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MANNED SPACECRAFT EMERGENCY SEPARATION DURING ATMOSPHERIC ASCENT

Abstract

Crew safety is a key point of manned space mission designing, especially for the atmospheric part of launch trajectory. The task of launch escape system in a case of catastrophic failure on the launch pad or launch vehicle in ascent is to separate the capsule, get it away from the launch vehicle, and provide landing. The paper considers reentry module separation dynamics in case of the launch vehicle failure during the atmospheric ascent for the modern modification of Soyuz spacecraft, which is currently the only means of delivering cosmonauts to the ISS. To protect against aerodynamic heating the Soyuz spacecraft is covered by fairing which is jettisoned after passing upper atmosphere. In case the launch vehicle fails, the spacecraft along with nosecone separates by means of mounted solid propellant engines and goes off the rocket. And then reentry module separates from the nosecone. The task of reentry module separation simulation is to get relative motion trajectories, estimate possibility of contact between reentry module and nosecone and the force of interaction. Initially a reentry module is almost completely hidden under the fairing, so aerodynamic forces and moments do not influence it. During separation the considered configuration constantly changes and so is the aerodynamic effect. The aerodynamic interference takes place. At the same time practical approaches are unfeasible because of nosecone rotation and variety of separation condition. Taking into account the aerodynamic interference and possible contact interaction, the calculation method of two bodies with overlapping zone separation is developed. It combines relative motion dynamics methods and numerical aerodynamic simulation ones. Soyuz reentry module separation is analyzed in case the launch vehicle fails at the end of atmospheric ascent. Simulation results are used for launch escape system's characteristics redetermination and safety validation of reentry module separation. Described approach could be used for considering relative motion of bodies with overlapping zone in atmosphere.