Paper ID: 35504
student

14TH IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Measurements (1)

Author: Mr. Thomas Scruggs
University of Florida, United States

Dr. Norman Fitz-Coy
University of Florida, United States
Mr. Kyle Kreiter
University of Florida, United States
Mr. Matthew Moraguez
University of Florida, United States
Mr. Kunal Patankar
University of Florida, United States

AVERAGE CROSS-SECTIONAL AREA OF DEBRISAT FRAGMENTS USING VOLUMETRICALLY CONSTRUCTED 3D REPRESENTATIONS

Abstract

Debris fragments from the hypervelocity impact testing of DebriSat are being collected and characterized for use in updating existing satellite breakup models. One of the key parameters utilized in these models is the ballistic coefficient of the fragment, which is directly related to its area-to-mass ratio. However, since the attitude of fragments varies during their orbital lifetime, it is customary to use the average cross-sectional area in the calculation of the area-to-mass ratio. The average cross-sectional area is defined as the average of the projected surface areas perpendicular to the direction of motion and has been shown to be equal to one-fourth of the total surface area of a convex object. Unfortunately, numerous fragments obtained from the DebriSat experiment show significant concavity (i.e., shadowing) and thus we have explored alternate methods for computing the average cross-sectional area of the fragments.

An imaging system based on the volumetric reconstruction of a 3D object from multiple 2D photographs of the object was developed for use in determining the size characteristic (i.e., characteristics length) of the DebriSat fragments. For each fragment, the imaging system generates N number of images from varied azimuth and elevation angles and processes them using a space-carving algorithm to construct a 3D point cloud of the fragment. This paper describes two approaches for calculating the average cross-sectional area of debris fragments based on the 3D imager. Approach A utilizes the constructed 3D object to generate equally distributed cross-sectional area projections and then averages them to determine the average cross-sectional area. Approach B utilizes a weighted average of the area of the 2D photographs to directly compute the average cross-sectional area. A comparison of the accuracy and computational needs of each approach is described as well as preliminary results of an analysis to determine the "optimal" number of images needed for the 3D imager to accurately measure the average cross sectional area of objects with known dimensions.