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Research on Simulation Method of Active Protection

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Abstract. This paper introduces an active protection simulation method. The active protection simulation software includes armor protection simulation component, incoming ammunition detection and alarm simulation component, soft kill active protection simulation component, hard kill active protection simulation component and so on. It can simulate the active protection process of armor target to typical ammunition. It not only considers the relevant elements of the protection process, but also facilitates the software implementation.

Keywords: simulation, active protection, armor.

1. Armor protection simulation component

The armor protection simulation component includes the front, side, top and bottom armor protection simulation. According to the armor material and thickness, projectile velocity and incident angle, the protection ability of armor is simulated. The armor protection simulation component is composed of the damage model of armor piercing projectile to armor target, the damage model of armor piercing projectile to armor target and the damage model of grenade to armor target.

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Table 1. Composition of armor protection simulation components.

No.	Name
1	Damage model of armor piercing projectile to armor target
2	Damage model of armor target by armor piercing projectile
3	Damage model of shrapnel to armored target

1.1. Damage model of armor piercing projectile to armor target

The simulation flow of damage model of armor piercing projectile to armor target is as follows.

If receiving the information that the armor piercing projectile directly hits the armor target, query the armor thickness of the hit surface, calculate the incident angle and armor piercing thickness, and calculate the damage degree and casualties of the armor target.

1.2. Damage model of armor target by armor piercing projectile

The simulation flow of the damage model of the armor target by the armor piercing projectile is as follows.

If receiving the information of direct hit to armor target, the armor thickness of hit surface is queried, the armor thickness is calculated, and the damage degree and casualties of armor target are calculated.

1.3. Damage model of shrapnel to armored target

The simulation flow of damage model of shrapnel to armored target is as follows.

Determine the type of information received. If the information is directly hit the armor target, query the armor thickness of the hit surface, and calculate the damage degree and casualties of the armor target. If the armor target information is not directly hit, the distance between the projectile landing point and the armor target is calculated, and the damage degree and casualties of the armor target are calculated.

2. Incoming ammunition detection and alarm simulation component

The active protection component of actual equipment consists of detection module, information processing control module and protective ammunition module. The detection module is used to continuously scan the whole protection area, and the information processing control module is used to automatically control the detection equipment and the whole system.

The simulation components of detection and alarm of incoming ammunition include vehicle simulation model, incoming ammunition simulation model, radar detection and alarm simulation model. As shown in Table 2.

Table 2. Composition of incoming ammunition detection and alarm simulation component.

No.	Name
1	Vehicle simulation model
2	Incoming ammunition simulation model
3	Radar detection and alarm simulation model

2.1. Vehicle simulation model

The simulation process of vehicle simulation model is as follows.

Before the simulation, read the vehicle motor data file, obtain the number of vehicle motion break points, and the time and location of arriving at the break point. During the simulation, in each simulation step, judge the break line (i to i + 1), and calculate the position and speed of the vehicle.

2.2. Incoming ammunition simulation model

The simulation process of the incoming ammunition simulation model is as follows.

In the process of simulation, the ammunition parameters issued by other simulation systems are received, including the movement speed, starting point and ending point position of the ammunition. In each simulation step, the position and speed of the ammunition are calculated.

2.3. Radar detection and warning simulation model

The simulation process of radar detection and alarm simulation model is as follows.

In the simulation process, in each simulation step, call the vehicle simulation model, calculate the vehicle position, call the incoming ammunition simulation model, and calculate the location of the incoming ammunition. Calculate the distance between the vehicle and the incoming ammunition. If the distance is greater than the maximum detection distance of the radar, carry out the next simulation cycle. Otherwise, if the distance is greater than the minimum detection distance of the radar, no target is detected, the simulation ends. If the distance between the vehicle and the incoming ammunition is within the radar detection range, judge whether the incoming ammunition is within the radar azimuth detection range. If not, carry out the simulation in the next simulation cycle. If yes, calculate whether the radar detects the target.

