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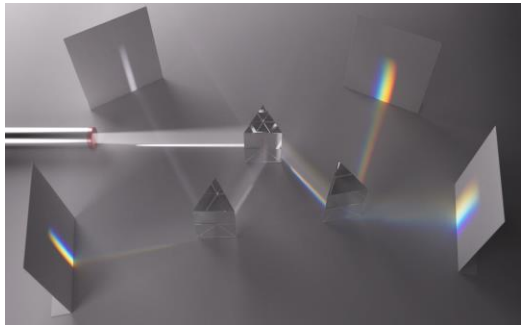
1. Introduction

Ray tracing is a popular light simulation technique for rendering high-quality, photo-realistic images. While traditional forms of ray tracing simulate light and color in RGB color space, much of the desired advanced light phenomena, such as dispersion, caustics, or iridescence, can only be properly handled with **spectral rendering**.

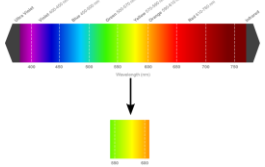


2. Problem

Path tracing is the go-to method to achieve spectral rendering. However, the process is extremely **slow**, **unresponsive**, and can easily suffer from wavelength undersampling, leading to extremely **distracting visuals** showing up in images as chromatic noises. Therefore, we want to transform this process into a **progressive renderer** where users can receive feedback at each iteration.

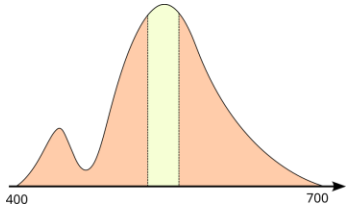
3. Methodology

1.



Choose an initial range to restrict the original wavelength distribution.

2.

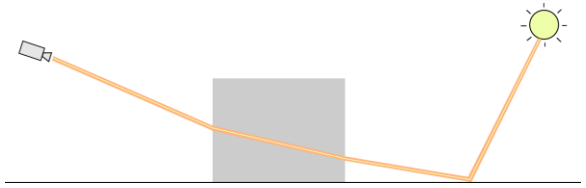


Restrict the original wavelength distribution.

All wavelengths outside the restricted range (orange) are tracked.

Sample a wavelength (yellow) from the new distribution.

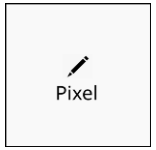
3.



Generate a path through the dispersive material based on the sampled wavelength (yellow), and record its contribution to Li.

Along the same path, propagate all unused wavelengths (orange) and track their contribution separately through Lbase.

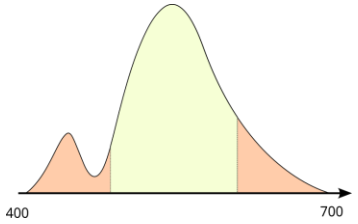
4.



If the current iteration of the progressive method does not exceed a threshold, the pixel value is calculated as Li + Lbase.

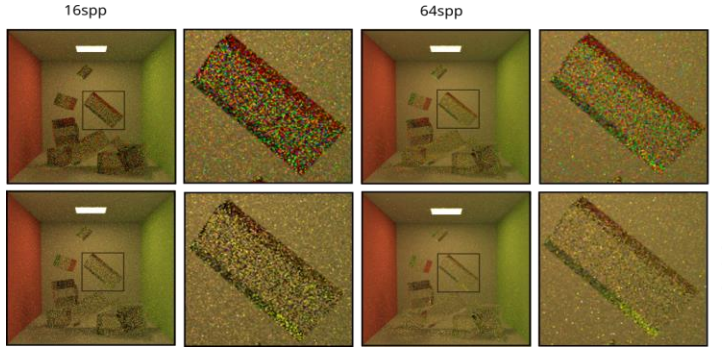
Otherwise, the pixel value is defined by Li only.

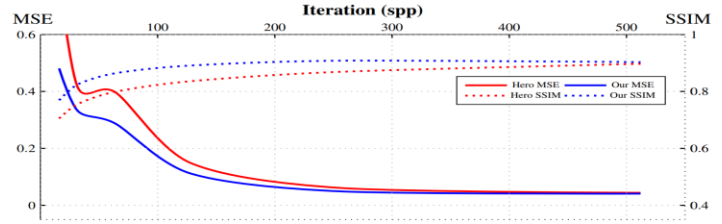
6.



Relax the range of wavelengths and repeat from step 2.

4. Results





Comparsions of our method against hero wavelength spectral sampling [1] in structual similarityy [2] and MSE.

5. Conclusions

While our method initially introduces bias in early renders, the bias gradually disappear as we obtain the final render.

Our method produces little to no overhead and can be combined with hero wavelength spectral sampling [1].

Our spectral progressive method can significantly increase structural similarity [2], and improve visual quality in early renders.

6. References

[1] WILKIE A., NAWAZ S., DROSKE M., WEIDLICH A., HANIKA J.: Hero wavelength spectral sampling. In Proceedings of the 25th Eurographics Symposium on Rendering (EGSR) (2014).
[2] WANG Z., BOVIK A., SHEIKH H., SIMONCELLI E.:Image quality assessment: From error visibility to structural similarity. IEEE Transactions on Image Processing 13, 4 (Apr. 2004).