Feasibility Analysis and Simulation study of Shooting after Shortest Distance between Target and Projectiles

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Abstract

In order to make full use of the performance of high-muzzle-velocity anti-aircraft weapon, make full use of the target firing segments on the entire route of the target, fully grasp all the firing opportunities, and reduce the possibility of a target breaking through the defense, the original pre-navigation firing (firing before shortest distance between target and anti-aircraft gun) method based on a muzzle velocity below 3ma cannot meet the needs mentioned above. Based on the establishment of high-muzzle velocity projectiles, this paper aims at the current situation of less post-navigation firing (firing after shortest distance between target and anti-aircraft gun), verifies the feasibility of post-navigation firings by analyzing the relative remained velocity required to penetrate the target, and verifies that with the gradual increase in projectile muzzle velocity, its firing range and timing can increase simultaneously. It provides a theoretical basis for post-navigation firing, increases the firing opportunities for the target on the entire route, and provides a reference for the demonstration, design and testing of the new anti-aircraft fire control system.

Post-Navigation firing Analysis

I. Anti-aircraft Artillery Damage Analysis

According to the kinetic energy formula, the kinetic energy of the flying armor-piercing projectile can be obtained: $W = \frac{1}{2} \times m \times v_m^2$

And this paper uses Demar's formula which is given as follows:

$$v_c = K \frac{d^{0.75} b^{0.7}}{m^{0.5} \cos(\alpha)}$$

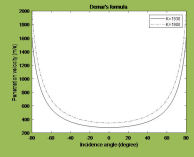

Figure 1. Relation between incident penetration angle and target velocity

The dichotomy or secant method combined with firing table fitting function is used to solve the firing elements. The firing elements at different times are shown in the following Figure 2.

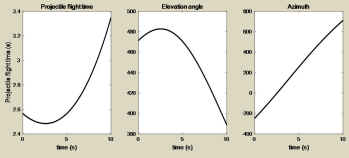

Figure 2. Firing elements

The future hit points corresponding to different firing elements are given in Figure 3 and Figure 4.

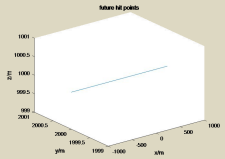

Figure 3. Figure Future hit points

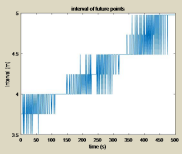

Figure 4. Interval of future points

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Analysis of Examples

To simplify the analysis of the example, it is assumed that the target flight trajectory is within the firing plane of the anti-aircraft gun, that is, the azimuth angle of the firing elements is ignored, and the height angle problem is analyzed in a two-dimensional plane.

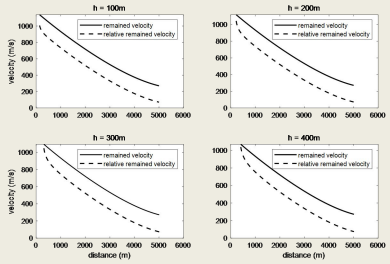

Figure 10. Relationship between target velocity and relative remained velocity

As shown in the figure above, with the increase of distance between target and anti-aircarft gun, the remained speed and relative remained speed of projectile is decrease. With the increase of distance between target and anti-aircraft gun, the storage speed of projectile decreases, but the decline process is not obvious.

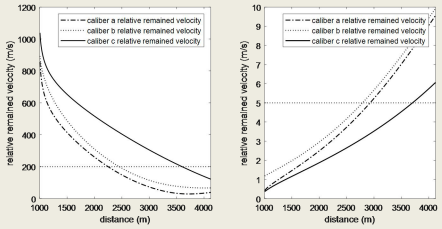

Figure 11. Relationship between slope distance and remained velocity at target velocity of 200m/s

Conclusion

By analyzing the firing method that firing only before the shortest distance between anti-aircraft gun and target, the reason for choosing the new method that firing after the shortest distance between anti-aircraft gun and target is gotten, and then the possibility and feasibility of the new method are analyzed by calculating the velocity required to penetrate the armor and the relative speed of the projectile and target. A example is used to verify that with the increase of the projectile exit velocity, the projectile's remained velocity can still penetrate the target under certain conditions. When the anti-aircraft gun's muzzle velocity is above 1000m/s, the height of target is about 400m, and its velocity is below 300m/s, the firing area of the post-navigation can reach more than 4000m. The research mentioned above provides a reference for increasing the firing timing in the actual system design. When the software is implemented, the existing fire control solution model can be extended by modifying the method of sending fireable instructions just before the

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