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SPACE STATION SHORT-TERM MISSION PLANNING UNDER DYNAMIC RESOURCE CONSTRAINTS USING DIFFERENTIAL EVOLUTION

Abstract

The planning of the space station operation mission is actually essential and challenging, and can be divided into two levels: the long term planning and the short term planning. The short term planning focuses on the everyday activities of the space station in the scale of one month, and mainly determines the start and ending times of these activities. It is characterized by its nature as a constrained nonlinear scheduling problem. Currently, most published space station short-term mission planning (STMP) studies employ the assumption of static resource constraints, not taking fully account of the characteristics of dynamic resource constraints in practical engineering, which will affect the reasonableness of the planning results. By combining one popular evolutionary algorithm with the domain-knowledge based conflict-repair strategy, a novel mission planning method of STMP problem considered dynamic resource constraints is proposed. The main contents of this paper are organized as follows:

(1) The conceptual model of the STMP is built using the ontology theory, which can describe the concepts, constraints and relations of the planning domain formally, abstractly and normatively. Further, considering the dynamic characteristics of power, thermal and other resource constraints during the actual operation, a dynamic constraints satisfaction planning model is set up; (2) The conflict-repair strategy of dynamic constraints is proposed by employing the domain knowledge of space station operation mission, and then is effectively incorporated into the search process of differential evolution (DE) algorithm. Several additional improvements including multiple mutation strategy and parameters self-adaption are imposed to make the DE much more effectively. (3) The proposed approach is evaluated in a test case of fifteen missions, thirteen resources and three astronauts with considering dynamic resource constraints. The influence on the planning results induced by the dynamic resource constraints is analyzed and compared with different configurations. And also the optimization results obtained by different algorithms are compared. Thus, the mission planning model considering dynamic resource constraints and the effectiveness of the DE based optimization algorithm are verified.