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ONLINE TRAJECTORY REPLANNING FOR LAUNCH VEHICLES EXPERIENCING THRUST-DROP FAULT USING NEURAL NETWORK

Abstract

To replan the flight trajectory of launch vehicles experiencing thrust-drop faults rapidly, an online trajectory replanning method is proposed via a rescue orbit decision-making method based on neural network. Due to the improper initial guess, the contradiction between the orbital elements in cost function, and the nonlinearity of the dynamics and constraints, the computation efficiency of the online trajectory replanning cannot meet the real-time requirement. The original trajectory replanning is divided into four rescue types, the launch vehicle settling into the original orbit, the optimal elliptical rescue orbit, the optimal circular rescue orbit, and mission failure. The datasets are first generated by offline solving the trajectory optimization problems. Then, on basis of these offline datasets, neural networks are trained for mapping the relationship from the fault states to the rescue orbit decisions. At last, in the stage of the actual flight, the neural networks are migrated for the online decision-making of the rescue type, rescue orbital elements, and final control variables. Benefiting from the results of the online decision-making, the rescue type is decided rapidly, proper initial guesses are set for online optimization problems, and the cost function of optimal elliptical rescue orbit problems is simplified by constraining the terminal orbital elements. Simulation results validate the effectiveness of the multi-type rescue orbit decision-making method, and illustrate the real-time performance of the proposed trajectory replanning.Compared with the traditional method, the trajectory replanning method combining neural networks and numerical trajectory optimization method can potentially be implemented online application and improve the reliability of the launch mission.