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DESIGN FOR ADDITIVE MANUFACTURING IN THE CONTEXT OF CUBESAT PRIMARY STRUCTURES

Abstract

This paper investigates the effects of additive manufacturing (AM) on the design, structural performance, manufacturing process and cost of CubeSat primary structures. The motivation of the paper is to arrive at a structure that can outperform classic CubeSat designs, at a lower production cost that relies on a shorter manufacturing time. Small satellites are intended to be an affordable alternative to full scale satellites for Universities to design and build, and more recently they have become a way to attract commercial revenue as part of constellations. As a result, a more affordable and well performing structure can lead to more Universities taking up small satellite projects and to more profit on the commercial side. The paper first analyzes the performance of a regular CubeSat structure produced through Subtractive Manufacturing (SM) at the University of Southampton. Having gathered the baseline data, the paper investigates various gridded structures which will replace the classic cutouts on the CubeSat sides. Gridded structures have the advantage of requiring far less effort and resources in the cleanup phase, after the metal 3D printing takes place, because their gaps can be small enough to not need support structures. They also offer the potential for an improved structural performance over the regular triangular cutouts. The gridded structures shall be put under various loading scenarios in ANSYS and then they shall be integrated in the CubeSat structure for further dynamic analysis. The paper shall arrive at an optimal type of gridded structure both from a performance and a manufacturing standpoint. The paper will then analyze various ways to split the structure, since 3D printing allows for the CubeSat to be manufactured out of fewer parts instead of the usual six. This can lead to a more monolithic structure that can offer better performance and weight saving capabilities. This investigation will also be performed with an awareness of the importance of access for systems integration. Finally, the best combination between a grid type and a cube partition shall be further tested and optimized. The cell size of the grid can be varied along with the wall thickness, all within the printing capabilities of the metal 3D printer at the University of Southampton.