SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

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MATHEMATICAL MODEL FOR EVALUATION OF THE PRECISION OF GUIDED FLIGHT DURING TERMINAL PHASE AND AUTOMATIC LANDING FOR PRIDE VEHICLE

Abstract

The paper presents a random calculus model for precision of guided flight during terminal phase and automatic landing of PRIDE vehicle. The proposed method is based on canonical separation of the random inputs, allowing solving a class of problems, which can be easily implemented as calculus software. The method consists of integration the equations of motion (6 degree of freedom) during terminal phase of the descending trajectory, considering influence of the random constraints as aerodynamic asymmetry, thrust command error, or noise sensors, using the canonical separation of random input functions. The method allows obtaining directly the output dispersion of velocity and coordinates of the vehicle from dispersion of any kind of random input signal which pass thru differential equations of motions using a decomposition of input signal on pulsation domains (PD) and integrate the differential equation system for each PD. This method is approximate, because the number of PD is limited. Theoretically, if we use an infinite number of PD we can obtain the exact solutions. The results obtained in test cases show that this method, applied to the differential equations with the random input, gives good results if a high number of frequencies is selected. 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. Furthermore, because mechanical system function like low pass filter, we can choose a limited number of frequency, which ensure a good accuracy of the results. In terms of results obtained with the considered calculus model, we will evaluate the average of terminal trajectory and landing position and the dispersion around them. The novelty aspect results in its technical purpose that to finding solutions for a real problem, using an adequate model from random function class. Even if the model may be subject to improvements, the results obtained there are technically acceptable and useful. 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 novelty of the paper result from the theoretical method, of random functions theory, applied to solve the technical problem of precision for guided flight during terminal phase and automatic landing of PRIDE vehicle.