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Application of advanced modeling technology in complex network architecture

Ruixian Zhang[1, *] , Xinrui Wang[2]

[1]Yunnan Normal University School of Mathematics Kunming, Yunnan Province, 650000, China

[2]Yunnan University School of Information Kunming, Yunnan Province, 650000, China

Abstract

the operational command system of information warfare has the characteristics of high complexity, strong dynamic and fast timeliness. The problem of operational command system is abstracted by using complex network modeling technology. Through the quantitative description and algorithm construction of relevant information, the dynamic deduction of the model, and the simulation evaluation experiment of combat effectiveness, valuable conclusions have been obtained,It has important theoretical significance and application value to summarize the application research progress of complex network modeling technology in the army combat system to promote the military transformation of our army and win the future war.

Keywords

Complex network, combat command model, dynamic reconfiguration.

1. Introduction

Modern war has developed into information war, and information confrontation has become an important part of modern war. The development of war form and the change of operation mode lead to more and more attention to the analysis of combat system in recent years. The network centered system confrontation has become the leading role in modern war. Modern information war is a joint operation between multiple arms, which is "man-machine combination"The combination of organization system and equipment system

With the development of complex network theory, scholars at home and abroad have carried out a lot of research on the combat model based on complex network. The number of combat units in information war is increasing, the operation mode is complex and changeable, and the battlefield information is changing rapidly. Using the complex network theory to study the operation under the condition of informatization, the combat system is abstracted as the relationship between combat nodes and combat nodes,The dynamic deduction system confrontation simulation experiment can promote the improvement of our army's combat system from the evaluation and analysis of the characteristics of the combat network, such as the invulnerability, coordination and actual combat of the combat network. In the system confrontation, we can quickly reconstruct the model according to the algorithm combining with the actual combat factors, and obtain the dynamic and efficient combat planTherefore, sorting out and analyzing the application and research progress of complex network modeling technology in military combat system can better reflect the experimental evaluation of combat system based on complex network modeling technology, improve operational efficiency, quickly establish accurate combat model according to different operational factors in the future battlefield, and constantly improve the algorithm to deduce the combat system in line with the real battlefield

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2. Application and research progress of complex network modeling technology in combat system

2.1. Research progress of complex network model in combat system construction

Aiming at the construction of combat system network model, Wang Qinggong, Shen Shoulin and Yuan Changping proposed to build the model by using complex network method, analyzed the basic characteristics of combat system network, and revealed the relationship between the main parameters of combat network and the real characteristics of combat system[1]Chen Chun, Li Luji, Tao Jin based on the network loop and adjacency matrix algorithm of the combat model in the information age constructed by Jeff kels in distributed networked warfare, and used the complex network theory to construct the sensor, information processing node, information countermeasure node, and target confrontation interaction network model, and investigated the aggregation characteristics of system combat capability from the perspective of complex network,Thus, the overall behavior of system of systems operations in the war system is analyzed and evaluated[2].

Aiming at the problem analysis of traditional combat simulation, Jiang Xiaoping, Zhu Yi and San Ye proposed the superiority of using complex system theory to guide information-based combat simulation. The research progress of two frontiers of combat simulation based on complex system theory was analyzed, including multi-agent combat simulation based on complex adaptive system theory and multi-agent combat simulation based on complex network theory[3].

For the application of complex network in combat modeling, Qi Yanbo, Liu Zhong and Xu Jianghu constructed and analyzed the basic topology model, invulnerability model and dynamic network model[4]of combat network.

Aiming at the key problems of cyberspace operations, such as the calculation of overall effectiveness, the analysis of dynamic effectiveness, the quantification of confrontation effectiveness and the construction of aggregation relationship, Xu Xiangli and Hu Xiaofeng proposed a framework of networked index system based on complex network theory, and built a specific index system through an example, and carried out a simulation experiment[5].

Rao dehu, Hu Xiaofeng and Wu Lin proposed to build a network model of system of systems warfare by using detection nodes, intelligence nodes, decision-making nodes, communication nodes, fire strike nodes and information confrontation nodes;Based on the network model of system of systems operations, the distance of characteristic information and the rhythm of network information interaction[6]are proposed by extending the structural characteristic parameters such as average path of complex network.

