Study on Simulation Model of Fire Strike

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Abstract. In this paper, a simulation model of firepower strike is proposed based on some assumptions, including firepower strike equipment simulation component, reconnaissance radar simulation module, gun simulation model and tactical missile simulation model. The model is simple and feasible.

1. Fire strike equipment simulation components

Fire strike equipment simulation, include physical state simulation, positioning and distribution simulation, fault simulation and etc.

Assume that the current simulation time is t. Within each simulation period $\Delta T$, for K units in the combat unit deployment data, the following operations are performed:

Query the combat state, if not the fighting state, fire time $TT=-1$.

Query the combat unit deployment data, if the main gun ammunition types number $N > 0$, and all remaining ammunition quantity of the main gun is 0, and the operational status is not ammunition supplementary status, the combat status is set to ammunition replenishment.

Query the combat unit fault data file, if exist, when the simulation time $t$ meet:

| The combat unit failure time $\leq t + \Delta T$ |

The combat state is set to fault state, a record is added to the combat unit deployment data and the maneuvering data to record the status of the moment, all the records of the combat unit deployment data and the maneuvering data after the failure time are deleted and publish entity status information.

Query the combat unit fault data file, if exist, when the simulation time $t$ meet:

| $t < (The$ combat unit failure time + the required time of check the combat unit fault) $\leq t + \Delta T$ |

According to the fault information, fill in the battlefield situation information and publish to the communication network evaluation module.

Query the combat unit damage data file, if exist, when the simulation time $t$ meet:

| $t < (The$ combat unit damage time + the required time of check the combat unit damage) $\leq t + \Delta T$ |

According to the damage information, fill in the battlefield situation information and publish to the communication network evaluation module.

If the combat unit has a positioning function (according to the combat unit model query performance data file) and the combat unit is not damaged or failure, set the positioning information distribution cycle is $\Delta T1$ (query combat unit network deployment data file), $\Delta T1$ take integer multiple of $\Delta T$, let $N = \Delta T1/\Delta T$. In N simulation cycles, the basic model of the equipment location simulation is called, the combat unit position outputted by the positioning system is calculated, and the positioning information data structure is filled and published to the communication network evaluation module.

For the fire unit, query the quantity of ammunition consumption, when it is consumed to a certain percentage, the battlefield situation information is filled and published to the communication network evaluation module.
The maneuvering simulation base model is called, the battle unit position of the box number (I, J) is calculated at t time, and compare to (I, J) of the last entity state, if there is a change, the entity status information is published.

Using the combat unit deployment data and maneuver data, the entity status information is calculated at time t, and the DR algorithm state information is used to judge whether the entity state information is published.

Query the combat state, if it is war state and the entity type is the howitzer, mortar or rocket, the gun simulation model is called.

Query the operational status, if it is war state and the entity type is tactical missiles, the tactical missile simulation model is called.

Query the radio data in the combat unit N, and publish N radio working status information (assuming the operation of the radio station has been working).

Query information and command and control information data files, if there is non-formatted intelligence and command and control information published by simulation equipment in the simulation cycle, the information is published to the communication network evaluation module.

2. **Reconnaissance radar simulation components**

Reconnaissance radar can be used for enemy artillery positions reconnaissance, but also can be used for our artillery spotting, this assessment tool only consider the simulation of enemy artillery positions reconnaissance.

Set reconnaissance radar coordinates is (X1, Y1, Z1), enemy artillery positions coordinates is (X2i, Y2i, Z2i), the number of targets processed per minute is N, azimuth reconnaissance range is (θ1, θ2), the detection range is Dmax1, the circular probability error of the target location is σD, and the time of projectile from the muzzle to be searched by the reconnaissance radar is Gaussian distribution, the mean is mt1, the mean square error is σt1, the system reaction time is Gaussian distribution, mean is mt2, The mean square error is σt2.

When TT = -1 (the first transition to combat), let TT=t, X3i=0, Y3i=0, and N1=0.

