Research on Situation Assessment of Short-range Air Combat with Adaptive Variable Weight

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Abstract. Aiming at the problem of poor information dynamics caused by the summation of constant weight in traditional air combat situation assessment is not flexible enough, based on the variable weight theory, the traditional method is improved, and an adaptive variable weights method for the situation assessment of short-range air combat is proposed. Based on the characteristic of air combat situation, the weight of situation assessment index is adjusted dynamically with the change of situation type. By making full use of situation information, this paper describes the contribution of indicators to situation value under different situation types. The feasibility and effectiveness of this method in air combat situation assessment are verified by real air combat data simulation experiments. The simulation results show that compared with the traditional evaluation method, the adaptive variable weight assessment method is more consistent with the actual situation of air combat situation change.

Introduction

With the development of artificial intelligence, more and more researchers are concerned about how to realize the intelligent air combat of UAV. Different from the "human-in-loop" mode of UAV combat, intelligent air combat is the combat mode in which the UAV enters the combat area under the guidance of the command, independently processes battlefield information, completes situation assessment, tactical maneuver, attack or avoidance decision, and launches weapons. Therefore, the realization of real-time situation assessment of unmanned aerial vehicles (UAVS) and the improvement of the accuracy of situation assessment has become the key links of intelligent air combat decision-making.

In this paper, the parameters of the situation assessment are briefly introduced. In the situation assessment, the static capability parameters and dynamic situation factors are considered. According to the influence of different factors on the attack effect, the height, speed, angle and distance advantage functions are constructed. Then based on the Bayesian theory, the situation type in the current situation is determined, and the situation is dynamically assigned according to the situation type. Finally, the proposed method is verified, and the simulation results further verify the rationality of dynamic variable weights.

Establishment of Situation Assessment Model

Situation Assessment Parameters Selection

During the air combat confrontation, the capability parameters and geometric placeholder information of both sides are important parameters for the situation assessment. The capability parameters of both
sides are mainly determined by the performance of the equipment, and the geometric occupation situation information is shown in figure 1.

![Figure 1. Occupation situation for both parties.](image)

**Establishment of Situation Assessment Index**

The evaluation index system should be based on the system utility theory [13], and the indicators should have the requirements of completeness, independence and minimality. Therefore, in order to conduct the situation assessment objectively, the establishment of the system should not only consider the air combat capability assessment, but also include the dynamic situation assessment based on the air combat process. The specific situation assessment index system is shown in figure 2:

![Figure 2. Situation assessment indicator system.](image)

**Air Combat Static Capability Assessment.** Situation capability assessment involves many factors in actual air combat. In order to improve the credibility of situation assessment and the practicability of situation assessment, this paper selects 7 factors related to air combat capability for modeling. The dominant function based on air combat capability [14] is shown in formula (1):

$$
C = \ln B + \ln(\sum A_1 + 1) + \ln(\sum A_2) \epsilon_1 \epsilon_2 \epsilon_3 \epsilon_4 \\
T_c = \frac{C}{\max(C)}
$$

Where, $T_c$ is the advantage function of air combat capability; $C$ is the Combat capability; $B$ is the maneuver parameter; $A_1$ is the firepower parameter; $A_2$ is the detection parameter; $\epsilon_1$ is the maneuverability coefficient; $\epsilon_2$ is the survival coefficient; $\epsilon_3$ is the distance coefficient; $\epsilon_4$ is the coefficient of electronic countermeasures.

**Air Combat Dynamic Situation Assessment.** According to the theoretical analysis of attack zone, the dynamic situation assessment of air combat mainly considers the advantages of speed, angle, distance and height. The parameter information of the aircraft can be obtained by the airborne equipment, and the parameter information of the target can be obtained by the aircraft’s own radar or early warning aircraft data link information.
During an air combat, the side with speed advantage can get into the firing range of the missile faster, and at the same time, it can save itself and quickly withdraw from the battle. However, fast speed will also lead to problems such as difficult target tracking and large turning radius. Therefore, the optimal air combat speed must be designed dynamically. The optimal air combat speed is shown in formula (2):

\[
v_0 = \begin{cases} 
  \left( \frac{d}{D_{M_{\text{max}}}} \right)^3 v_R & D_{M_{\text{max}}} \leq d \\
  1 - \left( \frac{D_{M_{\text{max}}} - d}{D_{M_{\text{max}}}} \right)^3 v_R & D_{M_{\text{max}}} \leq d < D_{M_{\text{max}}} \\
  \left( \frac{D_{M_{\text{max}}}}{d} \right)^2 v_R & d < D_{M_{\text{max}}} 
\end{cases}
\]

