Accelerating View Factor Computations for Complex Geometries notably with Obstacles

Abstract:

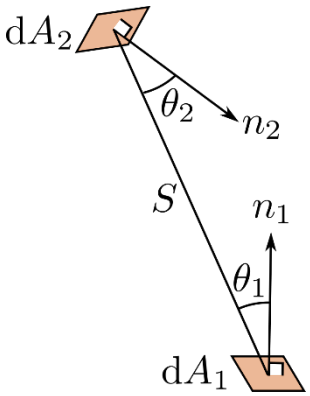
View factor, also known as form factor, shape factor, or configuration factor, is a crucial parameter in various scientific and engineering applications, such as heat transfer analysis, radiation modelling, and urban planning. Accurate computation of view factors, especially in the presence of obstacles and complex geometries, is often computationally intensive, which can limit the efficiency of simulations and analyses. This research project aims to develop innovative methods and algorithms to significantly reduce the computation times of view factors while maintaining high accuracy, particularly in scenarios where obstacles bring additional computational challenges.

$$dF_{1\to 2} = \frac{\cos\theta_1 \cos\theta_2}{\pi s^2} \mathrm{d}A_2$$

Formula for two differential areas

$$F_{1\to 2} = \frac{1}{A_1} \int_{A_1} \int_{A_2} \frac{\cos\theta_1 \cos\theta_2}{\pi s^2} \, \mathrm{d}A_2 \, \mathrm{d}A_1$$

Formula for general surfaces



The previous formulae are not that trivial to solve depending on the configuration of the two considered geometric elements. Abacuses and forms have been edited and used for common industrial configurations. State of the art papers even proposed a closed form formula for any pair of convex polygons. However, all the previous methods, including the original formulae above, no longer apply in presence of visibility obstacles between the two considered faces. To bypass this issue, research have been conducted to approximate the view factor value using quadrature techniques, such as polygonal quadrature or even point base quadrature from Monte Carlo Ray Tracing approaches. The main drawbacks of such methods rise from the intensive computation times and the difficulty to quantify the associated error.

References:

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