Comprehensive Evaluation of Shooting Goals Based on Rough Sets

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***Abstract*—In this paper, the Rough Sets theory was introduced, then on the basis of analyzing and creating the index system of certain weapon system's shooting targets, RS was used to impersonally distribute weight vectors. It overcame the problems of subjectivist empower rules The RS comprehensive evaluation model of the targets system was given out according to the practical cases. The sequence of threatening degree and evaluation grade of the targets were educed last. This practical model offers reference for the commanders of the antiaircraft forces.**

Keywords- antiaircraft defense;shooting targets ; rough sets; comprehensive evaluation

I. INTRODUCTION

Battleground situation is complex variation in modern sophisticated wars. The means of warfare are manifold. It becomes increasingly important for the commanders of the antiaircraft forces that how they choose the targets with emphasis and annihilates efficiently the offensive force, when they are attacked by several aerial enemies synchronously. Thus, whether the reasonable comprehensive evaluation of the threatening degree of the shooting targets can be obtained will directly affect the rationality and efficiency of the military movement program and the final results of the whole war.

Comprehensive evaluation means to give out the holistic evaluation on the whole scale of the object with multi-attribute [1]. It is a complicated question. There is always subjectivity and obscurity, when we set the weight vectors and evaluation matrix in the usual ways used for comprehensive evaluation, which always limits our realization towards the objects. We can get rid of the limitation of the choice of the weighting coefficient when we use RS to carry out the comprehensive evaluation on the shooting goals, because it can deal with qualitative and quantitative factors and can analyze efficiently the imprecise, the inconsistent and the imperfective information [2]. Meanwhile, it is very important for us to carry out the military movement program.

II. THE RS THEORY [3]

The RS (rough sets) theory educed by the polish scholar Z. Pawlak in the 1980s was a new mathematical tool for dealing with the fuzzy and uncertain information. It can analyze and operate the imprecise, the inconsistent and the imperfective information. The clou of the theory is to get the classifying regulations and the decision of the question by reduction on precondition that it retains the ability of classifying [4]. The advantage of the RS theory is that it relies only on the information included in the data and needs no transcendental information. Its arithmetic is simple.

The frame of the theory can be reduced to dividing the information in the field under relation that cannot be divided, constituting the information expressing system, inducting the object depicted in the upper and lower approximately approaching way, reviewing the importance of the attributes and wiping off the redundant attributes, predigesting the expressing space and finding out the regulations.

A. Evaluating the evaluation index

The value of the index of the evaluation system and subsystems was gained by dealing with the experimental or testing data in the statistical way [5]. As the data used by RS are discrete, the types of the index value must be transformed before used. Then a predigested datasheet can be gained after eliminating the redundant indexes in the datasheet according to RS.

B. Calculating the weighting vectors of the indexes

How to get the weighting coefficient of the indexes is very important in the process of comprehensive assessment. There are mainly two ways to get them. The first one is called subjectively evaluating [6] method which is a qualitative way basing on the comprehensive consultation grading. Another one is called objectively evaluating method which relies on the correlativity among the indexes or variation degree of the indexes. This paper introduced the objectively evaluating method basing on RS to obtain the weighting vectors. The method is more precise than the Delphi mentioned in [2].

According to the conception of attribute importance in the RS theory, we can define the importance of the index i as [6].

$$\omega_i = \frac{\left|pos_P(Q)\right| - \left|pos_{P-\{i\}}(Q)\right|}{\left|U\right|} \quad (1)$$

In the expression, U is the set of objects evaluated, P、Q are the attribution sets of U, and $pos_P(Q)$ is the P positive field of Q , the set of objects in Q classified by P accurately. The bigger ω_i is, the more the evaluating indexes contribute

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to the results. If $\omega_i = 0$, the index i can be deleted as a redundant index. The weighting coefficient of i can be defined as

$$\lambda_i = \frac{\omega_i}{\sum_{k \in P} \omega_k} \quad (2)$$

It denotes the proportion of the importance of i in the field P.

III. THE COMPREHENSIVE EVALUATING MODEL OF THE SHOOTING TARGETS BASING ON RS

A. The influencing factors of the shooting [7]

The targets choice mainly depends on the threatening degree and the degree of the advantageous condition for shooting of the objects. The threatening degree of the objects depends mainly on its distance, state of movement, attacking capability, mobility and opposing capability. The degree of the advantageous condition for shooting depends mainly on the targets' exposed degree, effective area for shooting, and vulnerable degree. Suppose that an antiaircraft unit need to take comprehensive evaluation on 7 groups of targets. According to the fact, the main influencing factors of the targets' comprehensive quality can be ranged as the 8 indexes mentioned above.

B. The value of the evaluation indexes of the objects

According to the experience and statistical work, we can get the value of the evaluation indexes of the 7 group targets in table Ⅰ.