(2)

When the blue aircraft does not enter the red’ missile attack region, the greater the speed, the more convenient to meet the enemy; as the distance becomes shorter, the blue plane enters the maximum launching distance of the enemy’ missile. The blue plane should slow down appropriately to facilitate the stable scanning and tracking of the missile. When the aircraft continues to approach, the aircraft enters the red side of the inescapable distance, increase the speed can effectively get rid of the red side pursuit. On the basis of the optimal air combat speed, the velocity advantage function is constructed as formula (3). Among them, \( v_R \) is the speed of our aircraft; \( v_B \) is the speed of enemy aircraft; \( v_0 \) is the best air combat speed for our aircraft.

\[
T_v = \begin{cases} 
  \left( \frac{v_R}{v_B} \right)^2 e^{\frac{v_B-v_R}{v_0}} & 0 \leq v_R/v_B < 0.5, v_R > v_0 \\
  \left( \frac{v_R}{v_B} \right)^2 e^{\frac{v_B-v_R}{v_0}} & 0 \leq v_R/v_B < 0.5, v_R \leq v_0 \\
  \frac{(v_R/v_B - 0.5)^2}{4(1.0-0.5)^2} + 0.25 e^{\frac{v_B-v_R}{v_0}} & 0.5 \leq v_R/v_B < 1.0, v_R > v_0 \\
  \frac{(v_R/v_B - 0.5)^2}{4(1.0-0.5)^2} + 0.25 e^{\frac{v_B-v_R}{v_0}} & 0.5 \leq v_R/v_B < 1.0, v_R \leq v_0 \\
  \frac{(v_R/v_B - 1.0)^2}{2(2.0-1.0)^2} + 0.5 e^{\frac{v_B-v_R}{v_0}} & 1.0 \leq v_R/v_B < 2.0, v_R > v_0 \\
  \frac{(v_R/v_B - 1.0)^2}{2(2.0-1.0)^2} + 0.5 e^{\frac{v_B-v_R}{v_0}} & 1.0 \leq v_R/v_B < 2.0, v_R \leq v_0 \\
  e^{\frac{v_B-v_R}{v_0}} & 2.0 \leq v_R/v_B, v_R > v_0 \\
  e^{\frac{v_B-v_R}{v_0}} & 2.0 \leq v_R/v_B, v_R \leq v_0 
\end{cases}
\]

(3)

In air combat, when the azimuth angle is greater than the radar detection angle, but less than the maximum off-axis angle of the missile, even if the missile can hit the target, the missile does not meet the launch condition, because the radar cannot intercept. When the azimuth angle is smaller than the maximum detection angle of the radar, the missile achieves the lateral launch conditions. The smaller the absolute value of the azimuth, the larger the missile launch area.
The size of the entry angle reflects the threat of the target to the attack aircraft. When the entry angle is 0°, it indicates that the target is moving away from the attack aircraft. When the azimuth and the entry angle are both 0°, a typical pursuit situation is formed. When the entry angle is 180°, it indicates that the target is approaching the attack aircraft. When the entry angle is 180° and the azimuth is 0°, a typical positive head posture is formed. Therefore, the angular advantage function is modeled as formula (4). Where \( p \) is the angle between the attacker's velocity vector and the target line, which \( q \) is the angle between the target speed vector and the target line.

\[
T_e = \begin{cases} 
0 & D > D_{M_{\text{max}}} \\
\left(1 - \frac{(D - D_{M_{\text{max}}})^2}{(D_{M_{\text{max}}} - D_{MT_{\text{max}}})^2}\right) & D_{MT_{\text{max}}} \leq D < D_{M_{\text{max}}} \\
1 & D_{MT_{\text{min}}} \leq D < D_{MT_{\text{max}}} \\
\left(1 - \frac{(D - D_{M_{\text{min}}})^3}{(D_{MT_{\text{min}}} - D_{M_{\text{min}}})^3}\right) & D_{M_{\text{min}}} \leq D < D_{MT_{\text{min}}} \\
0 & D < D_{M_{\text{min}}} 
\end{cases}
\]

(4)

The distance advantage in the air combat is mainly reflected in the impact of air-to-air missile attack. When the distance between the two sides is much larger than the maximum launching distance of the missile, there is no attack condition at the time, and the distance advantage of the fighter is small. In the process of meet enemy, the relative distance decreases. When it is between the maximum inescapable distance and the minimum non-escape distance, the missile hit rate is higher and has a higher attack advantage. When the relative distance is less than the minimum inescapable distance, the missile fuse cannot be effectively unlocked, and the warhead cannot be detonated, and the attack effect cannot be achieved.

