Appendix T

Enhancement of ray tracing method for radiative heat transfer with new Isocell quasi-Monte Carlo technique and application to EUI space instrument baffle

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Abstract

The finite element method (FEM) is widely used in mechanical engineering, especially for space structure design. However, FEM is not yet often used for thermal engineering of space structures where the lumped parameter method is still dominant. Radiative exchange factors (REFs), used to calculate radiative thermal exchanges in space, are usually computed through Monte Carlo ray-tracing. Due to the large number of elements composing a FE model, the computation of the REFs is prohibitively expensive. In the frame of a global approach, several research axes will be investigated to reduce the computational effort of the REFs with FEM. The first one focuses on accelerating the convergence and enhancing the accuracy of the ray-tracing process to decrease the number of rays required to achieve a given accuracy. The developments of the new Isocell quasi-Monte Carlo ray tracing method are presented. Based on Nusselt's analogy, the ray direction sampling is carried out by sampling the unit disc to derive the ray directions. The unit disc is divided into cells into which random points are then generated. The cells have the particularity of presenting almost the same area and shape. This enhances the uniformity of the generated quasi-random sequence of ray directions and leads to faster convergence. This Isocell method has been associated with different surface sampling to derive the REFs. The method is benchmarked against ESARAD, the standard thermal analysis software used in the European aerospace industry. Various geometries have been used. In particular, one entrance baffle of the Extreme Ultraviolet Imager (EUI) instrument developed at the Centre Spatial de Liège in Belgium is used. The EUI instrument of the Solar Orbiter European Space Agency mission and will be launched in a Sun-centered (0.28 perihelion) orbit in 2018.



































Thank you for your attention...

Any question?

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