3. Soft kill active protection simulation component

The simulation component of soft kill active protection simulates the photoelectric information countermeasure system, which is composed of integrated countermeasure component and air countermeasure component. The integrated countermeasure component consists of infrared interference, millimeter wave shielding/suppression interference, multi spectrum smoke screen shielding, etc. the air countermeasure component consists of millimeter wave compensation, millimeter wave interference, etc.

The simulation process of soft kill active protection simulation component is as follows.

The current simulation time is t, and the last active protection time is t0. If t-t0 < Δ T10 (response time of active protection system for soft kill), this active protection fails and exits the simulation module of active protection for soft kill.

If ε (high and low defense range of the target) > θ (attack angle), the attack angle is within the high and low defense range of the target, otherwise, exit the simulation of soft kill active protection.

It is assumed that the angle between the target direction (or moving direction) and the north direction is α0 (obtained from the entity state information of the target), the target's azimuth defense range is (α0-θ, α0+θ), and θ is half of the target's azimuth defense range.

If the missile's flight direction α'is within the target's defense range (α0-θ, α0+θ), simulate the detection of incoming ammunition, otherwise, exit the simulation of active protection of soft kill.

The judgment method of whether the missile's flight direction α'is within the defense range of the target (α0-θ, α0+θ):

If α'≥ 180 degrees , α1'=α'- 180.

If α' < 180 degrees, α1'=α' + 180.

If α0 + θ > α0 - θ and α0 -θ <α1' ≦α0 + , the missile's flight direction is within the target defense range.

If α0 + θ <α0-θ and α0-θ <α1' or α1'≦ α0 + θ, the projectile's flight direction is within the target defense range.

θ fall angle and α' get from direct hit target information.

If the ammunition fall angle and orientation are within the defense range, a random number η is uniformly distributed between (0, 1). If η <P1 (probability of detecting incoming ammunition), it means that the soft kill active protection system can detect incoming ammunition Otherwise, exit the simulation of soft kill active protection.

If the soft kill active protection can detect the incoming ammunition, let t0 = t and extract a random number η uniformly distributed between (0, 1). If η <P2 (probability of successful interference), the soft kill active protection system interferes successfully.

4. Hard kill active protection simulation component

The hard kill active protection simulation component simulates the hard kill active protection ammunition, and simulates the protection process of the protective ammunition based on the azimuth range, high and low range, and protection ability of the target speed of the active protection ammunition. The protective ammunition generally adopts the projectile mode. The projected warhead blasts in the air to generate a fragment stream that is used to attack and destroy incoming ammunition. It has the ability to intercept multiple targets at the same time. The protective ammunition components are generally arranged on both sides of the turret to achieve the side of the vehicle Protection of anti-tank missiles, rockets, etc. at a speed of 70 to 1400 meters per second.

The simulation process of the hard kill active protection simulation component is as follows.

The current simulation time is t, and the last active protection time is t0. If t-t0 <△ T10 (hard-kill active protection system response time), the current active protection fails and the hard-kill active protection simulation module is exited.

If ε (target's high and low defense range)> θ falls angle, the attack angle or ammunition fall angle is within the target's high and low defense range; otherwise, exit the simulation of hard kill active protection.

Let the angle between the target's orientation (or movement direction) and the north direction be α0 (obtained from the entity's state information), the target's azimuth defense range is (α0-θ, α0 + θ), and θ is half of the target azimuth defense range.

If it is within the target's defense range (α0-θ, α0 + θ), simulate the detection of incoming ammunition; otherwise, exit the simulation of hard kill active protection.

If the ammunition fall angle and orientation are within the defensive range, a random number η is uniformly distributed between (0, 1). If η <P1 (probability of detecting incoming ammunition), the hard kill active protection system can detect incoming ammunition. , Otherwise, exit the simulation of hard kill active protection.

If the hard kill active protection can detect the incoming ammunition, let t0 = t, extract a uniformly distributed random number η between (0, 1), and if η <P2 (the probability of a successful counter-attack counterattack), it means the hard-killing active protection system protection success.

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