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CONTINUOUS ESTIMATOR FOR SPACE LOGISTICS NETWORK OPTIMIZATION WITH MULTIPLE VEHICLES

Abstract

Networks of space logistics, such as refueling and repairing stations, and the strategy to deploy these services in space missions are complex and involve NP-hard computation. The number of targets could be over hundreds, or even more. The logistics are complex by their combinatorial nature; the structure might vary during the mission, particularly when the dynamics are involved. Combinatorial options forof the strategy design, increase dramatically with the number of targets. The continuous mapping with likelihood analysis can transform the mixed integer space design into a continuous optimization problem. The expected positions of the targets to be visited, given the impacts of the preceding targets, are set as the variables to be optimized instead of the integer ID of the targets. A gradient-based search will then determine the path with maximum likelihood. However, considering the derivatives computation, of which each component should be computed, the gradient-based search is computationally expensive for large-scale mission design. In addition, the one-versus the rest criterion in the determination may lead to bias in multiple vehicle planning, leaving some regions easily confused in the design space for the likelihood-based classifier. A more flexible and higher efficiency model is therefore required to for the logistics with a complex and multiple vehicle network. In this paper, a new continuous estimator strategy is developed to model and analyze the problem. The input space and decision boundary for the path planning are defined using a separable boundary function. Impacts of the discrete decision-making between the individual vehicles are bridged and modelled with a continuous weighted Gaussian-like metric. Bias of preceding node decision due to each vehicle's impacts isare then analyzed and modelled. The Least Square (LS) adaptations search directly for the logistic solutions. No gradient computation is performed during the planning processdetermination. Preliminary results show promising efficiency in tests of static vehicle routine benchmarks. We extend the method further to large-scale space logistics with dynamics. More complex scenarios taking into accountconsidering vehicle capacity constraints are then considered. A sequential visit to multiple targets, such as asteroids, is used to test the dynamic version of the algorithm.