Design of Target Detection and Tracking Simulation System of Networking Fire Control Radar

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Abstract. Fire control radar is a key detection sensor that decides the result of war in the modern electronic warfare, which is considered as the main combat target by the enemy. In order to improve radar anti-coutermeasures ability, from the basic idea of HLA, in combination with the federation development process of simulation system, the networking fire control radar target detection and tracking simulation system was designed based on HLA. According to the system function demands, the federation constitution and federate function of the system are given and the simulation system structure is designed, which provides platform and technology support for anti-coutermeasures theory argument, test and training simulation of networking fire control radar.

Keywords: Fire control radar; Detection and tracking; Radar network; High level architecture(HLA).

1. Introduction

Fire control radar is an important part of modern air defense system. Its precise target detection and tracking is always the primary task of modern and future air defense combat mission and is also the premise and base of the subsequent tactical tasks. Nowadays fire control radar network is an effective anti-coutermeasures technology, and scientific and effective collaborative target detection and tracking is the most basic guarantee, therefore, the study on networking fire control radar is very urgent.

At present, the research on fire control radar networking technology is rarely involved, and the research on target detection and tracking of fire control radar is rarer. Usually the practical test is the best technology to explore, but by the limitations of time-consuming, not strong confidentiality, high cost and poor repeatability, the computer simulation can realize actual equipment real virtualization, that so far is a very effective method in the field of military.

According to practical demand of the current battlefield, target detection and tracking simulation system of networking fire control radar was designed based on HLA. Firstly, the basic idea of HLA is introduced and the federation development process of simulation system is presented. Then, According to the system function demand, the federation constitution and federate function of the system are given and the simulation system structure is designed.

2. HLA Overview

HLA is to establish a simulation system by using object oriented modeling and simulation, and the simulation system is considered as a federation, every subsystem of simulation system is as a federate, the federate can use their advanced technology in the field to develop by maximum degree and relative independence [1]. Target detection and tracking simulation system of networking fire control radar is a complicated system of military electronic equipment simulation system, at the same time is a distributed collaborative simulation system integration, HLA is a good choice to build the system.

Reasonable system requirements analysis, design is the premise and foundation of software development and functional programming, and a complete set of standardized software engineering theory as a guide is required to ensure the effective and efficient engineering application. In order to ensure that the development standardization and standardization, the federation development and execute process model (FEDEP) as a general framework has been widely recognized [2], as shown in

Fig 1. Usually the development cycle can be divided into initial, middle and late stages, in total of three stages, including six steps.

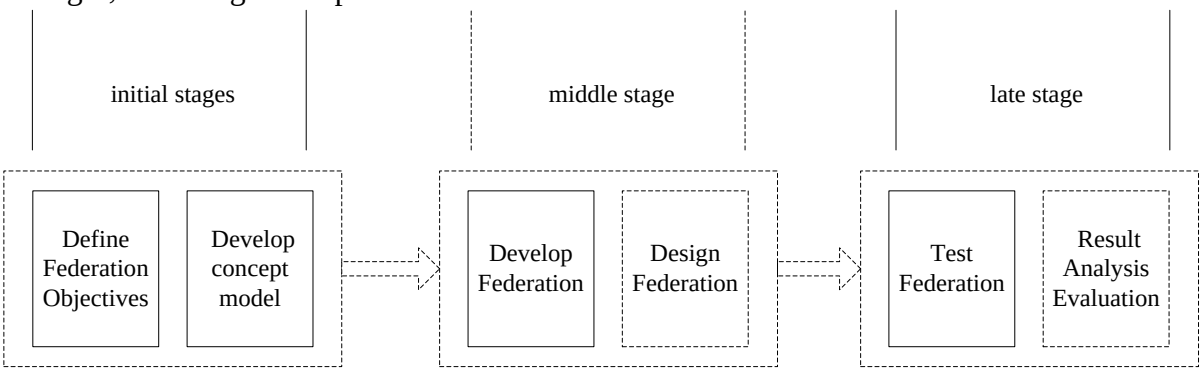

Fig. 1 Federation development and execute process

3. System Federation General Design

3.1 Federation Structure

HLA is considered as the support platform for designing target detection and tracking fire control radar network simulation system in the paper, from the battle scene and combat task demand， the simulation system federation is divided into dispatch center, fusion control center, target, fire control radar 1, fire control radar 2, fire control radar 3, a total of six federate, the federation structure as shown in Fig. 2. For every federate in the federation, accurate, fast and effective information transmission and interaction is achieved through the RTI, which makes the whole federation has characteristic of a high degree system integration, perfect function, resource sharing.

