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CUBESAT THERMAL ANALYSIS AND DESIGN: TECHNIQUES AND REFERENCE GUIDELINES FOR CUBESAT DEVELOPERS

Abstract

In recent years, the number of CubeSat missions launched have increased significantly. Although CubeSat projects have gathered a lot of interest and success, studies show that approximately 30% of CubeSat projects still end up not meeting all of their mission success criteria. There can be many factors in the design process that can lead to failure, and one of these factors which is equally as important is CubeSat thermal analysis and design. A lot of literature available for spacecraft thermal analysis is mostly generic but we know that different spacecraft designs require different thermal analysis approach for which extensive knowledge combined with experience is necessary. Nanosatellite developers come from a vast range of backgrounds, therefore, many of them are not familiar with the space mission design requirements. This can result in thermal analysis being neglected in initial stages, which can force changes to the design to meet the thermal requirements in later phases of the project; consequently, adding complexity and delays to the whole project. This paper will discuss the importance of thermal analysis methods and techniques applicable only to CubeSats in order to help increase the mission success rate. To achieve such a goal, the paper will discuss two main techniques using three different software packages. These include MATLAB, Ansys, and ESATAN using FDM, FEM and FDM techniques respectively. HinCube is taken as a reference CubeSat, developed by the UiT students, to apply the above tools and validate the results. The paper is intended to provide the CubeSat community with baseline methodology combined with indispensable geometric modeling required to get optimum thermal analysis results. Moreover, it will compare the differences of the tools mentioned above in order to be able to choose between them depending on specific mission requirements. Finally, the proposed methodology will be verified by comparing results with laboratory testing and basic hand calculations. As discussed earlier, one requires experience to do their job successfully as a thermal engineer. So, the objective of this paper is to give head start to those who are new to nanosatellite by providing them with clear, concise, and tailor solution which cater only CubeSat thermal analysis and eventually help increase the mission success rate for them. This can also contribute towards a reduction in cost, time, and personnel resources. In the end, thermal control methods tailored for CubeSats will be discussed, with a special focus on the passive control methods.