

## The Multi-objective Decision-making of Coordinated Attack Research based on the Index of Posture

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### Abstract

In this paper, we studies specifically about assessing the battlefield situation and quantitative calculation of index and situational matrix, illustrated by the example of that our multiple combat units attack coordinately moving targets on the sea. In favorable circumstances or attack feasible, how to reasonable distribution of decision science the enemy target group, which makes our battle group at the lowest cost and biggest success probability integral damage effect on the top of enemy target group, improving the operational effectiveness of our as much as possible. The principle is analyzed in detail and the feasibility of this method is proved by the actual data. It's very important for cooperative engagement methods.

### Keywords

Situation Assessment, Situational Index, Target Assignment.

### 1. Introduction

The cooperative engagement based on the modern high technology becomes more and more important mode of operation. The aim of cooperative engagement is to fight over the platform integration for the whole organic system, and through the reasonable cooperation and coordination between each platform, as much as possible to play out the biggest operational effectiveness of the whole system. The key of cooperative engagement is building specific criteria and methods between various operational platforms. As modern mathematics, control theory, computer technology and the continuous development of information technology, effectively solve the cooperative principles and methods are more and more possible. So that the cooperative engagement is from the traditional decision into a quick and efficient automated decision-making and promote the cooperative engagement towards qualitative change. If the target decision technology used in the practical phase, it have a significant impact for various cluster operations in the future.

In this paper, two of the most important parts of objective decision-making, namely the principle of situation assessment and target assignment method is studied, based on this background and trend, Based on missile attack enemy group of moving targets on the sea, for example, situation assessment and target assignment principle and algorithm are studied based on the enemy, complete and accurate data gained assumedly.

### 2. Situation Assessment

Situation assessment is to give an accurate and comprehensive assessment of the enemy target group of comprehensive threat to our situation, and on this basis to determine how to divide the objectives and targets. Enemy each ship will create a threat to our each combat unit. The degree of size can be quantified by available threat index .It also reflects the feasibility of our combat units attacking the enemy ship.

Set  $s_{ij}$  expression the threat index of enemy ships  $j$  to combat unit  $i$ , then the index should be determined comprehensively by relative movement by both parties threat index  $a$ , the ship's air defense threat index  $b$ , the index of naval battle value  $c$ .

Relative motion threat index  $a$  is relative with azimuth angle  $a_1$ , distance  $a_2$ , height index  $a_3$ . It can be expressed as

$$a = a_1 \times a_2 \times a_3 \quad [1]$$

Air defense threat index  $b$  is relative with carrier-based fighter planes, anti-aircraft missiles, dense array nearly system integrated air defense fire parameters  $\sum b_1$  and a variety of detection equipment to detect ability index  $\sum b_2$ , the parameters of the ship maneuverability  $b_3$ , control effectiveness coefficient  $\varepsilon_1$ , survival force coefficient  $\varepsilon_2$ , coefficient of electronic countermeasure  $\varepsilon_3$ . It can be expressed as

$$b = [\ln(\sum b_1 + 1) + \ln(\sum b_2) + \ln b_3] \varepsilon_1 \varepsilon_2 \varepsilon_3 \quad [2]$$

Battle value index, the higher the value, the greater the attack feasibility, considering the threat index is smaller, the greater the attack feasibility. Aimed to the consistency about the both expression, battle value index  $c$  take the bottom  $1/c$ .

Then the comprehensive threat index is

$$s_{ij} = k(a + b) / c$$

Among them,  $k$  is the weight coefficient, usually take  $k = 0.5$ .

We can get threat situation index matrix  $S_{m \times n}$  of enemy unit to our battle group after gaining the synthetic threat situation index of each enemy unit to our battle group  $s_{ij}$ . Among them,  $s_{ij}$  is the threat situation index of ship  $j$  to our combat unit  $I$  and  $m$  is the number of our fight unit,  $n$  is the number of enemy ships.

### 3. Target Assignment

The task of target assignment is assigning the enemy target to our combat units as a target. In order to make our overall operational effectiveness of combat group and cause the enemy target group to be damaged efficiency, target assignment should follow the following principles [3]:

- (1) Our combat unit should choose the target as far as possible whose threat index is the smallest;
- (2) Each combat unit has a target, that is, no combat unit idle;
- (3) When our combat unit number is less than the number of enemy ships, each of the target distribution can't be repeated.

