

Article

Chaos Particle Swarm Optimization Enhancement Algorithm for UAV Safe Path Planning

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Abstract: For safe path planning of unmanned aerial vehicles (UAVs) in a three-dimensional (3D) environment with multiple threats, first, a cost function is introduced according to the terrain constraints and UAV overall performance constraints of the path planning problem. Then, improved nonlinear dynamic inertia weights (INDIW) are introduced into the particle swarms optimization (PSO) algorithm, and when the particles fall into the local optimum, the velocity is perturbed, and the velocity and improved nonlinear dynamic inertia weight PSO (VAINDIWPSO) algorithm are obtained. The algorithm improves the speed of convergence and fitness function value of the PSO algorithm. However, the impact of flyable path optimization is now not obvious. Therefore, to further enhance the overall performance of the VAINDIWPSO algorithm, the adaptive adjustment of the velocity is introduced, the chaotic initialization is carried out, and the improved logistic chaotic map is introduced into the algorithm, and an improved chaotic-VAINDIWPSO (IC-VAINDIWPSO) algorithm is obtained. Then, the corresponding relationship between the algorithm and constraints is used to efficiently search complicated environments and find paths with excessive security and small cost function. The simulation outcomes exhibit that in a complicated environment the IC-VAINDIWPSO algorithm substantially improves the speed of convergence of the algorithm, reduces the fitness function value of the algorithm and the initialization time of the algorithm, and the acquired path is additionally smoother. A near-optimal solution is obtained.

Keywords: unmanned aerial vehicle; path planning; improve particle swarm optimization; improved nonlinear dynamic inertia weights; chaos theory; adaptive adjustment of velocity



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1. Introduction

UAVs have the advantages of top maneuverability, robust battlefield adaptability, small size, and low cost and are extensively used in military and civilian missions, such as surveillance, reconnaissance operations, search and rescue, emergency communications, and agriculture. The secure path planning of UAVs is of excellent magnitude to the completion rate and efficiency of UAVs performing tasks. Path planning [1,2] refers to calculating the optimal path between the beginning point and the goal point based on totally satisfying the constraints of the UAV itself and exterior threats. UAV secure path planning performs a key function in enhancing the autonomy and intelligence level of unmanned systems, so research on this topic has received greater and greater attention.

For the path planning issue of UAVs or robots, domestic and international scholars have proposed many techniques [3–7], such as the A* algorithm [8], the rapidly exploring random tree [9], the probabilistic roadmap algorithm [10], the Voronoi diagram algorithm [11], etc. However, these algorithms ignore the dynamics and kinematic constraints of UAVs, so they typically cannot be utilized in practical situations. The potential field methods, such as the artificial potential field method [12] and the interfered fluid dynamical system algorithm are additional superb techniques for path planning [13]. However,

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