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MATHEMATICAL MODELS FOR RISK AND DANGER ZONES IN CASE OF SMALL ORBITAL LAUNCHERS

Abstract

The purpose of this paper is to present some aspects regarding two calculus models: one to evaluate risk zone and the other to define danger zones of the Small Orbital Launcher (SOL). Regarding the model for risk zone, different from that one used for evaluation of the launcher performance, we will use a mathematical model build on non-inertial frames which participle to the diurnal Earth rotation. This is necessary in order to link risk zone of the launch location, and place them on the map of the launching site. For risk zone we will use actually two models: one build in start frame which is more suitable for guided ascending phase and second in quasi – velocity frame used for unguided motion especially in descending phase. For dangerous zone, the model is based on canonical decomposition of the random inputs, and outputs. This approach allows solving a class of problems, which can be easily implemented as calculus software. The method is applied through integration of the equations of motion in linear form during ascending guided phase of the trajectory. It is take in consideration the influence of the random constraints as aerodynamic asymmetry, thrust command error, or noise sensors during guided flight. The method allows obtaining directly the output dispersion of the coordinates of the SOL starting from dispersion of any kind of random input signal. Although the solution appears to be complicated, leading to a high number of equations (4 times the number of frequencies), due to its symmetry and generality character, is a convenient method for solving these categories of problems, the majority of them having no analytic solutions. In terms of results obtained with the considered calculus model, we will evaluate the average of guided trajectory and the dispersion around them in horizontal plane. The novelty aspect results in its technical purpose that to finding solutions for a real problem, using an adequate model from random function class. The model proposed is an alternative to other models class, which uses random generated numbers, and can be use for cross checking between this two model classes. The discussions will focus around the possibility to find a launching area which satisfies in terms of risk and danger conditions that arising from the work. The work is a part of ESA project Study – concept, to achieve a Small Orbital Launcher through zonal cooperation - SOL