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USE OF AN OPTIMISATION TECHNIQUE FOR THE CORRELATION OF AEROTHERMAL DATA ON GEOMETRIC PRIMITIVES FOR DEBRIS DEMISE CALCULATIONS

Abstract

The accuracy of numerically simulated space debris demise scenarios is of key concern to space agencies and hardware manufacturers around the world, particularly in the case of spacecraft heating. This study describes the use of Kriging, a multivariate engineering optimisation technique otherwise known as Wiener-Kolmogarov prediction, and various sampling techniques to correlate normalised convective thermal fluxes on the surfaces of geometric primitives towards the improvement of the accuracy of debris demise calculations.

The data from a series of three-dimensional, low-enthalpy DSMC analyses, run using the University of Strathclyde's dsmcFoam solver, are presented. These scenarios simulate rarefied (slip regime) flow as it develops over the curved edge of a cylindrical geometry - such as that used in modern debris demise codes – at varying angles of incidence to the flow using the conditions for a single trajectory point. A subset of the data from these analyses is then generated using two different methods: simple index-based sampling, and a combination of linear interpolation and Latin Hypercube Sampling technique. Hence, a basic two-variable Kriging model of the edge thermal fluxes is generated using the angle of incidence and radial coordinate of the cylinder as the input arguments. The predictions of this model are then compared to historic correlations for this type of flow, and to other data sets extracted from the same simulations which have not been correlated against. From this, the accuracy of the method for larger datasets with more input arguments (such as Mach and Knudsen numbers) is assessed.