

Simulation Analysis of Automatic Motivation Based on ADAMS

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Abstract. With the dynamic simulation software ADAMS as the simulation platform, the virtual prototyping technology is applied to the dynamic research of the grenade launcher. The virtual prototype model is established. The kinematic parameters of the main mechanism are determined by simulation and the automata, the simulation results are in good agreement with the measured values of the shooting test, which proves that the simulation results are credible and provide a theoretical basis for the subsequent design of the grenade launcher.

1. Introduction

A type of automatic grenade launcher adopts the automatic principle of elastic chain loop feeding mode and free-lance mode, and is an infantry squad standard grenade launcher. The action process is as follows: After the projectile is fired, the propellant gas pushes the projectile forward. At the same time, the remaining propellant gas causes the automaton and the cartridge to sit back. During the process of recoil, the shell is compressed and the shell throwing action is also performed at this time. Completed, under the action of a hydraulic shock absorber, excess squat energy is absorbed; during the re-entry phase, the grenades are pushed into the magazine by automatic machines, and after the re-entry is in place, the striker strikes the cap and hits the ammunition. Under fire, when the projectile is fired, the automatic grenade launcher completely relies on the inertia of the automaton itself to complete the closing of the magazine during a series of actions. For the bolted slam-fire weapons, direct live-fired shooting experiments consume human and financial resources. Using the dynamic simulation technology of automatic machines, the live firing test process is simulated and the dynamic parameters of the tested weapons are evaluated without live firing. The weapon system, the bolt mechanism, the supply mechanism, and the recoil mechanism are relatively complex. The advantage of the simulation test platform is used to set the parameters of these power sources. The motion process of the robot can be intuitively obtained and the motion parameters and dynamics of the robot are obtained. Characteristics, and based on the obtained parameters, evaluate the rationality of the structural parameters of the new R&D weapon structure or the old weapon automaton, the motion stability, the strength of the components, the overall matching, the coordination and timeliness of the feeding mechanism, etc. The physical dynamic behavior of the grenade launcher can be directly displayed, and the problems existing in the movement process of the automatic machine can be directly seen, providing experimental data support and basis for theoretical research, further optimization design, and high reliability design of the grenade weapon[1 -3].



The evaluation of the performance of automatic machines using live firing tests is not only a waste of time and effort, it is also difficult to convince the evaluation results, the use of simulation experiment technology instead of live fire test, the automatic simulation test of the guns squat weapon, and the development of weapon systems. Production acceptance is of high value, and it has obvious effects in improving R&D efficiency and shortening the R&D cycle. The economic benefits are very significant [4-8]. In the process of experimental simulation, only a professional simulation test platform is required to obtain the effect of live firing, and it is not necessary to coordinate the use of ammunition transport shooting range. The test is simple and convenient, which can not only save expenses, but also avoid the use of live ammunition. The safety problems brought about by the shooting test, the data can also be generated directly, and repeatedly reproduced until the ideal available data [9-10].

The short-stemming and air-guiding mixing of the barrel is the automatic principle of the grenade launcher, and is locked under the action of the bolt rotation. The firing process is completed by the propellant gas and the recoil spring. In the process of automatic weapon design, the motion law of an automatic machine is the theoretical basis for optimizing structural parameters, checking the strength of parts, and adjusting energy distribution. In order to further optimize the structure parameters of the automaton and more clearly observe and master the motion laws of the automaton, the ADAMS dynamic multi-rigid body system simulation analysis software is used to establish a simulation model that is basically the same as the actual prototype, and the simulation design forces the live firing process. In combination with the exercise process, theoretical analysis and practical observation, external forces and constraints were added to the dynamic simulation model, related parameters were set, and the motion process of the actual robot was analyzed using dynamic simulation.

