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Target Threat Level Assessment Based on Cloud Model under Fuzzy and Uncertain Conditions in Air Combat Simulation

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Abstract: The real-time performance and correctness of the target threat level assessment is very important in air combat simulation. In order to solve the problem of target threat level assessment caused by the fuzziness and uncertainty of battlefield information collection, the target threat assessment technology based on cloud model is proposed. Using fuzzy description, battlefield situation is expressed in many qualitative concepts, and then these qualitative concepts are expressed and processed using cloud model related theory, and through Bayes revision on the membership clouds obtained depending on experts' experience which evaluated qualitative concepts, the staff gauges clouds were obtained. Finally the cloud diagram of target threat assessment was obtained through battlefield situation information matching the staff gauges clouds, and threat level assessment was realized. The description of battlefield situation with qualitative concept and membership clouds achieve a good integration in fuzziness and uncertainty, which reflect fuzziness and uncertainty when obtain information in air combat. Qualitative and quantitative concepts descriptions do not need precision battlefield situation data in target threat level assessment using cloud model. An example was given to validate the target threat level assessment technology based on cloud model, and the results indicate that threat level assessment can be realized availably by this technology.

Key Words: threat level assessment; cloud model; Bayes; intelligent decision; reasoning under uncertainty;

1 Introduction

Common modeling methods of target threat assessment are multiple attribute Decision-making method, neural networks method, Bayesian networks method, grey relational analysis theory method, rough set theory, Agent-based method, genetic algorithms, information entropy-based method, and a combination of multiple methods. The disadvantage of these methods is to get high precision battlefield situation data, and most of these methods can't take into account the uncertainty and fuzziness.

There are some researches in detection, prediction and control under uncertain conditions. In [1], a novel particle filtering technique named sequential evolutionary filter (SEF) is introduced, A GA-inspired strategy is designed and incorporated in SEF, by which the particle impoverishment problem can be effectively mitigated, and the particle diversity can be maintained. In [2], an improved incremental learning approach is presented. It takes advantage of the algorithm overlapping of locally weighted projection regression (LWPR) and partial least squares (PLS), implementing the PLS-based prognosis in each locally linear model. It can finally be extended to a long-term voltage prediction. In [3], a new structure of preprocessing-modeling-postprocessing is proposed, within which modified orthogonal projections to latent structures (MOPLS) method is developed, the new method significantly improves the performance of quality-related fault detection, and it has a quite lower computational load than the previous ones.

There are some researches on detection and control under fuzzy conditions and unknown disturbances and propose some effective methods. Such as in [4], an approximated-based adaptive fuzzy control approach with only one adaptive parameter is presented in order to deal with phenomena like dynamic disturbances, and unknown time delays. Paper [5] focuses on fault detection and isolation for vehicle suspension systems. The number of clusters is confirmed based on principal component analysis, the faults are detected by fuzzy positivistic C-means clustering and fault lines, and the root causes for faults are isolated by utilizing the Fisher discriminant analysis technique.

Cloud model have the excellent feature to convert between qualitative concepts and their quantitative numerical representations, and have a good combination of uncertainty and fuzziness [6]. Most research of cloud model is to use various cloud generators in series or in parallel[7-8], constituting an information processing system, and make the practical problems abstract in some form to represent by cloud model, and resolve the practical problems using cloud model related theory.

The target threat assessment technology based on cloud model is proposed in this paper. Using fuzzy description, battlefield situation is expressed in many qualitative concepts, and then these qualitative concepts are expressed and processed using cloud model related theory, at last, the quantitative cloud diagram which integrating variety threats properties and threat assessment is achieved, so the target threat assessment is realized. Qualitative and quantitative conversion can easily be achieved using cloud model [6, 9]. Qualitative concepts do not require too much precision situation data, the battlefield situation description and cloud

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