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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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OPTIMAL ORBITAL TRANSFER FOR SPACE TUG RENDEZVOUS BASED ON ARTIFICIAL IMMUNE ALGORITHM

Abstract

Communication satellites in GEO are expensive and have a design life of 12 to 15 years. Usually, it is the amount of fuel available for station keeping that determines their lifespan. To mitigate the problem of accumulating space debris, it requires that at the end of operational life, these satellites should be moved to a disposal orbit. So satellites use their residual propellant for the transfer and often sacrifice at least six months of their design lifetime. This problem can be solved by a new type of vehicle called space tug, which will be launched to LEO. When the propellant supply of a target communication satellite in GEO is nearly exhausted, the space tug will transfer from LEO to GEO to rendezvous and dock with the target satellite, and move it to a disposal orbit. The space tug will prolong the operational life of target satellite and make the target satellite obtain extra revenue.

How to complete the space tug mission with a low cost is concerned primarily. The mission cost of space tug should be minimum to make sure that it is less than the extra revenue of the target communication satellite. One of key factors influencing the mission cost is the fuel consumption for the space tug's transfer from LEO to GEO. This is a optimal problem in which objective function is the fuel consumption for orbital transfer of space tug, the initial position of space tug transfer, the final position(rendezvous point between two spacecraft) and the transfer time are variables to be optimized. The optimal problem of orbital transfer with unfixed initial position, final position and transfer time was rarely studied.

The main works in this paper include: (1)a optimal model for orbital transfer is set up, (2)a guiding artificial immune algorithm(GAIA) is applied to solve this optimization problem, (3)numerical simulations are performed and GAIA is compared with adaptive genetic algorithm(AGA) in solving the optimal problem for orbital transfer of the space tug by the simulation results.