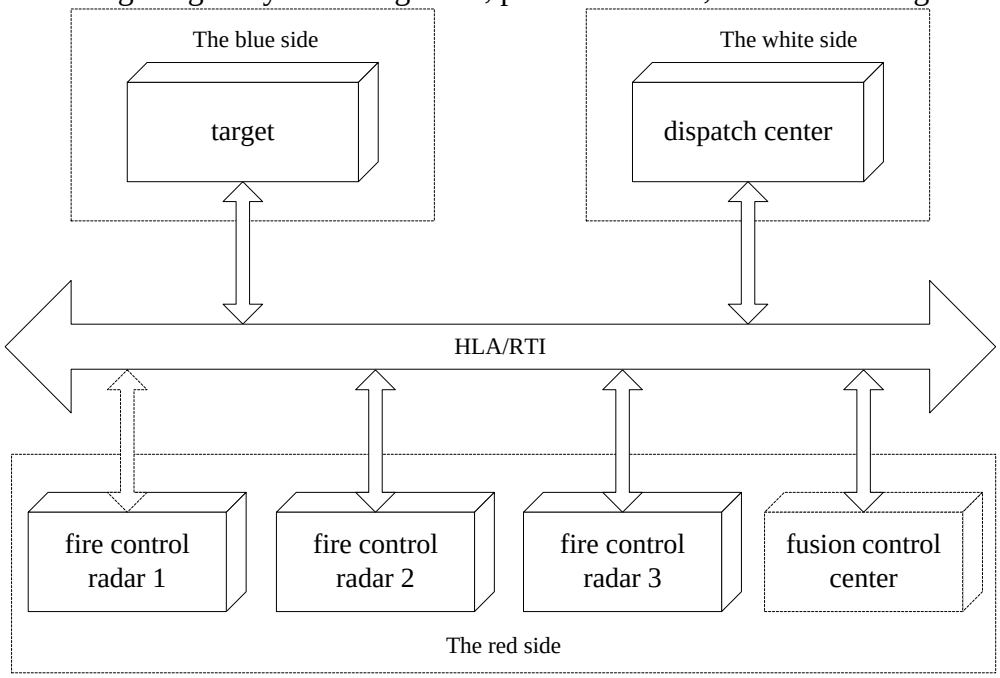

Fig. 2 Federation structure of simulation system

3.2 Federate Function

(1) Dispatch center

The dispatch center federate as the total combat is set to white side. It is responsible for the management and control of the whole system simulation, and plays the role of the simulation director which is mainly used to conduct the battle scene setting, battlefield initialization parameters setting and state of other federate monitor and control of the whole simulation system the start, the end. Besides, according to a certain evaluation index, the federate can get some data simulation nodes in the simulation process for completing the reasonable and effective evaluation.

(2) Fire control radar 1, 2, 3

The three fire control radars are considered respectively as a federal member, which is set to red side. In the actual battlefield environment, the federate is responsible for realistic simulation of fire control radar for space target dynamic, closed-loop, automatic detection and tracking process, which has real-time measurement data acquisition of the target distance, azimuth and elevation angle measurement data. In the simulation before the start, the federate can set the radar deployment location to meet the needs of combat tasks. In the simulation operation, real-time control strategy instruction is received from fusion control center that is used to complete target handover. Finally, the stable and continuous target detection and tracking the radar network is realized [3].

(3) Fusion control center

Fusion control center federate is set to red side, that is responsible for network fire control radar data processing and management control, etc. The main goal is used to complete tracking filtering and prediction of the target measurement information from fire control radar transmission. The filter data is distributed to radar network as the target guide data, on the other hand, transmitted to the dispatch center for evaluation. Another important function is that sets the control strategy based on the operational mode, the radar working state of the network is effectively control, which achieves the radar cooperative operation. [4]

(4) Target

Target as the other side of the offensive and defensive confrontation is set to the blue side. A function is specific motion track set based on the actual combat task, which simulates target flight path to provide the necessary and real track coordinate information for fire control radar echo signal generating; on the other hand, on the basis of the target type, target scattering characteristics is simulated, which determines the scattering law, the target cross-sectional area is given.