Considering the maximum inescapable distance, the minimum inescapable distance, the minimum launch distance of the missile and the maximum launch distance of the missile, the distance advantage model is constructed as formula (5). Among them, \( D \) indicates the relative distance between the enemy and us, \( D_{MT_{\text{min}}} \) is the minimum launch distance of the missile; \( D_{MT_{\text{max}}} \) is the maximum attack distance of the missile; \( D_{MT_{\text{max}}} \) is the maximum distance of the non-escape zone; \( D_{MT_{\text{min}}} \) is the minimum distance of the non-escape zone.

\[
T_d = \begin{cases} 
0 & D > D_{MT_{\text{max}}} \\
\left(1 - \frac{(D - D_{MT_{\text{max}}})^2}{(D_{MT_{\text{max}}} - D_{MT_{\text{min}}})^2}\right) & D_{MT_{\text{max}}} \leq D < D_{MT_{\text{max}}} \\
1 & D_{MT_{\text{min}}} \leq D < D_{MT_{\text{max}}} \\
\left(1 - \frac{(D - D_{MT_{\text{min}}})^3}{(D_{MT_{\text{min}}} - D_{MT_{\text{min}}})^3}\right) & D_{MT_{\text{min}}} \leq D < D_{MT_{\text{min}}} \\
0 & D < D_{MT_{\text{min}}} 
\end{cases}
\]

(5)

The height of the aircraft affects the launching area of the air-to-air missile. When the carrier is at the optimal altitude for missile launch, the launch area is the largest and the situation is correspondingly the largest. The height difference reflects the difference in energy between the two sides. The same type of missile is carried. When the aircraft missile is at a high range, it will be larger than the range of the aircraft missile in the low position. The highly dominant function is constructed as in formula (6). Among them, \( h_r \) is the flight altitude of the red aircraft, \( h_b \) is the flight altitude of the blue aircraft, \( h_i \) is the height of the attack aircraft in the largest missile launch area.
Establishment of Situation Assessment Model

Accurate situation assessment model is an important basis for decision making. Based on the previous research, this paper establishes a situation assessment model, considering the static capability assessment parameters and the dynamic situation assessment parameters, the situation assessment model is established as shown in formula (7):

\[
T_h = \begin{cases} 
0.5 - \frac{1}{2} \left( \frac{\Delta h}{2000} \right)^2 e^{\frac{h_R - h_0}{h_0}} & \Delta h < 0, h_R \leq h_0 \\
0.5 - \frac{1}{2} \left( \frac{\Delta h}{2000} \right)^2 e^{\frac{h_R - h_0}{h_0}} & \Delta h < 0, h_R > h_0 \\
1 - \frac{1}{2} \sqrt{\frac{2000 - \Delta h}{2000}} e^{\frac{h_R - h_0}{h_0}} & \Delta h \geq 0, h_R \leq h_0 \\
1 - \frac{1}{2} \sqrt{\frac{2000 - \Delta h}{2000}} e^{\frac{h_R - h_0}{h_0}} & \Delta h \geq 0, h_R > h_0 
\end{cases}
\]

(6)

\[
T = k_1 T_c + k_2 T_a + k_3 T_d + k_4 T_v + k_5 T_h \\
\sum_{i=1}^{5} k_i = 1
\]

(7)

Where, \(T_c\) is the capability factor, \(T_a\) is the angle factor, \(T_d\) is the distance factor, \(T_v\) is the speed factor, and \(T_h\) is the height factor.

When the situation is different, the impact of each indicator on the situation value is different. Therefore, the adjustment of the weight needs to be dynamically adjusted according to the type of situation. The process of situation assessment is as shown:

\[\text{Start} \quad \rightarrow \quad \text{Get all kinds of flight status data} \quad \rightarrow \quad \text{Determine the type of situation} \quad \rightarrow \quad \text{Determine indicator weights based on situation type} \quad \rightarrow \quad \text{Constructing an adaptive variable weight situation assessment model} \quad \rightarrow \quad \text{End}\]

Figure 3. Air combat situation assessment flow chart.

