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Research on the Design and Control Strategy of Change-3 Soft Landing Orbit and its Sensitivity Analysis During the Epidemic of Coronavirus Disease

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Abstract

Aiming at the control strategy of the Chang'e-3 lunar landing, this paper establishes a single-target optimization model based on the variable dynamic Newton differential equation, uses iterative method to obtain the time discrete model, and uses the genetic algorithm based on double-precision real-number coding to obtain the variable dynamic parameters. The control strategy of each stage is given according to the constraint conditions of the six stages and the actual situation during the epidemic of Coronavirus Disease in China.

The error propagation law is used to analyze the systematic deviation of the key parameters of the Chang'e-3, such as the velocity near the moon and the flight time. The Sobol method based on the Monte Carlo sampling method is used to analyze the global sensitivity of the two-body dynamic model by using the total order effect of the Sobol method.

In response to Question One, according to Kepler's third law and the law of universal gravity, the speed size of the near moon point and the distant moon point are 1692.7 km/s and 1614.4 m/s. Based on the dynamic differential equation of variable force, a single-target optimization model is established with the minimum fuel consumption as the constraint target. Using iterative method to separate time, the angle of thrust size, thrust direction and velocity in the opposite direction is encoded in real number, the range of the angle in the motion is 5.8°−7.6°, the thrust size is 7500 N, and the horizontal is obtained in the inverse equation. The displacement is 38306m, and the position of the distant moon point ($160.49W$,$31.38N$) is determined by the definition of longitude and latitude of the lunar heart coordinate system ($19.51W$,$31.38N$).

In response to Question Two, a single/multiple objective optimization model is constructed based on the discrete dynamics equation of Question One and the optimization objectives and constraints in six stages. In the main deceleration stage, the target is the minimum deceleration time and the minimum fuel consumption, and weights of 0.6 and 0.4 are given, respectively. The genetic algorithm is used to solve the problem to obtain that this stage takes 416s, consumes 1062.1 kg of fuel and has a final speed of 57 m/s. The goal of the rapid adjustment stage is to minimize fuel consumption, which takes 257.7 s and consumes 41.98 kg of fuel. The final speed is 0.189m/s. Coarse obstacle avoidance phase Sobel operator is used to calculate the attachment image digital elevation map the gradient of the $S(x, y)$ using median filter method to many times to deal with the noise of the gradient map, by the meshing method elevation graph corresponding to the denoising of gradient graph can be divided into 9 regions, with fuel consumption optimal, the optimal flatness as the optimization goal to determine the best mobile strategy for the regional center moved to the left of 44 pixels. The rough obstacle avoidance stage took 133 s, consumed 91.98 kg of fuel, and the final speed was 0.5401 m/s. In the fine obstacle

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