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Iterative Dynamic Programming for 4D Flight Trajectory Optimization

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Abstract : 4D flight trajectory optimization is one of the key ingredients to improve flight efficiency and to enhance the air traffic capacity in the current air traffic management (ATM). The present paper explores the iterative dynamic programming (IDP) as a potential numerical optimization method for 4D flight trajectory optimization. IDP is an iterative version of the Dynamic programming (DP) method. Due to the numerical framework, DP is very suitable to deal with nonlinear discrete dynamic systems. The 4D waypoint representation of the flight trajectory is similar to the discretization by a grid system; thus DP is a natural method to deal with the 4D flight trajectory optimization. However, the computational time and space complexity demanded by the DP is enormous due to the immense number of grid points required to find the optimum, which prevents the use of the DP in many practical high dimension problems. On the other hand, the IDP has shown potentials to deal successfully with high dimension optimal control problems even with a few numbers of grid points at each stage, which reduces the computational effort over the traditional DP approach. Although the IDP has been applied successfully in chemical engineering problems, IDP is yet to be validated in 4D flight trajectory optimization problems. In this paper, the IDP has been successfully used to generate minimum length 4D optimal trajectory avoiding any obstacle in its path, such as a no-fly zone or residential areas when flying in low altitude to reduce noise pollution.

Keywords : 4D waypoint navigation, iterative dynamic programming, obstacle avoidance, trajectory optimization
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