2. Automatic machine structure and its movement

The short recoil and air-guiding mixing of the barrel is the automatic principle of the grenade launcher. After the bolt is turned, it is locked on the barrel section and the air guiding device is installed inside the barrel. After the primer is fired, the gunpowder gas pressure pushes the projectile forward. The projectile moves forward under the external force. Before the movement to the air guide hole, the gun and barrel are combined with the bolt mechanism after the movement is over, and finally realized. Atresia. A portion of the propellant gas is introduced into the air guide chamber after the projectile passes through the air guide hole, the gas pressure of the air guide chamber is continuously increased, the bolt is not moved, the bolt frame is relatively accelerated, and before the unlocking, the bolt box finishes its free movement. After that, the bolt mechanism is used to drive the unlocking action through the unlocking slope of the curve groove on the bolt. Subsequently, under the action of gunpowder gas, the combined bolts and bolts are seized together under the action of external forces, and the ammunition achieves the shelling action, and the feeding mechanism and the throwing shell action are also completed. After sitting in position, it hits the machine, and the recoil spring drives the frame of the gun into the front position. The gun enters the barrel section during the reentry process. Under the action of the protrusion of the mechanism, the locking mechanism on the bolt is retracted. , Bolting machine relative to the rotation of the bolt box frame is lifted, in the section of the gun after a certain distance movement, the section sleeve and the bolt collision to stop forward movement, driving the pin and the bolt frame under inertial to continue to move forward Through the locking slope of the curve slot of the bolt machine, the bolt is rotated and locked by the bolt. At this moment, the protrusion on the knot sleeve and the locking bolt on the bolt plane are locked under the external force.

3. The establishment of automatic machine movement model

3.1. Basic assumptions of automatic machine dynamic model

According to the movement law of the automata during the shooting process and the structural characteristics of the automatic grenade launcher itself, in order to facilitate the analysis, and to

achieve the simulation of live firing is basically the same, and to maintain the model's rationality, the following assumptions are made for the transmitter movement process:

- 1) Grenade launcher elastic chain and spring as flexible body treatment;
- 2) The rest of the components in the grenade launcher are treated as a rigid body;
- 3) The earth is fixed with the casing;
- 4) The force on the projectile and the barrel is not taken into account when launching, and the external force forms the gunpowder gas pressure on the piston and the bolt machine;
- 5) During live firing, the dialing pressure and shell resistance acting on the grenade launcher are much smaller than the air-guiding pressure and the low load. Therefore, the pressure in this part can be ignored.

3.2. Simplification of Automata Model

After using ADAMS to build the solid model of the automaton, use Avview to import the model. For some relatively stationary parts, use one part instead; for some that do not affect the simulation but the motion and rigid body are directly deleted, and then perform further calculations.

For the barrel section, the barrel and mouthpiece can be reduced to one entity; for some pins and shafts, because these constructions and the gas block are connected together, they can be combined into blocks for the mass and actual grenade launch of the barrel section. Consistent.

For the self-used machine, in the nose part, the pulling shell axis and the ejection pin can be combined; the bolt frame, the striker and the driving pin can also be combined into a rigid body; the bolt frame can also include the combined system. Transfer card lock shaft.

3.3. Prototype Load Definition

According to the inner ballistic equation constructed during the shot shooting, the pressure-time curve of the air chamber and the pressure-time curve of the inner ballistics are obtained after differentiation. The pressure in the air chamber and the pressure in the crucible are calculated and the relationship between the pressure of the propellant gas and the pressure in the crucible is calculated. The thrust is calculated using ADAMS. First, the force needs to be fitted by fitting the value using the AKISPL function and applying the fitted value to the bottom of the projectile in the form: AKISPL (time, 0 Spline_n, 0) In the process of simulation movement, time is the current time; In the simulation test, the automatic machine adopts the automatic principle of short barrel recoil and air conduction. After firing the projectile, driven by the self-use machine, the barrel will also move back a distance, and the gun will be under the action of the recoil spring. The tube returns to its original position.

The simulation of the automatic machine and the simulation of the feeding mechanism are carried out separately. The elastic resistance is obtained by the simulation of the feeding mechanism, and then the calculated throwing resistance is applied to the prototype of the grenade launcher, and then the simulation of the grenade launcher is performed, using the AKISPL. The function applies the value to the springboard for pushing and then applies the value to the springboard of the grenade launcher prototype.

4. Automaton simulation results

The barrel of an automatic weapon is one of the main components. In the barrel, the rifling and gunpowder gas give the bullet a certain initial velocity and ensure that the bolus during the flight of the projectile is stable.

