

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 (ENDIW) 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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Optimization and Chaos Mukul Majumdar, Tapan Mitra, Kazuo Nishimura, 2013-06-29 This collection of essays brings together some articles on dynamic optimization models that exhibit chaotic behavior Chapters 3 4 5 6 7 and 9 appeared in a Symposium on Chaotic Dynamical Systems in Economic Theory Volume 4 Number 5 1994 Also Chapters 10 11 and 12 appeared in the Journal of Economic Theory We would like to thank the authors and Academic Press for permission to reprint We are grateful to Professor C D Aliprantis for suggesting the idea of a book structured around the Economic Theory Symposium and without the support and patience of Dr Mueller this project could not have been completed We would like to thank Ms Amy Gowan who cheerfully performed the arduous task of typing the manuscript Thanks are also due to Xiao Qing Yu Tridip Ray and Malabika Majumdar for their help at various stages in the preparation of the manuscript For a course on dynamic optimization addressed to students with a good background in economic theory and real analysis one can assign Chapter 2 as a partial introduction to the basic techniques Chapters 3 and 4 can be assigned to provide examples of simple optimization models generating complicated behavior

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Charged System Search Magnetic Charged System Search Field of Forces Optimization Dolphin Echolocation Optimization Colliding Bodies Optimization Ray Optimization These are presented together with algorithms which were developed by other authors and have been successfully applied to various optimization problems These consist of Particle Swarm Optimization Big Bang Big Crunch Algorithm Cuckoo Search Optimization Imperialist Competitive Algorithm and Chaos Embedded Metaheuristic Algorithms Finally a multi objective optimization method is presented to solve large scale structural problems based on the Charged System Search algorithm The concepts and algorithms presented in this book are not only applicable to optimization of skeletal structures and finite element models but can equally be utilized for optimal design of other systems such as hydraulic and electrical networks In the second edition seven new chapters are added consisting of the new developments in the field of optimization These chapters consist of the Enhanced Colliding Bodies Optimization Global Sensitivity Analysis Tug of War Optimization Water Evaporation Optimization Vibrating Particle System Optimization and Cyclical Parthenogenesis Optimization algorithms A chapter is also devoted to optimal design of large scale structures

Advances in Neural Networks - ISNN 2008 Fuchun Sun, 2008-09-08 The two volume set LNCS 5263 5264 constitutes the refereed proceedings of the 5th International Symposium on Neural Networks ISNN 2008 held in Beijing China in September 2008 The 192 revised papers presented were carefully reviewed and selected from a total of 522 submissions The papers are organized in topical sections on computational neuroscience cognitive science mathematical modeling of neural systems stability and nonlinear analysis feedforward and fuzzy neural networks probabilistic methods supervised learning unsupervised learning support vector machine and kernel methods hybrid optimisation algorithms machine learning and data mining intelligent control and robotics pattern recognition audio image processing and computer vision fault diagnosis applications and implementations applications of neural networks in electronic engineering cellular neural networks and advanced control with neural networks nature inspired methods of high dimensional discrete data analysis pattern recognition and information processing using neural networks

Recent Advances in Computer Science and Information Engineering Zhihong Qian, Lei Cao, Weilian Su, Tingkai Wang, Huamin Yang, 2012-01-25 CSIE 2011 is an international scientific Congress for distinguished scholars engaged in scientific engineering and technological research dedicated to build a platform for exploring and discussing the future of Computer Science and Information Engineering with existing and potential application scenarios The congress has been held twice in Los Angeles USA for the first and in Changchun China for the second time each of which attracted a large number of researchers from all over the world The congress turns out to develop a spirit of cooperation that leads to new friendship for addressing a wide variety of ongoing problems in this vibrant area of technology and fostering more collaboration over the world The congress CSIE 2011 received 2483 full paper and abstract submissions from 27 countries and regions over the world Through a rigorous peer review process all submissions were refereed based on their quality of content level of innovation significance originality and

legibility 688 papers have been accepted for the international congress proceedings ultimately *Intelligent Energy Demand Forecasting* Wei-Chiang Hong, 2013-03-12 As industrial commercial and residential demands increase and with the rise of privatization and deregulation of the electric energy industry around the world it is necessary to improve the performance of electric operational management Intelligent Energy Demand Forecasting offers approaches and methods to calculate optimal electric energy allocation to reach equilibrium of the supply and demand Evolutionary algorithms and intelligent analytical tools to improve energy demand forecasting accuracy are explored and explained in relation to existing methods To provide clearer picture of how these hybridized evolutionary algorithms and intelligent analytical tools are processed Intelligent Energy Demand Forecasting emphasizes on improving the drawbacks of existing algorithms Written for researchers postgraduates and lecturers Intelligent Energy Demand Forecasting helps to develop the skills and methods to provide more accurate energy demand forecasting by employing novel hybridized evolutionary algorithms and intelligent analytical tools

Nonlinear Dynamics and Entropy of Complex Systems with Hidden and Self-excited Attractors