Zhu Jiang, Cai xianbo, Shen Shoulin and Chen Haoji built command and control test-bed based on complex network and complex adaptive system technology. Aiming at the typical network command and control structure, the static slice analysis is carried out by selecting the complex network index and the "dynamic deduction" analysis is carried out through the combat situation emerging from the artificial battlefield,The traditional command and control test focuses on process and entity and ignores relationship and structure[7].

The Distributed Combat network model based on the complex combat network is proposed;In view of the application background of variable combat network structure, the controllable optimization method of Distributed Combat network based on topology structure is proposed;Aiming at the situation that the network topology can not be changed, the controllability optimization strategy of Distributed Combat network based on edge pointing is proposed;[8]ntrollability analysis model of Distributed Combat network with node load failure

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is constructed, and[8]ntrol robustness measure index is defined, and the dynamic optimization method of control robustness for Distributed Combat network is proposed.

In view of the dynamic evaluation of the impact of operational organizational structure on operational effectiveness, Zhang Qiang, Li Jianhua, Shen Di, and Zhao Junwei used complex networks to analyze the networked characteristics of operational organizational structure under the condition of informatization. Considering the heterogeneity of operational organization entities and organizational structure, a combat network model based on multidimensional weighting was constructed,In this paper, the cooperative gain feature is defined to describe the performance of combat network[9]er to improve the combat effectiveness as the power of network evolution, two kinds of dynamic evolution models of operational network are designed, which are the optimal evolution model and the random evolution model.

According to the theory of modern combat cycle, Liu Peng, Dai Feng and Yan Kun proposed to abstract various combat units of the combat system as nodes, and the relationship between nodes as the edges between nodes. The construction rules of combat system model were formulated. The traditional combat system model and the "cloud operation" system model were constructed respectively. The measurement index of combat system was proposed and simulated,[10]mbat capability and survivability of the two combat systems are compared.

Based on the quantitative analysis of the problem of combat synchronization, Wang Wei, Liu Fuxian, Xing Qinghua proposed to build a complex network model of multi combat units cooperative operation, and analyzed the internal mechanism of combat synchronization from two aspects of combat unit dynamic behavior and network topology structure;[11]ing to different combat situations, two kinds of networks, static synchronization and dynamic synchronization, are designed, and discrete particle swarm optimization (DPSO) is applied to optimize the network structure.

According to the characteristics of combat system network structure, Zhu Lin and Fang Shengliang proposed to construct the combat system dependent network model from the perspective of complex network dependency, and quantitatively analyzed the cascading failure process of the model, and simulated the robustness of the combat system network under different attack strategies through examples,[12]mulation results show that the network model of combat system based on dependency can reflect the characteristics and laws of system of systems operations.

In view of the complexity, dynamics and timeliness of time domain coordination of organizational operational plans in information warfare, Yu Hongyuan and ye Xiongbing proposed a method of time-domain coordination of organizational operational plans based on the characteristics of complex network model. The operational actions were represented by network nodes and the constraint relationship between operations was represented by network edges,The complex network model of time domain collaborative elements of operational plan is represented by network update rules;A time series algorithm[13]is designed, which takes the minimum total time of operations as the goal, the constraint relationship between operations as the constraint conditions, and the average degree of network nodes as the heuristic rule.

Based on the commonness of combat system and complex network, Liu Desheng found that the complex network model can be constructed by abstracting the abstract nodes and edges of complex network from the real combat system, which can be used as a substitute for the research of combat system[14].

In view of the fact that the combat system can be abstracted into a certain network topology by using complex network theory, Wei Qing, Shen Yanli, Xiao taoshun and Kong Ruiyuan proposed that the comprehensive evaluation index[15]of system nodes' importance was constructed by

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considering the substitutability of nodes themselves, local connectivity and the impact of nodes on the effectiveness of the whole system.

He Rong, Wang Dajing and Cui Shuai Hao evaluated and analyzed the effectiveness of networked combat architecture based on complex network theory. With the help of complex network parameters, four kinds of structural effectiveness indexes were constructed, which were in line with the network combat system. The effectiveness of the network-based combat system was compared with that of the traditional combat system from the perspective of complex network,The method and strategy of optimization and improvement[16]are put forward.

2.2. Research progress of complex network model in actual combat

In view of the complexity and networking of air defense combat system under the condition of informatization, Wang Xiaoguang, Tang Hong, Wan Yijiu combined the theory of complex network to give three kinds of network expansion rules, established the network model, discussed the network characteristic parameters, and then analyzed the network characteristics and key node discovery under different expansion rules by simulation[17].