TABLE I. THE VALUE OF THE EVALUATION INDEXES OF THE TARGETS

The index	target1	target2	target3	target4	target5	target6	target7
Object distance C1	0.89	0.82	0.84	0.96	0.95	0.80	0.75
Movement state C2	0.68	0.74	0.71	0.76	0.69	0.61	0.77
Attacking capability C3	0.92	0.55	0.72	0.89	0.82	0.66	0.58
Mobility C4	0.63	0.62	0.74	0.71	0.68	0.79	0.70
Opposing capability C5	0.77	0.69	0.72	0.70	0.66	0.62	0.65
Exposed degree C6	0.60	0.69	0.75	0.76	0.67	0.79	0.69
Shooting area C7	0.88	0.52	0.85	0.78	0.58	0.90	0.56
Vulnerable degree C8	0.91	0.65	0.82	0.92	0.86	0.76	0.72

According to the fact, we separate the assessment criterion into 3 classes, big, normal, and small. They denote the threatening degree of the indexes. When the value is in the range 0.80~1.0, the index is assigned 1. It denotes big. When the evaluation value is in 0.60~0.79, we assign the index 2. It means the index is normal. When the value is smaller than 0.59, it is small. We assign the index 3. According to the type of the data used in RS, the value in the datasheet must be transformed into discrete ones as in the table Ⅱ. As C2, C4, C5, and C6 are equal to denote the index value of the objects， we just retain one of them, C2.

C. Calculating the index weighting vectors and the comprehensive evaluation value

According to the impartibility relativity in RS, we can get the calculating result from table Ⅱ.

$$U/ind(C) = \{\{1\},\{2\},\{3\},\{4\},\{5\},\{6\},\{7\}\}$$
$$U/ind(C-\{C_1\}) = \{\{1\},\{2,7\},\{3\},\{4\},\{5\},\{6\}\}$$
$$U/ind(C-\{C_2\}) = \{\{1\},\{2\},\{3\},\{4\},\{5\},\{6\},\{7\}\}$$
$$U/ind(C-\{C_3\}) = \{\{1,3\},\{2\},\{4\},\{5\},\{6\},\{7\}\}$$
$$U/ind(C-\{C_7\}) = \{\{1,4,5\},\{2\},\{3\},\{6\},\{7\}\}$$
$$U/ind(C-\{C_8\}) = \{\{1\},\{2\},\{3,6\},\{4\},\{5\},\{7\}\}$$

TABLE II. THE DISCRETE VALUE OF THE EVALUATION INDEXES OF THE TARGETS

The index	target1	target2	target3	target4	target5	target6	target7
Object distance C1	1	1	1	1	1	1	2
Movement state C2	2	2	2	2	2	2	2
Attacking capability C3	1	3	2	1	1	2	3
Mobility C4	2	2	2	2	2	2	2
Opposing capability C5	2	2	2	2	2	2	2
Exposed degree C6	2	2	2	2	2	2	2
Shooting area C7	1	3	1	2	3	1	3
Vulnerable degree C8	1	2	1	1	1	2	2

Then, we can get the weight of the 5 index from (1).

$$\omega_{C_1} = \frac{|pos_C(C)| - |pos_{C-\{C_1\}}(C)|}{|U|} = \frac{2}{7}$$

$$\omega_{C_2} = \frac{|pos_C(C)| - |pos_{C-\{C_2\}}(C)|}{|U|} = 0$$

$$\omega_{C_3} = \frac{|pos_C(C)| - |pos_{C-\{C_3\}}(C)|}{|U|} = \frac{2}{7}$$

$$\omega_{C_7} = \frac{|pos_C(C)| - |pos_{C-\{C_7\}}(C)|}{|U|} = \frac{3}{7}$$

$$\omega_{C_8} = \frac{|pos_C(C)| - |pos_{C-\{C_8\}}(C)|}{|U|} = \frac{2}{7}$$

As ω_{C_2}=0, index C2 can be reduced. Then from（2）, we can get the weight of the other 4 indexes:

$$\lambda_{C_7} = \frac{\omega_{C_7}}{\omega_{C_1} + \omega_{C_3} + \omega_{C_7} + \omega_{C_8}} = \frac{3}{9} = 0.3\dot{3}$$

$$\lambda_{C_1} = \lambda_{C_3} = \lambda_{C_8} = \frac{2}{9} = 0.2\dot{2}$$

So, according to the weighting coefficient and the index value in table 1(except C4, C5, and C6), the comprehensive evaluation value of the 7 group targets can be worked out as (the value of target i is recorded as MBi):

$$MB_1 = 0.22\times0.89 + 0.22\times0.92 + 0.33\times0.88 + 0.22\times0.91 = 0.8888$$

$$MB_2 = 0.616\text{，}\quad MB_3 = 0.8041\text{，}\quad MB_4 = 0.8668$$

$$MB_5 = 0.77\text{，}\quad MB_6 = 0.7854\text{，}\quad MB_7 = 0.6358$$

D. The comprehensive evaluation result

So, it is obvious that the comprehensive evaluating sequence of the 7 group targets is target 1＞target 4＞target 3＞target 6＞target 5＞target 7＞target 2.It means that the threatening degree of the 1st target is the maximal, the threatening degree of the 2nd target is the least. Therefore, the order of the 7 group targets' threatening degree must be 1，4，3，6，5，7，2. So we must deal with the No.1, No.4 and No.3 targets with priority.

IV. THE CONCLUSIONS

The RS comprehensive evaluating model proposed in this paper is pellucid, easy to be actualized and objective. We can get rid of the limitation of the choice of the weighting coefficient as Delphi mentioned in [2]. The model can be used with the suited software. Once the parameter of the objects is input, the threatening degrees of the targets can be obtained. Thus it can provide the commanders real time and reliable information. It is strategic for the army to win the advantage of the opportunity for combat.

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