When setting the firing angles to 0° and 30° for a single shot, the speed-time curve and displacement-time curve of the grenade launcher frame speed are shown in Figure 1, Figure 2, Figure 3 and Figure 4.

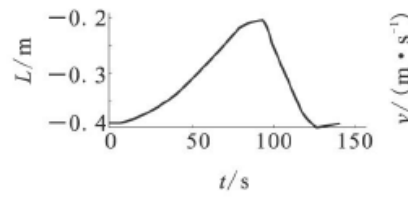


Figure 1 Displacement-time curve at 0° angle of attack

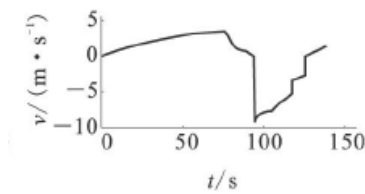


Figure 2 Velocity-time curve at 0°

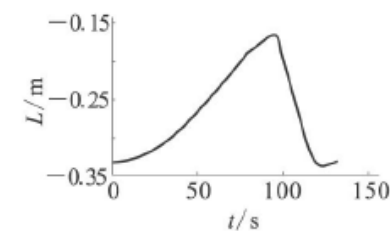


Figure. 3 Displacement-time curve at a 30° angle of attack

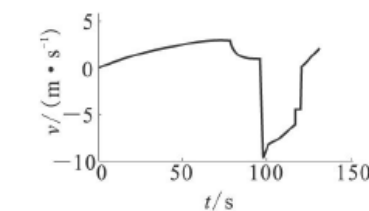


Figure 4 Velocity-time curve at 30° angle of attack

Through analysis and live firing test, a viable virtual prototype is established to simulate the actual structure data of some inconvenient measurements. The simulation experiment platform can clearly see the mechanism action process, without any human and material support, and the simulation has obvious advantages.

5. Virtual Prototyping Simulation Results and Experimental Results

5.1. Experimental results

In the live fire test, the speed-time curve of the bullet box at the 0° angle of attack of the grenade launcher is shown in Figure 5.

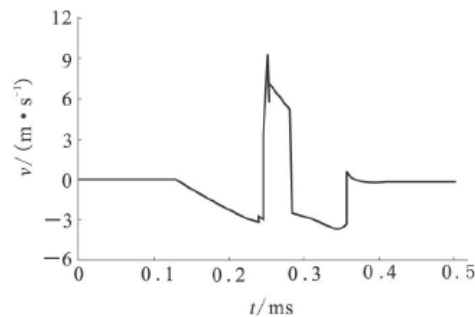


Figure 5 Measured frame speed-time curve at 0° firing angle

Through the analysis of the observed simulation test curve and motion animation process, during the action of the grenade launcher, the locking action has high reliability, moderate speed after recoil, smooth recoil, short barrel recoil movement in place, and simulation of the movement of the movable mechanism. The displacement can be controlled within the design range. The designed simulation model has high reliability and reasonable design. Research results and conclusions provide theoretical support and design design references for the development of automatic machines and in-depth research on handheld automatic weapons.

5.2. Contrast analysis of the speed of bolt box at 4.2 feature points

In order to further illustrate the consistency of test data and simulation data, the data feature points of the two tests are compared. The list is shown in Table 1. From Table 1, it can be seen that the live fire test results and the simulation test results are basically the same, only when the bolt is collided with the barrel, the speed of the bolt frame drops faster at the moment when the blockage begins.

Table 1 Comparison of simulated experimental values and live firing speeds

Feature Point	Simulation Results(s)	Experiment Results(s)	Relative Error/%
Bolt collision barrel	3.54	3.40	4.1
Re-entering the free trip ends	0.47	2.70	82.6
Reach the unlocked position	9.15	9.38	2.4
Start buffering	4.98	5.49	9.3
Re-entering the hook position	2.07	2.33	11.3

6. Conclusion

In order to obtain the motion characteristics and test data of the automaton, this article uses the ADAMS simulation test platform to establish a certain type of automatic grenade launcher automaton simulation model. Through the simulation test, the shooting movement parameters are obtained. Through the comparison, the simulation result and the live fire shooting result are basically the same. Consistent, the simulation model was established with reasonable accuracy.

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