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RAPID THERMAL DEFORMATION ANALYSIS OF ON-ORBIT SATELLITES BASED ON TELEMETRIC DATA OF TEMPERATURE

Abstract

Different from the optical imaging payload, hard X-ray modulation telescope (HXMT) can't be calibrated using the target whose position is already determined. While the image of a X-ray source is reconstructed using the data obtained by the HXMT, the position of the X-ray source will be determined by the orientation position offered by the control system of the satellite. So, it is necessary to develop a suitable method to ensure the position accuracy offered by the satellite meets the requirements of the mission.

The error of the orientation position of the HXMT is influenced by several factors, in which the most significant factor is the thermal deformation caused by the drastic changing of structure temperature in space. While the HXMT is operating on-orbit, it is difficult to measure the thermal deformation of the structure directly. Alternatively, temperature of the HXMT can be easily obtained from telemetric data. But compared to the amount of temperature data needed to finish the finite element analysis, HXMT only has very few temperature sensors. So, to obtain the temperature field of the HXMT based on the small amount of temperature sensors, statistic methods such as interpolation are needed.

A rapid thermal deformation analysis method based on telemetry temperature is developed in this work. To improve the accuracy of the thermal deformation analysis, the ordinary kriging method which is widely used in geo-statistics is applied into the process of temperature estimation of the HXMT satellite. Based on a small amount of temperature sensors, estimation of the temperature field is carried out during vacuum thermal test of the satellite. Then, the temperature field is used for the finite element analysis to accomplish the thermal deformation analysis. Differences between the analytical and the experimental results of the changing of orientation position caused by thermal deformation are around 1 minute. What's more, compared with using thermal physical method, the time period needed to obtain the temperature

field of the structure using the method proposed in this paper can be reduced from several days to a few minutes. This paper provides guidance for rapid thermal deformation analysis for on-orbit satellites.