SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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ESTIMATING LANDING SITE DISPERSION AND SAFETY FOR LANDING SYSTEMS WITH HAZARD DETECTION AND AVOIDANCE CAPABILITY

Abstract

The terminal descend and landing of a planetary landing system marks a critical phase in a landing mission. The interaction of the flight system with the planetary surface still presents a significant degree of uncertainty to the design and operation of such a spacecraft. Past landed missions applied successfully probabilistic methods to predict the likelyhood of an encounter with terrain features exceeding the flight systems capabilities to withstand them. Therefore the landing dispersion and resulting landing ellipse has been described as a bivariate Gaussian probability distribution and the likelihood to land in a certain area (a pixel or grid cell of a map of the target area) considered as unsafe has been accounted. Future landing missions under study shall allow the access to more challanging terrains and will provide hazard detection and avoidance functionality as key enabling technology. These functionality modifies an initial approach dispersion when the final landing phase is enterend and has to be considered in a landing site dispersion analysis. If the functional chain from terrain recognition, hazard map generation, decision making and piloting is regarded as a stochastic process with probabilities assigned to each of the functional elements the whole process can be modelled as semi-Markov process. The state space is defined by the number of pixels of the landing area map and the associated values are the probabilities to land in the respective pixel. The Markov process's transition matrix contains the stochastic representation of the functional chain from hazard detection to its avoidance and propagates the intial states to the new states after a hazard avodance manoeuver. This paper presents the underlying theory and concept and links the probabilistic expressions to the engineering model of the landing system. An application example is given.