Determination of the type of Situation

This paper defines the situation of air combat as four categories, mainly with air combat advantages \(\Gamma = 1\), disadvantages \(\Gamma = 2\), mutual balance \(\Gamma = 3\), and mutual disadvantages \(\Gamma = 4\). During the short-range air combat, the height of both sides is limited by the aircraft overload in a little time, and the value of change is small. In order to simplify the model and improve the computational efficiency, the relative height and relative speed are ignored in the situation assessment model. The type of
situation is mainly determined by the angle and distance. The state variables are: $S_i = [p \ q \ R]$. Among them, $p$ is the azimuth of the target, $q$ is the entry angle of the target.

The situation classification probability model is established based on Bayesian theory. The situation classification model at each moment can be calculated by (8):

$$P(\Gamma_{k}^r = j \mid S = s_{k}^i)$$

(8)

Among them, $j = 1, 2, 3, 4$ represent four different situations, and the conditional probability meets the condition $\sum_{j} P(\Gamma_{k}^r = j \mid S = s_{k}^i) = 1$. According to Bayesian theory:

$$P(\Gamma_{k}^r = j \mid S = s_{k}^i) = \frac{P(\Gamma_{k}^r = j)P(S = s_{k}^i \mid \Gamma_{k}^r = j)}{\sum_{l=1}^{4} P(\Gamma_{k}^r = l)P(S = s_{k}^i \mid \Gamma_{k}^r = l)}$$

(9)

Since air combat is a dynamic process, the process of situation assessment can be approximated as a Markov process. In other words, the result of the situation assessment is only related to the state of the current time, and has nothing to do with the previous state. Therefore, the prior probabilities ($P(\Gamma_{k}^r = j)$) are independent of each other and meet the condition $P(\Gamma_{k}^r = j) = 0.25$. The formula (9) can be simplified as follows:

$$P(\Gamma_{k}^r = j \mid S = s_{k}^i) = \frac{P(S = s_{k}^i \mid \Gamma_{k}^r = j)}{\sum_{l=1}^{4} P(S = s_{k}^i \mid \Gamma_{k}^r = l)}$$

(10)

The elements in the classification state variable $S_i$, $p$, $q$, $R$ are independent of each other. The joint conditional probability density can be calculated by formula (11):

$$P(S = s_{k}^i \mid \Gamma_{k}^r = j) = P^p(p_{k}^i \mid \Gamma_{k}^r = j) \cdot P^q(q_{k}^i \mid \Gamma_{k}^r = j) \cdot P^R(R_{k}^i \mid \Gamma_{k}^r = j)$$

(11)

The conditional probability function $P^p(\cdot)$, $P^q(\cdot)$, $P^R(\cdot)$ are defined as Table 1. Therefore, the type of situation can be determined by equation (10).

**Determination of Adaptive Weight**

When our aircraft is in the rear area of the enemy aircraft and the enemy aircraft is within the effective attack distance of our aircraft, our aircraft should shorten the distance between the two sides as much as possible, so that the enemy aircraft is in an inescapable area and maintain the angle advantage. At the same time increase the height advantage and speed advantage. Therefore, the weight factor of the dominant situation has the largest weight, followed by the angle factor, and finally the height factor and the speed factor.

When the enemy aircraft is in the rear area of our aircraft, our aircraft should increase the relative distance and increase the advance angle of the enemy aircraft to escape the attack area of the enemy aircraft as soon as possible. Therefore, the distance factor and the angle factor in the inferior situation account for the main factor, and the height factor and the speed factor have less influence.

When the two sides approach closely, the distance gradually increases. In this case, our aircraft should increase the angle and occupy the dominant position as soon as possible, followed by increasing the height factor and speed to obtain a larger energy advantage.

When the two sides fly in the opposite direction, our aircraft should increase the angle factor, height factor and speed factor to obtain a larger energy advantage and battlefield initiative.

Since the performance of the aircraft belongs to the inherent properties of the aircraft and does not change with the change of the situation, $k_i$ are equal.
According to the above analysis, the dynamic weight of situation assessment is given according to the situation type, as shown in table 2.

