

Adaptive Path Guiding for Global Illumination

Masters 2 Internship (4-6 months)

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Context and goal

Monte Carlo path tracing, and related algorithms (such as Metropolis) are now the standard way to produce realistic imagery in production of films, and in several other industrial domains [Fascione 18]. Importance sampling [Veach 95] is a key element to accelerating the computation of global illumination, and path guiding [Muller 17, Herlholz 16] is a specific approach that builds data-structures that model incoming light to achieve better importance sampling, that has also achieved popularity in production [Vorba 19].

Path guiding has received a lot of attention in recent years ([Muller 17, Herlholz 16, Reigold 18, Guo 18]), demonstrating its effectiveness in accelerating computation of global illumination. A major drawback of the approach is that it is not always guaranteed to perform better than the baseline method [Vorba 19]. In this internship we will perform a first study to determine a way to identify when the use of path guiding is beneficial, and develop a complete algorithm that restricts the usage of path guiding only to such cases.

Approach

Empirically, when the incident radiance field has low variance, BRDF sampling tends to outperform path guiding. We will start by analyzing this hypothesis on a test set of scenes, and investigate a set of possible measures. The goal is to robustly learn to identify the cases when path guiding is not beneficial, and define a single algorithm that automatically chooses the best rendering approach for a given scene.

A first approach will be to run rendering with path guiding (e.g., at low resolution) and then without and compare different measures that can provide a good prediction. We will investigate various statistical measures, e.g., spatial and directional variance of incoming radiance and test their efficiency. We will then investigate predictive approaches, e.g., using a machine learning approach with additional information such as geometry and materials, allowing a fast initial estimation of the effectiveness of path guiding, reducing the expense of initial rendering.

Work environment and requirements

The internship will take place at Inria Sophia Antipolis, in the beautiful French Riviera. Inria will provide a monthly stipend between 450 and 1100€ depending on the situation of the candidate. The intern will work closely with the Ph.D. students in the group.

Candidates should have strong programming and mathematical skills as well as knowledge in computer graphics (a 4th year or higher graphics course is desirable), computer vision, geometry processing and machine learning. Successful Masters internships may lead to a Ph.D. in the context of the ERC FUNGRAPH project (<http://fungraph.inria.fr>)

References

[Fascione 18] Fascione, L., Hanika, J., Pieké, R., Villemin, R., Hery, C., Gamito, M., Emrose, L. and Mazzone, A., 2018, August. Path tracing in production. In *ACM SIGGRAPH 2018 Courses* (p. 15). ACM.

[Veach 95] Veach, Eric, and Leonidas J. Guibas. "Optimally combining sampling techniques for Monte Carlo rendering." In *Proceedings of the 22nd annual conference on Computer graphics and interactive techniques*, pp. 419-428. ACM, 1995.

[Vorba 19] Jiří Vorba, Johannes Hanika, Sebastian Herholz, Thomas Müller, Jaroslav Křivánek, and Alexander Keller. 2019. Path guiding in production. In *ACM SIGGRAPH 2019 Courses* (SIGGRAPH '19). ACM, New York, NY, USA, Article 18, 77 pages. DOI: <https://doi.org/10.1145/3305366.3328091>

[Herlholz 16] Herholz, Sebastian, Oskar Elek, Jiří Vorba, Hendrik Lensch, and Jaroslav Křivánek. "Product importance sampling for light transport path guiding." In *Computer Graphics Forum*, vol. 35, no. 4, pp. 67-77. 2016.

[Reibold 18] Reibold, Florian, Johannes Hanika, Alisa Jung, and Carsten Dachsbacher. "Selective guided sampling with complete light transport paths." In *SIGGRAPH Asia 2018 Technical Papers*, p. 223. ACM, 2018.

[Guo 18] Guo, J., Bauszat, P., Bikker, J. and Eisemann, E., 2018. Primary sample space path guiding. In *Eurographics Symposium on Rendering* (Vol. 2018, pp. 73-82). The Eurographics Association.

[Muller 17] Müller, Thomas, Markus Gross, and Jan Novák. "Practical path guiding for efficient light-transport simulation." In *Computer Graphics Forum*, vol. 36, no. 4, pp. 91-100. 2017.