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USING THE ANALYTIC HIERARCHY PROCESS IN THE ASSESSMENT OF THE PROBABILITY FOR AN EXPLOSION TO OCCUR DURING THE ATMOSPHERIC RE-ENTRY

Abstract

Most unmanned space missions end up with a destructive atmospheric re-entry. From ten to forty percent of a re-entering satellite's mass may survive re-entry and hit the Earth's surface. This has the potential to be a hazard to people, fauna, flora and produce economic damages.

The severe consequences of inaccurate predictions of the area where the debris can re-enter and land result in the need to consider all the possible causes of fragmentation. This paper proposes a risk assessment model aimed to assess the probability for a high speed atmospheric explosion to occur during the re-entry. Risk assessment for re-entering spacecraft is made difficult because there is very litte historical information.

The scenario of a re-entering spacecraft explosion can be considered as the result of the occurrence and combination of the failures of specific components. These failures are named elementary or triggering events. In this respect, after the identification of the triggering events that can lead to an explosion of the vehicle, the main issue is the lack of data that can be used to assess the probability for each elementary events to occur. As a consequence, effective evaluation of the probability for an explosion to occur must be based on the judgement of experts in atmospheric re-entry.

In this paper we describe the developed algorithm and how a multi-criteria decision making approach, called the Analytic Hierarchy Process, can be applied as method for the elicitation, combination and quantification of the expert opinion. Elicitation is the process of formulating and translating in statistical terms the scientific hypothesis of a group of experts. The mathematical details of the procedure are discussed and the results of a case-study are reported.