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A Threat Assessment Algorithm Based on AHP and Principal Components Analysis

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Abstract

In allusion to the shortage of traditional analytic hierarchy process in the determination of weight coefficient, a threat evaluation model based on the principle components analysis and analytic hierarchy process was proposed in the article. The subjective and objective factors were comprehensive considered. The importance of each index in index layer obtained by the principal components analysis method was used to gain the judge matrix in the analytic hierarchy process to improve the veracity and rationality of the judge matrix. The simulation proved that the threat assessment result of anti-warship missiles to warship obtained through the threat assessment algorithm based on AHP and the principal components analysis was objective and reasonable.

Key words: The Principal Components Analysis; Threat Evaluation; Analytic Hierarchy Process (AHP)

1. Introduction

The threat assessment of anti-warship missiles is the foundation for the antimissile weapon system to do WTA. At present, AHP, the method of multiattribute decision and the principal components analysis are mostly using for threat assessment, and it has some success (Tian and Sun, 2005; Qu et al., 2000; Zhang, 2005; Zhu et al., 2010). Bai et al.(2008) introduce a ameliorate AHP method which using fuzzy

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integration judgment and geminating comparing to establish the judge matrix, it has some progress to the traditional AHP method, but it is still affected by the subjective factors of expert judgment when deciding the index weight that affect the target treat degree. Hong et al. (2006) introduce a threat assessment model based on principal components analysis, it translated the original variable into principal components, which conquered the influence of subjective factors and objectively reflected the real relationship among the sample. The principal components analysis method used few principal components to do integration judgment, which was not making the best of data information. A threat assessment algorithm based on AHP and the principal components analysis is used in this article, which not only solved the influence of subjective factors, but also objectively reflected the real relationship among the sample, and meanwhile, the data information was fully used.

2. Problem Description

Suppose the target threat region is $D = |D_i|$, $i = 1, 2, L\ n$, n represents the number of anti-warship missiles. The index musters of target i is $C = |C_j|$, $j = 1, 2, L\ p$, p represents the number of index. The steps of deciding target treat degree are as follows:

(1) Deciding the index musters C, establishing the hierarchy model.

(2) Using the principal components analysis to gain the importance of each index C_j, establishing the geminating comparing matrix of index layer and other layers.

(3) Getting the taxis of each layer, and carrying out consistency check.

(4) Getting the final total taxis and carrying out consistency check.

3. Introduction Design of Threat Assessment Algorithm

3.1. Establish the hierarchy model

For the threat assessment of anti-warship missiles, five indexes of target threat factor are considered. They are target velocity, fairway shortcut, and target distance, target pitching angle and target height. The hierarchy model can be established as showed in figure 1.
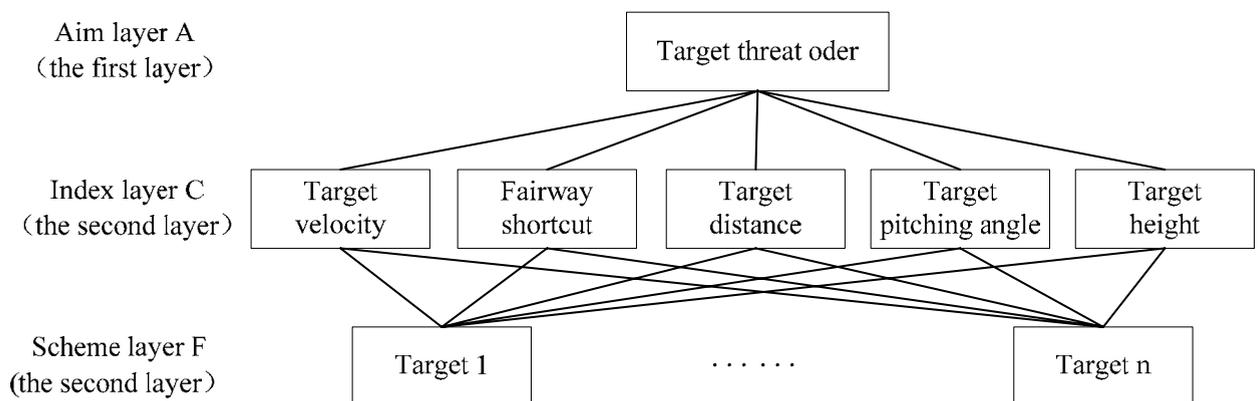

Fig. 1 the hierarchy model