International Journal of Multimedia Data Engineering and Management
Volume 12 • Issue 2 • April-June 2021

Adaptive Multi-Agent Control Strategy in Heterogeneous Countermeasure Environments

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ABSTRACT

In the rapidly changing air combat environment, it is quite difficult for pilots to make speedy and reasonable decisions in a very short period due to lack of experience and the uncertainty of perception situation. Hence, the authors propose an intelligent cognitive tactical strategy framework of air combat on multi-source information in uncertain air combat situations for decision support. A fuzzy inferring tree method is proposed to simulate human intellection. Then, to further improve the accuracy of the reasoning results, a genetic algorithm is introduced to optimize the structure and parameters of fuzzy rules. The simulation results show that the proposed model is reasonable, fast, accurate, repeatable, and fatigue-free, which lays a good foundation for future high-end unmanned combat explorations.

KEYWORDS

Cognitive Strategy, Fuzzy Inferring Tree, Genetic Algorithm, Multi-Source Information, Uncertain Environment

1. INTRODUCTION

With the development of science and technology, the advantage of artificial intelligence in man-machine games has gradually emerged, and it has made breakthroughs in games such as the two-person zero-sum, in-depth decision-making, multi-agent control, and incomplete information game scenarios. In March 2016, AlphaGo beat top player Lee Se-dol 4:1 in real-time go games(Joshi & Shashank, 2016), and later in 2018 and 2019, artificial intelligence based machines beat the world's top human players in real-time strategy games Dota2 and Starcraft II(Raiman, Zhang, & Wolski, 2019).

In the system of system operations, the confrontation is not only limited to the performance of weapons but also includes the intelligence competition. Relying solely on pilots' independent evaluation and decision-making has been unable to meet the complex and changeable combat environment. The future air combat time will be reduced and the confrontation will be more intense. Pilots should predict the situation and maneuver decision-making. Greater demands were being placed on the pilots by a large amount of battlefield information, However, the current control system in use mainly displays the status information of the target and the aircraft, which increases the control burden of the pilot in target tracking, attack occupation, and maneuver evasion. This will inevitably lead to an increase in pilots' decision-making error rate and the decrease of pilots' survival probability, which will affect air combat effectiveness. Therefore, it will be of great significance for future warfare decision-making

DOI: 10.4018/IJMDEM.2021040103

problem. For example, in severe climate areas such as high and cold areas, military personnel have limited acting ability and develop unmanned counter equipment for unmanned intelligent control, assisted decision-making, simulated counter training, etc. This transformation reduces the burden of pilots, liberates them from tedious micro-operations, and has sufficient time and energy to command Macro mission combat.

Air combat decision-making refers to the choice of attack and defense strategies according to the battlefield situation. Air combat decision-making is a NP hard problem(Leitmann & Skowronski, 1977). In this work, we focus on this problem into a sequential multi-step problem, and a genetic fuzzy reasoning based and intelligent assistant decision-making method is designed. By using fuzzy reasoning method to extract the battlefield feature vector including the opponent commander's emotion, behavior and the decision state of the evolution process of the battle method, then using the rule tree method to simulate the decision process in series, and based on the genetic algorithm to search and evaluate the fuzzy rule tree until the best action decision sequence is obtained.

2. RELATED WORKS

2.1. Technology Research

Warfare is complex and chaotic behavior, with the battlefield environment is uncertain and unpredictable. Air combat is not constrained by the rules of engagement, and the influencing factors are more complex. It is a game under the condition of incomplete information, which is more difficult than go. The construction of an intelligent assistant decision-making system is to solve two kinds of problems: battlefield situation awareness and autonomous decision-making. Scholars at home and abroad have studied it and put forward many methods.

2.1.1. Research on Situation Awareness

Situation assessment is the basis of air combat decisions, and the objective assessment result is the key part of air combat decisions. The situation data sensed in air combat is unstructured data, and the unstructured information often shows the following characteristics: the data form is high-dimensional, massive, and dynamic; at the same time, the content is incomplete and uncertain. Unstructured environmental awareness is based on the real object information collected by physical sensors and the virtual object information of the combat system to reconstruct the real physical scene. It is very difficult for the UCAV to realize high reliability and strong real-time environment perception in a complex environment. At present, there are two main types of air combat situation assessment: non-parametric method and the parametric method. The non-parametric method is to quantitatively analyze the situation information of both sides of air combat, and extract the situation factors that can fully reflect the situation characteristics of air combat and facilitate quantitative analysis, mainly including Advantage function method(Zhou, Wen-Hai, Zhi-Gang, & Zhu, 2011), artificial potential field method(Wang, Zhang, & Chen, 2015), fuzzy evaluation method(Duan, Guanjun, & Zhao, 2013), and neural network method(Xiao, Huang, & Xu, 2013). The parameter method is also known as the uncertainty theory method. It describes the relationship between evaluation indexes by probability theory, including Bayesian network (Das, Grey, & Gonsalves, 2002; Girija, 2008), DS evidence theory (Yu, Chen, Bai, & Ling, 2013), etc.

Environmental awareness has made great progress in theory and application, but it cannot deal with complex environmental awareness problems, especially in the future intelligent air combat process.

2.1.2. Research on Autonomous Decision Making

Air combat autonomous decision-making is a dynamic decision-making problem. It needs to take corresponding maneuver actions according to the situation assessment results and the autonomous decision-making model. At present, experts and scholars have carried out a lot of research on

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Fu-Hai Frank Wu (2017). *International Journal of Multimedia Data Engineering and Management (pp. 21-41).*
www.irma-international.org/article/applying-machine-learning-in-optical-music-recognition-of-numbered-music-notation/182649