In this paper, we use the complex network theory of Yin xutao to build the network model of complex network, and use the network model to analyze the complex network of Yin Yutao;Through the comparison of simulation results, it is shown that under the condition of network centric warfare, the network model of cooperative antimissile operation of warship formation realizes the exchange and sharing of battlefield information, and can greatly improve the combat effectiveness of warship formation[18].

In view of the research of command information system, Zhang Hongxia proposed to establish the overall performance model of command information system structure. Based on the model, the network problem of the system was studied. According to the research content, combined with the ground air defense mixed group command information system, the practical significance of the influence of system networking mode and degree on the overall performance of the structure[19]was studied.

In order to improve the effectiveness and practicality of the operational network topology model of air combat system, Yang Zhe, Li Shulin, Zhou Li and Xie Zilong proposed to divide the combat entities into different types of node units, and select the corresponding connection mode between nodes according to the types of nodes, and establish the network model of air combat system based on the complex network theoryThe analysis of average degree and invulnerability provides a theoretical basis for the optimization of air combat command network system[20].

Aiming at air attack operations, Yang Yinghui, Li Jianhua, Ding Wei and Nan Mingli proposed the information flow mode based on the maximum information flow, the best information quality and the minimum transmission time. Using the complex network theory, the statistical characteristics of the three information flow modes were compared from the aspects of average distance, degree distribution, agglomeration coefficient and betweenness[21].

In view of the establishment of the network model of force formation in landing operations, Wang yinlai, Chen Songhui and Jia Ziying proposed to establish the evaluation model of force formation effectiveness from two aspects of independent and cooperative operational effectiveness of force formation by using complex network analysis method and system dominance function, and analyze the overall operational effectiveness of different formation modes,It is concluded that group formation is more effective than echelon formation[22].

Based on the complex network theory, Yan Feilong and Jia Ziying constructed the blue army anti landing deployment network model. The problem of target selection was transformed into the node value evaluation problem. The node value was divided into two dimensions: tactical value and network value. The node tactical value evaluation model was established by using

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fuzzy partial order relationship. The node connectivity and node criticality were defined, and the node network value evaluation algorithm was determined,Evaluate the value of each node in the blue army's anti landing deployment network, and then determine the airborne combat target[23].

He Rong, Luo Xiaoming and Zhu yanlei based on the US air space defense operational command system, abstracted the command system structure from the network, took the military institutions in the command system as the nodes of the network, and the command or coordination relationship as the edge of the network. On the basis of the traditional hierarchical tree type command system, the horizontal connection between network nodes was increased with different probability,The relationship between command effectiveness and structure of different models is discussed by using the correlation measure of complex network theory[24].

Chen Xiaonan, Hu Jianmin, Chi Benliang and Cui Yang established the reconstruction model of enemy network based on the study of the combat game relationship between the two sides in the complex combat network system, and proposed three reconstruction methods[25]including reconstructing the enemy network link, reconstructing the importance of the enemy node value and reconstructing the enemy's unknown area.

3. Conclusion and Prospect

The application research of complex network modeling technology in combat system is an important research method to promote information system confrontation. Through the dynamic deduction model simulation experiment, the optimal combat command system with reasonable structure, flexibility, efficiency, stability and security can be constructed. The model can be reconstructed according to the actual combat factors in the combat system, and the combat plan can be quickly and effectively decided.

In the military field, the use of complex network modeling technology has become a research direction in the construction of information warfare combat system. From the construction of "static" combat system with complex network theory to the analysis of actual battlefield change factors, the complex network modeling technology plays an important role in the reconstruction of combat system.

Information warfare is complex and changeable, and the actual battlefield environment is more complex. When considering the battlefield factors, we should pay more attention to the time-domain collaborative elements in the combat system, analyze the correlation between the relevant combat tasks, units, resources and other elements, and realize the optimization of information resource sharing. Therefore, it is necessary to actively promote the construction of the network description model of the actual combat system,At the same time, the corresponding evolution model needs to be rapidly reconstructed according to the actual situation of the battlefield. The complex network is used to abstract and quantify the actual combat system problems. More actual combat elements will be considered and more battlefield conditions need to be analyzed. How to carry out rapid model reconstruction and reasonable tactical change in actual combat will be the next research focus.

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