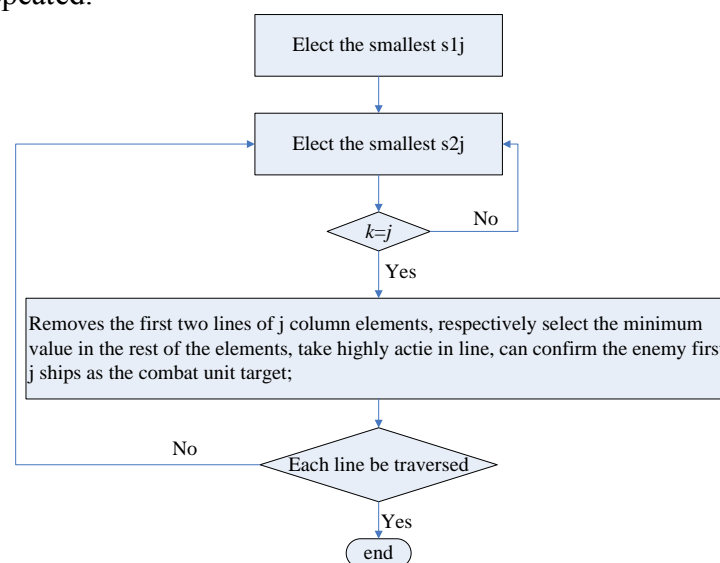


Fig.1 Algorithm flow chart

Worth pointing out that the thought of this algorithm combines the greedy algorithm and improves it. The improved algorithm has reflected the following advantages:

- (1) Choosing each row of the matrix of the minimum as far as possible always, which is in play a system of the principle of maximum efficiency;
- (2) If two rows appear at the same time, the smallest element in the column ordinal phase can be modified in a timely and effective manner. So accordancing with the above algorithm for target allocation in strict, the same target will not be attacked by multiple combat units and individual goals are not missing;
- (3) If each row of the matrix is choosed due value, our each combat unit is assigned a goal;
- (4) If our combat unit is more than the enemy ships, the more units can be formed a matrix and assigned targets using the same algorithm.

#### 4. Instances Verification

Equipped with moving targets on the sea, the total number of all kinds of ships is  $n = 9$ . Our missile attack the team intensively and the number of missile is  $m = 12$ . Through information acquisition and processing, we get the matrix of state.

$$S = \begin{pmatrix} 0.7 & 1.4 & 0.6 & 1.4 & 0.8 & 1.0 & 1.3 & 0.9 & 0.8 \\ 0.7 & 1.2 & 0.8 & 1.2 & 0.4 & 1.0 & 1.0 & 1.4 & 1.1 \\ 1.1 & 0.7 & 0.7 & 0.9 & 0.7 & 1.5 & 0.9 & 0.8 & 0.6 \\ 1.0 & 0.9 & 1.1 & 1.2 & 1.2 & 1.1 & 1.2 & 0.8 & 1.5 \\ 1.4 & 1.4 & 0.8 & 1.3 & 0.7 & 1.3 & 1.0 & 1.4 & 1.1 \\ 1.3 & 1.4 & 0.7 & 0.5 & 1.0 & 1.2 & 0.9 & 1.2 & 0.9 \\ 1.0 & 0.9 & 0.5 & 1.2 & 1.0 & 0.4 & 1.2 & 0.6 & 1.0 \\ 0.6 & 1.4 & 1.2 & 0.9 & 1.2 & 0.8 & 0.5 & 1.1 & 0.8 \\ 1.3 & 0.6 & 0.9 & 1.3 & 0.9 & 0.8 & 1.3 & 1.4 & 0.9 \\ 0.9 & 0.9 & 1.4 & 1.0 & 1.4 & 1.0 & 1.5 & 0.7 & 0.8 \\ 1.1 & 1.3 & 0.8 & 1.2 & 1.3 & 1.2 & 1.0 & 1.0 & 1.1 \\ 1.3 & 0.5 & 0.9 & 0.9 & 1.1 & 0.8 & 1.4 & 1.2 & 1.3 \end{pmatrix}$$

Based on the above algorithm, we can get the following results of matrices.

$$R = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Among the element of R, 1 express attack and 0 express not attack.  $R_{ij}$  express combat unit i attacking the target j.

## 5. Conclusion

Much attention has been paid to the technology about target decisions, meanwhile, more and more power are putted into the study field. So complicated research perspective and research methods are born.

Methods to target decision is influenced by different factors and each have differences. Main factors is the combat background and intention, commander of the decision-making thought, etc. The current decision method has its advantages and disadvantages. Such as decision expert system based on artificial intelligence, neural network and the fuzzy inference decision, which have good prediction ability, strong adaptability, but the samples extraction and expression is very difficult. Furthermore, the real time capability is not strong.

In this paper, the method of target decision based on the situation of threat matrix considered the dynamic characteristics of both sides, the full consideration of enemy fire arrangement and battle the enemy target value, so the goal of information is relatively complete, situation assessment is more accurate. The target distribution by traditional calculation method, which have the advantage of optimal selection and easy to implement, so it has higher practical value.

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