Christos Volos, Sajad Jafari, Jacques Kengne, Jesus M. Munoz-Pacheco, Karthikeyan Rajagopal, 2019-05-03 In recent years entropy has been used as a measure of the degree of chaos in dynamical systems Thus it is important to study entropy in nonlinear systems Moreover there has been increasing interest in the last few years regarding the novel classification of nonlinear dynamical systems including two kinds of attractors self excited attractors and hidden attractors The localization of self excited attractors by applying a standard computational procedure is straightforward In systems with hidden attractors however a specific computational procedure must be developed since equilibrium points do not help in the localization of hidden attractors Some examples of this kind of system are chaotic dynamical systems with no equilibrium points with only stable equilibria curves of equilibria and surfaces of equilibria and with non hyperbolic equilibria There is evidence that hidden attractors play a vital role in various fields ranging from phase locked loops oscillators describing convective fluid motion drilling systems information theory cryptography and multilevel DC DC converters This Special Issue is a collection of the latest scientific trends on the advanced topics of dynamics entropy fractional order calculus and applications in complex systems with self excited attractors and hidden attractors

Energy Engineering and Environmental Engineering Tony

Sun, 2013-04-10 Selected peer reviewed papers from the 2013 International Conference on Energy Engineering and Environmental Engineering ICEEEE 2013 January 18 19 2013 Hangzhou China

Measuring Technology and Mechatronics Automation Zhixiang Hou, 2011-02-02 Selected peer reviewed papers from the Third International

Conference on Measuring Technology and Mechatronics Automation ICMTMA held in Shanghai China Jan 6 7 2011

Automatic Manufacturing Systems II Run Hua Tan, Ji Bing Sun, Qing Suo Liu, 2012-06-14 Selected peer reviewed papers from the 2nd International Conference on Advanced Engineering Materials and Technology AEMT 2012 July 6 8 2012 Zhuhai China

Metaheuristics and Chaos Theory Rui Tang, 2018 Chaos theory is a novelty approach that has been

widely used into various applications One of the famous applications is the introduction of chaos theory into optimization Note that chaos theory is highly sensitive to initial condition and has the feature of randomness As chaos theory has the feature of randomness and dynamical properties it is easy to accelerate the optimization algorithm convergence and enhance the capability of diversity In this work we integrated 10 chaotic maps into several metaheuristic algorithms in order to extensively investigate the effectiveness of chaos theory for improving the search capability Extensive experiments have been carried out and the results have shown that chaotic optimization can be a very promising tool for solving optimization algorithms

Key Engineering Materials II Wu Fan,2012-03-15 Selected peer reviewed papers from the 2012 2nd International Conference on Key Engineering Materials ICKEM 2012 February 26 28 2012 Singapore *Journal of Economic Literature* ,2000 **Advanced Development of Engineering Science IV** Helen Zhang,M. Han,X.J.

Zhao,2014-10-01 Selected peer reviewed papers from the 2014 4th International Conference on Automation Communication Architectonics and Materials ACAM 2014 September 27 28 2014 Wuhan China **Advanced Research on Industry, Information System and Material Engineering, IISME2011** Helen Zhang,Gang Shen,David Jin,2011-02-21 Selected peer reviewed papers from the 2011 International Conference on Industry Information System and Material Engineering IISME 2011 April 16 17 2011 Guangzhou China **Conference Record** ,1998 Automation Equipment and Systems Wen Zhe Chen,Pin Qiang Dai,Yong Lu Chen,Ding Ning Chen,Zheng Yi Jiang,2012-02-27 Selected peer reviewed papers from the 3rd international Conference on Manufacturing Science and Engineering ICMSE 2012 March 27 29 2012 Xiamen China

ASICON 2003 Ting-Ao Tang,2003 **Optimal Control of Discrete Chaotic Systems** Roman Senkerik,2009-09 The problem of control of chaos has attracted the attention of researchers and engineers and many methods have been developed since the early 1990 s The main aim of this book is to show that evolutionary algorithms EA which is a powerful tool for almost any difficult and complex optimization problem can be in reality be used for the optimization of deterministic chaos control This book aims to show how to use EA and how to properly define the cost function It is also focused on the selection of control methods and the explanation of all possible problems which arises in such a difficult task of chaos control optimization This book contains examples of EA implementation to methods for chaos control for the purpose of obtaining better results This implies faster reaching of desired state and superior stabilization which could be robust and effective means to optimize difficult practical problems This book introduces a different approach to the challenging task of chaos control and should assist students academic researchers and engineers working with either nonlinear and chaotic systems or evolutionary computation *Physical Review* ,1997-03 Publishes papers that report results of research in statistical physics plasmas fluids and related interdisciplinary topics There are sections on 1 methods of statistical physics 2 classical fluids 3 liquid crystals 4 diffusion limited aggregation and dendritic growth 5 biological physics 6 plasma physics 7 physics of beams 8 classical physics including nonlinear media and 9 computational physics

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