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A CONCEPTUAL DESIGN OF GUIDANCE & CONTROL SYSTEM OF REUSABLE UPPER STAGE OF SMALL SATELLITE LAUNCHER

Abstract

In this paper, a re-entry and landing method using aeroshell and Para-foil technology of upper stage of small satellite launcher is presented. Epsilon rocket is a Japanese small satellite launcher developed by JAXA, and in the future, it is expected to build up to next generation rocket which increases its launch capability and responsiveness to offer short term repetitive launch opportunities. It is also demanded that the launch price is reduced and the frequency of the small satellite launch is increased. To meet the same demands, many reusable rockets are proposed worldwide recently. The reuse of first stage such as Falcon 9 was realized as one of the reuse technologies, but the reuse of the upper stage is not carried out yet for expendable rocket. The purpose of reuse of upper stage is to reduce the launch cost by reusing the system including the expensive avionics and the post boost stage that are a dominant factor of the cost in the small launcher. We studied one of the key technologies to guide to the landing point while using an aeroshell to suppress the aerodynamic heating at the time of the re-entry of the upper stage. The flight path is optimized with the aeroshell and Para-foil guidance and control for reducing the heat input and landing safely. We show the demonstration results with the small Para-foil to land it in the planned landing area. This Para-foil also becomes an applicable technique for the recovery of small spacecraft from the low earth orbit with the aerobrake by aeroshell in the atmosphere. In the past, the flight dmonstration of the sub-size model of Para-foil was performed to confirm their performance. In this paper, we show the upper stage recovery system concept for advanced small satellite launcher and its guidance and control method using the aeroshell and the Para-foil. Finally, the aeroshell guidance and control method is newly presented.