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STATISTICAL ANALYSIS OF CUBESATS IN ORBIT FAILURES

Abstract

Development of CubeSat-type satellites has become more and more popular during last years. In the beginning of XX century, CubeSat projects were characterised for their educational-driven objectives. However, in the last years the education objectives have given way to CubeSat projects with other-than-education mission objectives, like Earth observation and technology demonstration. This new objectives require the development of appropriate technology. Furthermore, it is necessary to ensure a certain level of reliability, because CubeSats missions, and in particular education-driven missions, often failed. Even if this considerable number of failures is well known in the CubeSat community, there is no empirical analysis of CubeSats missions' reliability. The aim of this study is to fill this gap by characterising failure behaviour of CubeSats through a statistical analysis of actual in orbit failures. The evaluation is based on CubeSats missions rate of success gathered in a database created by the authors. The analysed data in this paper, contained in the database, consists on available public information regarding failures occurred on the 175 CubeSats launched from 2003 until 2013 (excluding launch failures). First, a thorough non-parametric statistical analysis of CubeSats failures is conducted, taking into account the characteristics of the available data (i.e. right censored with staggered entry). Then, a parametric method is used in order to identify what probability distribution function the observed data could be fitted into. Finally, the observed CubeSats reliability is compared with the reliability of all-type of satellites already available in recent studies. The statistical analysis shows the reduced observed reliability of CubeSats with respect to classical satellites. Moreover, the obtained output reveals that in orbit CubeSats failures data follows reasonably well a Weibull distribution. This evidence shows that CubeSats are characterised by an infant mortality. Concluding, these results confirm the CubeSat community perception of actual reduced reliability of this type of satellites and the need to individuate new techniques to improve CubeSats missions' rate of success.