<table>
<thead>
<tr>
<th>Situation Type</th>
<th>$k_1$</th>
<th>$k_2$</th>
<th>$k_3$</th>
<th>$k_4$</th>
<th>$k_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantage Situation $\Gamma = 1$</td>
<td>0.3</td>
<td>0.25</td>
<td>0.10</td>
<td>0.25</td>
<td>0.10</td>
</tr>
<tr>
<td>Disadvantage Situation $\Gamma = 2$</td>
<td>0.3</td>
<td>0.25</td>
<td>0.00</td>
<td>0.35</td>
<td>0.10</td>
</tr>
<tr>
<td>The Balance of Each Other</td>
<td>0.3</td>
<td>0.35</td>
<td>0.15</td>
<td>0.05</td>
<td>0.15</td>
</tr>
<tr>
<td>Each Disadvantage</td>
<td>0.3</td>
<td>0.30</td>
<td>0.20</td>
<td>0.00</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Table 1. Conditional probability function table.

<table>
<thead>
<tr>
<th>Situation Type</th>
<th>Conditional Probability Function</th>
<th>Conditions</th>
<th>Situational Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantage Situation $\Gamma = 1$</td>
<td>$P^a(p'_i</td>
<td>\Gamma'_i = j) = (90 - p'_i') / 90$</td>
<td>$0 \leq p' \leq 90$</td>
</tr>
<tr>
<td></td>
<td>$P^d(p'_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$90 \leq p' \leq 180$</td>
</tr>
<tr>
<td></td>
<td>$P^a(q'_i</td>
<td>\Gamma'_i = j) = -(q'_i - 90') / 90$</td>
<td>$0 \leq q' \leq 90$</td>
</tr>
<tr>
<td></td>
<td>$P^d(q'_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$90 \leq q' \leq 180$</td>
</tr>
<tr>
<td></td>
<td>$P^a(R_i</td>
<td>\Gamma'<em>i = j) = 1 - R_i / R</em>{adv}$</td>
<td>$[0,R_{adv}]$</td>
</tr>
<tr>
<td></td>
<td>$P^d(R_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$[R_{adv},\infty]$</td>
</tr>
<tr>
<td>Disadvantage Situation $\Gamma = 2$</td>
<td>$P^a(p'_i</td>
<td>\Gamma'_i = j) = -(p'_i' - 90') / 90$</td>
<td>$0 \leq p' \leq 90$</td>
</tr>
<tr>
<td></td>
<td>$P^d(p'_i</td>
<td>\Gamma'_i = j) = 0$</td>
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</tr>
<tr>
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</tr>
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<td></td>
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<td>$90 \leq q' \leq 180$</td>
</tr>
<tr>
<td></td>
<td>$P^a(R_i</td>
<td>\Gamma'<em>i = j) = R_i / R</em>{adv}$</td>
<td>$[0,R_{adv}]$</td>
</tr>
<tr>
<td></td>
<td>$P^d(R_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$[R_{adv},\infty]$</td>
</tr>
<tr>
<td>The Balance of Each Other $\Gamma = 3$</td>
<td>$P^a(p'_i</td>
<td>\Gamma'_i = j) = -(p'_i - 90') / 90$</td>
<td>$0 \leq p' \leq 90$</td>
</tr>
<tr>
<td></td>
<td>$P^d(p'_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$90 \leq p' \leq 180$</td>
</tr>
<tr>
<td></td>
<td>$P^a(q'_i</td>
<td>\Gamma'_i = j) = (p'_i - 90') / 90$</td>
<td>$0 \leq q' \leq 90$</td>
</tr>
<tr>
<td></td>
<td>$P^d(q'_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$90 \leq q' \leq 180$</td>
</tr>
<tr>
<td></td>
<td>$P^a(R_i</td>
<td>\Gamma'<em>i = j) = R_i / R</em>{adv}$</td>
<td>$[0,R_{adv}]$</td>
</tr>
<tr>
<td></td>
<td>$P^d(R_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$[R_{adv},\infty]$</td>
</tr>
<tr>
<td>Each Disadvantage $\Gamma = 4$</td>
<td>$P^a(p'_i</td>
<td>\Gamma'_i = j) = (90 - p'_i') / 90$</td>
<td>$0 \leq p' \leq 90$</td>
</tr>
<tr>
<td></td>
<td>$P^d(p'_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$90 \leq p' \leq 180$</td>
</tr>
<tr>
<td></td>
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<td>\Gamma'_i = j) = -(q'_i - 90') / 90$</td>
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</tr>
<tr>
<td></td>
<td>$P^a(R_i</td>
<td>\Gamma'<em>i = j) = R_i / R</em>{adv}$</td>
<td>$[0,R_{adv}]$</td>
</tr>
<tr>
<td></td>
<td>$P^d(R_i</td>
<td>\Gamma'_i = j) = 0$</td>
<td>$[R_{adv},\infty]$</td>
</tr>
</tbody>
</table>