2.1 Radar found projectile time simulation.

Suppose the i-th enemy artillery position fire information is received at time t, if X2i=X3i and Y2i=Y3i, no longer simulate the positioning process of the artillery, exit the simulation components.

If X2i-X1 > D max 1, the target is not within the detection scope.
If X2i-X1 < -D max 1, the target is not within the detection scope.
If Y2i-Y1 > D max 1, the target is not within the detection scope.
If Y2i-Y1 < -D max 1, the target is not within the detection scope.
If \(\sqrt{(X2i-X1)^2 + (Y2i-Y1)^2} > D \text{ max } 1\), the target is not within the detection scope.

\[\beta_i = \tan^{-1} \frac{Y2i-Y1}{X2i-X1}\]

If \(\theta_1 < \theta_2\) and \(\beta_i < \theta_1\) or \(\beta_i > \theta_2\), the target is not within the scope of the reconnaissance.
If \(\theta_2 < \beta_i < \theta_1\), the target is not within the scope of the reconnaissance.

If the target is within the reconnaissance range, calculation the found target probability P, if \(\eta < P\), consider that the projectile was found by radar, the time of found the projectile:\n
\[t_{ni} = t + m_{ni} + \sigma_{ni} \cdot r\]

\(r\) is a Gaussian white noise sample with mean 0 and mean square error of 1.
If the projectile fired from the i-th artillery position is found, let N1=N1+1, X3i=X2i and Y3i=Y2i.
2.2 The location simulation of radar to artillery position.

The positioning time is:

\[ t_{2i} = t_i + m_{12} + \sigma_{12} \cdot \text{gauss} \]

The artillery position output by the radar is:

\[ X_{z_i} = X_{z_i} + \sigma_D \cdot r_1 / 1.1774 \]
\[ Y_{z_i} = Y_{z_i} + \sigma_D \cdot r_2 / 1.1774 \]
\[ Z_{z_i} = Z_{z_i} \]

\( r_1 \) and \( r_2 \) are Gaussian white noise with mean 0 and mean square error of 1.

When the simulation time satisfy \( t - \Delta T < t_{2i} \leq t \), the reconnaissance information of the i-th artillery is published to the communication network evaluation module, and the reconnaissance information data structure of the radar reconnaissance vehicle is used:

The reconnaissance (weapon) equipment code, the target code, simulation time, reconnaissance equipment position \((X_0, Y_0, Z_0)\), target position \((X, Y, Z)\), target speed \((V_X, V_Y, V_Z)\).

3. Gun simulation model

When \( TT \neq -1 \), turn AA.

\[ TT=t \]

\[ K1 = \frac{\text{Simulation step } \Delta T}{\text{Gun simulation step } \Delta T1} \]

Gun simulation step \( \Delta T1 \) take 0.1 seconds.

AA:

Corresponding to \( JJ = 1-K1 \)

\( r1 = t + (JJ - 1) \cdot \Delta T1 \)

If the simulation time satisfy with \( t1 < TT \), turn AA1.

Query the combat unit deployment data files, if the number \( N \) of hit targets is greater than 0, the first batch of targets will be queried. If the target is in the state of destruction, delete the target, the number of targets will decrease by 1 and the following target move forward, until non-destructive targets are queried. After move forward, the first batch of the target hit bomb number \( M_1 \) minus 1, if \( M1 = 0 \), the batch target is deleted, the subsequent target is moved forward, and the striking target number \( N \) is decreased by one. If there is no goal to meet the combat conditions, exit the simulation component, if there are targets to meet the combat conditions, query the use type of ammunition against the target, the type of ammunition remaining ammunition quantity, if the remaining ammunition \( = 0 \), exit the simulation component, make

\[ TT = TT + \frac{1}{\rho} \]

Calling simulation basic model of gun intercepting launching platform.

AA1:

For \( II=0—99 \)

If \( t_3[II][0] = 0 \), proceed to the next cycle.