4. System Structure Design

According to the specific function of each federate of the above system, the information interaction between the federates is expressed directly, and the structure of the target detection and tracking simulation system of the network fire control radar is designed, as shown in Fig 3.

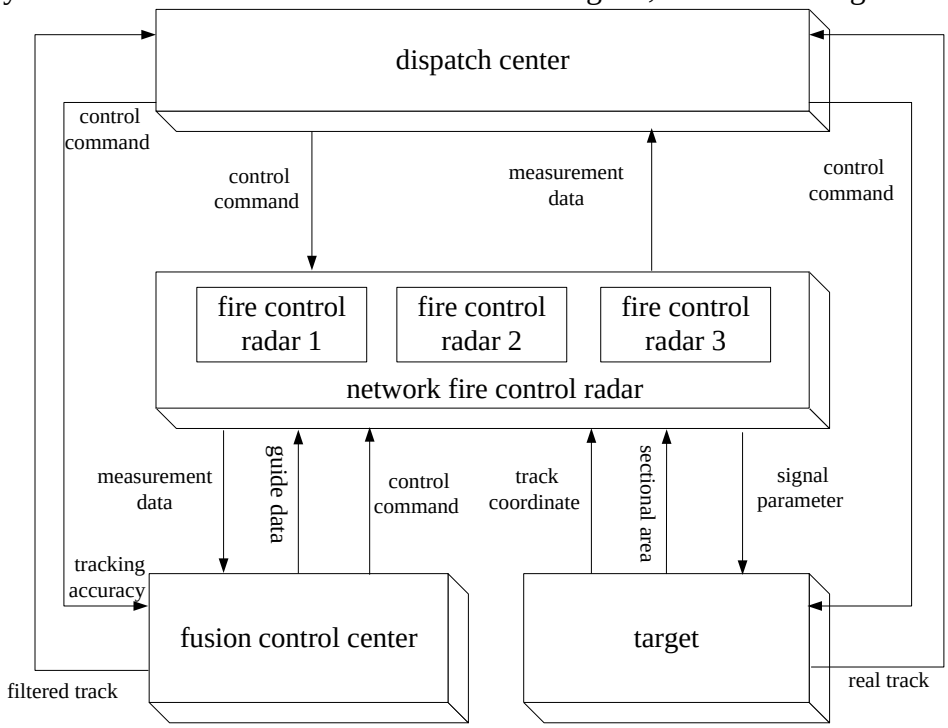

Fig.3 System Structure

The concrete working process of the simulation system is as follows: the whole system begins to run after the various federate receives the simulation control command of the dispatch center. After

the start of the simulation, three radiation fire control radars control radar strobe based on control strategy of the fusion control center, the strobe radar sends radiation signal and starts the target detection and tracking. At the same time, and real-time target track coordinates, instantaneous cross-sectional area are send to fire control radar in the working state. If the target is tracked, the fire control radar in the work carries out continuous, automatic, closed-loop target detection and tracking and real-time acquisition of measurement values, and the target measurement data is sent to the fusion control center. In this process, the target measuring coordinate is received by the fusion control center for tracking filtering and prediction processing obtaining a complete, high quality track, and the fusion control center sends real-time transmission of network fire control radar guide information, and on the basis of radiation control strategy, sends radar strobe control command.

Measurement data of the fire control radar federate, real track value of target federate, target measurement data filter estimation and real-time tracking accuracy of fusion control center federate are received and stored by dispatch center federate. After the simulation, the dispatch center through the contrast of target measurement, real track value, target filter value and the situation change of the tracking accuracy, and collaborative target detection and tracking performance of fire control radar network is analyzed and studied

5. Conclusion

This paper is mainly based on the HLA architecture to build a fire control radar network target tracking simulation system, system structure and each federate function are designed, which provides new ideas and new methods of evaluation and collaborative combat for fire control radar network. In the future research work, modeling of the federate will built, and make reasonable interconnection, that can not only realize the fire control radar network collaborative work process, but also provides an effective test platform and simulation environment of technology research on all aspects fire control radar network in the actual battlefield.

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