**Simulation Analysis**

Perform simulation analysis on the model established above:

1. Assuming that the optimal speed is 200m/s, the curve of the speed advantage function is shown in Figure 5:

   It can be seen from Fig. 5 that when the red’s speed is at the optimal speed and the blue’s speed is the minimum speed, the situation value is the largest. As the blue plane speed increases, the situation function decreases. When the red plane is not at the optimal speed, the speed advantage value gradually decreases.
(2) Assuming that the maximum detection angle of the airborne radar is 40 degrees, the change of the angular advantage function is shown in Figure 6:

![Figure 5. Speed advantage function diagram.](image)

![Figure 6. Angle advantage function diagram.](image)

It can be seen from Fig. 6 that when the entry angle and the azimuth angle are both 0 degrees, the pursuit situation is formed, and the angle advantage value is the largest. As the absolute value of the entry angle and the absolute value of the azimuth increase, the situation gradually decreases. Therefore, the target can increase the angle advantage by minimizing the absolute value of the azimuth angle, and the attack machine can reduce the target angle advantage by increasing the absolute value of the entry angle.

(3) Assume that the minimum launch distance of the missile is 0.5km, the minimum non-escape distance is 2km, the maximum non-escape distance is 8km, and the farthest launch distance is 10km. The change of the distance advantage function is shown in Figure 7:

![Figure 7. Distance advantage function diagram.](image)

It can be seen from Fig. 7 that when the relative distance is between the minimum launch distance and the minimum inviolable distance. As the distance increases, the target has little threat to the attack aircraft. Therefore, the advantage of the attack is gradually increasing; when the target is in the non-escape zone of the missile, the distance advantage is the greatest; when the target is between the maximum inescapable distance and the maximum launch distance, the distance advantage gradually decreases with time. When the target is outside the missile's maximum launch distance, the distance advantage is minimal.

(4) The change of the height advantage function is shown in Figure 8:

It can be seen from Fig. 8 that the increase of the advantage function depends on the difference between the reduction and the optimal height. The advantage in the height difference on the other
hand. When the height of the two sides are at the same height, the dominant value of both sides is same as 0.5.

![Height advantage function diagram.](image)

(5) This paper selects the flight record data of air combat training for simulation analysis. The aircraft models of the two parties are the same. Therefore, the air combat capability of both sides is the same in the simulation. The simulation results are shown in Figure 9 and Figure 10:

![Track chart of both sides in air combat.](image)

![Simulation results of air combat.](image)

Figure 9 shows the real air combat process between the red and the blue. Figure 10 reflects the change in the situation of both red and blue. At the initial position, both sides fly oppositely, in a state of mutual balance, so the situation values are substantially equal at the initial position. During the initial flight, since the red aircraft has been in a relatively high position, the situation value is slightly higher than the blue state in the initial stage. When the two planes continue to fly, although the red plane is in a higher position, the blue side is in the tail position of the red side, forming a tailing situation, and the situation value is higher than the red. When in the final stage, the red plane's altitude is lowered, and the blue side forms a tail-following situation for the red side. Therefore, the blue level state of the final stage in Figure 10 is higher than the red side.

It can be seen from the simulation that the situation assessment method based on dynamic variable weight is consistent with the actual air combat situation. According to the situation type of the air combat parties, the weights are appropriately adjusted, and the key situation elements in the air combat process are dynamically empowered, which can better reflect the indicators. The close connection with the air combat situation highlights the importance of situational assessment of situation indicators under different situation types.
Summary
The assessment of air combat situation is the key link in air combat decision-making. It is of great significance for the future development of man-machine intelligent assistant decision-making system or drone independent air combat technology. This paper constructs a dynamic variable weighting model based on Bayesian theory by analyzing the shortcomings of indicators' constant weight. The dynamic weighting method can dynamically adjust according to the type of air combat situation, which highlights the key elements reflecting the air combat situation in the situation assessment, and obtains more scientific and reasonable evaluation results. At the same time, the key elements provide the pilot with a brief and concise situation information.

Acknowledgement
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References