If \( t_3[II][12] \) (ammunition type of used) is a grenade or an ordinary cluster bomb, \( t_1 \equiv t_3[II] [0] \) and \( t_3[II] [0] > 0 \), call the gun intercepting launching grenade and ordinary cluster bomb simulation base model, order \( t_3[II][0]=0 \).
If \( t_3[II][12] \) (the ammunition type of used) is the terminal guided shell, \( t_1 \geq t_3[II][0] \) and \( t_3[II][0] > 0 \), call the gun intercepting launching end-guided gun shells simulation base model.

If \( t_3[II][12] \) (the ammunition type of used) is the end-sensitive shell, \( t_1 \geq t_3[II][0] \) and \( t_3[II][0] > 0 \), call the gun intercepting launching end-sensitive bomb simulation base model, order \( t_3[II][0] = 0 \).

If \( t_3[II][12] \) (type of ammunition used) is the chemical bomb, \( t_1 \geq t_3[II][0] \) and \( t_3[II][0] > 0 \), call the gun intercepting launching chemical bomb simulation base model, order \( t_3[II][0] = 0 \).

4. Tactical missile simulation model

Such as the US military "network fire" and other weapons equipment for the simulation object, these missiles generally use high-level ballistic trajectory, dive attack mode, seeker for the CCD, infrared, millimeter-wave radar, laser and so on.

When \( TT \neq -1 \), turn AA.

\[ TT = t, \ K = 0, \ K \] is the number of missiles flying in the air

\[ K1 = \frac{\text{Simulation step } \Delta f}{\text{Gun simulation step } \Delta T1} \]

Missile simulation step \( \Delta T1 \) take 0.04 seconds.

AA:
Corresponding to \( JJ = 1 - K1 \)

\[ t1 = t + (JJ - 1) \cdot \Delta T1 \]

4.1 Homing guidance missile simulation

If the guidance system is homing guidance, regardless of the missile launch, at regular intervals (missile launch interval) to launch a missile, the number of missiles in the air could have multiple pieces.

If the simulation time satisfy \( t1 < TT \), go to step 3).

Query the combat unit deployment data files, if the number \( N \) of hit targets is greater than 0, the first batch of targets will be queried. If the target is in the state of destruction, delete the target, the number of targets will decrease by 1 and the following target move forward, until non-destructive targets are queried. After move forward, the first batch of the target hit bomb number \( M1 \) minus 1, if \( M1 = 0 \), the batch target is deleted, the subsequent target is moved forward, and the striking target number \( N \) is decreased by one. If there is no goal to meet the combat conditions, exit the simulation component, if there are targets to meet the combat conditions, query the use type of ammunition against the target, the type of ammunition remaining ammunition quantity, if the remaining ammunition = 0, exit the simulation component, make

\[ TT = TT + \frac{1}{\rho} \]

\( \rho \) is the missile launch rate.

\( K = K + 1 \)

Call the missile launch platform simulation base model.

4.2 Remote control guided missile simulation

If \( K = 1 \), turn 3).
If the simulation time satisfy $t_1 < TT$, go to step 3).

Query the combat unit deployment data files, if the number $N$ of hit targets is greater than 0, the first batch of targets will be queried. If the target is in the state of destruction, delete the target, the number of targets will decrease by 1 and the following target move forward, until non-destructive targets are queried. After move forward, the first batch of the target hit bomb number $M_1$ minus 1, if $M_1 = 0$, the batch target is deleted, the subsequent target is moved forward, and the striking target number $N$ is decreased by one. If there is no goal to meet the combat conditions, exit the simulation component, if there are targets to meet the combat conditions, query the use type of ammunition against the target, the type of ammunition remaining ammunition quantity, if the remaining ammunition = 0, exit the simulation component, make

$$TT = TT + \frac{1}{\rho}$$

$$K = 1$$

Call the missile launch platform simulation base model.

### 4.3 Missile flight, hit target process simulation

If K is greater than 0, corresponding to $II = 1-K$, call the missile simulation base model, the input parameter is $II, t_1$.

## References


