Application of Big Data Visualization in Radar Electronic Countermeasure Simulation System

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Abstract: In order to understand the radar electronic countermeasure simulation system, an application research of big data visualization in radar electronic countermeasure simulation system is put forward. Firstly, this paper analyzes the effect of big data in radar electronic countermeasure simulation system, focusing on the design of radar countermeasure simulation system database, so as to effectively improve the countermeasures and drills. Secondly, using big data to realize the supervision of radar electronic countermeasure simulation system can realize the performance of radar electronic warfare system more efficiently, conveniently and economically. Finally, taking radar simulator system and target, interference and environment simulator as examples, this paper introduces how to establish and apply various system databases and special databases in the simulation system by using big data. The design of simulation database model is reasonable and feasible, which can meet the needs of simulation system for accessing simulation big data.

Keywords: big data; Radar; countermeasure

1 Introduction

The simulation data of radar electronic warfare equipment is an important part of radar electronic warfare simulation system. It is responsible for providing data access management, safety control and other services for the setting of simulation test situation, the configuration of simulation model and the evaluation of simulation test effect. It is a powerful means to improve the automation degree of the whole system. As a large relational data, the core content of radar electronic warfare equipment simulation data is the detailed tactical and technical parameters of various radar electronic warfare equipment. Because the simulation program can directly access every tactical technical parameter, its stored content essentially corresponds to the simulation model and its parameters adopted by various radar electronic warfare equipment during simulation. The design and development of large-scale data is a huge project, and the conceptual model design of entity relationship is a very key basic work of the whole project. Taking the simulation data of radar reconnaissance equipment as an example, this paper summarizes the design ideas and key technologies of establishing the conceptual model of entity relationship of radar electronic warfare equipment simulation data.

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2 Summary design structure of radar electronic countermeasures policy system

As far as radar countermeasure simulation system is concerned, it mainly uses HLA distributed interactive simulation structure to design, which specifically includes seven parts: simulation system console, two-dimensional situation display system, three-dimensional visual simulation system effectiveness evaluation system, radar display control system, RTI server and data server. The specific functions of each part of the system are as follows:

(1) Simulation system console: start and end of each system process; Setting and sending simulation subjects; Initialization setting of parameters of each subsystem; Operation control of simulation system, including its operation, pause and stop[1-2].(2) Two-dimensional situation display system: according to the subjects set in the simulation system console, the simulated forces, the display situation, initialization parameters and the entity content of the monitored forces are generated in the two-dimensional electronic map.(3) Three-dimensional visual simulation system: This system mainly sets the visual scene in the three-dimensional digital terrain according to the subjects in the console of the simulation system and the pathology set by the two-dimensional situation display system. Among them, it mainly includes displaying radar beams, displaying suppressed areas, selecting and switching viewpoints, observing and selecting troops and actual operation.(4) Effectiveness evaluation system: This system mainly displays the specific jamming effect, exposure area, suppression coefficient, early warning time, radar detection direction, tracking error and detection probability of the radar on the basis of the simulation system console, and then calculates the actual evaluation results according to the specific evaluation model.(5) Radar display control system: The system can display the radar picture according to the instructions issued by the console in the simulation system, and at the same time display the specific countermeasure picture through the radar. In the simulation system, there are a lot of radars. When the console is selected and switched, the radar display control system can accurately display the specific display interface of the radar, including the radar man-machine input interface.(6)RTI server: RTI, as a supporting environment, is the core content of information exchange in the whole simulation system, thus providing the system with four services: ownership management, object management, data management and time management.(7) Data server: During the actual operation of the simulation system, a lot of data information needs to be exchanged, stored and read. The data server can provide each station with the information needed for initialization setting, and can also effectively record and save the important information contained in the specific process and actual results of simulation [3].

3 The construction of big data of radar countermeasure simulation system.

The data of the radar countermeasure simulation system can be said to be the basic condition for the establishment of the simulation system. Its main task is to manage the relevant files, data and algorithm dynamic link libraries contained in the radar countermeasure simulation system, so as to create a more convenient and effective environment for the normal operation of the whole system. At the same time, it can also quickly complete the entry, query, trimming,

deletion, recovery and backup of various data in the data path.In addition, as the data support of the simulation database, the simulation system framework will directly run through the whole radar simulation process. Then the platform data, environment data, equipment data, algorithm base and model base are effectively scheduled, which mainly includes simulation operation data, combat scenario data and simulation result data.(1) Simulation operation data: it mainly refers to calling the simulation algorithm, simulation model and evaluation model in the algorithm library and model library during the whole process from start to end.(2) Operational scenario data: It can read the data information needed for the initialization of the simulation system contained in the operational scenario file for indexing. After starting the simulation, according to the specific situation of the index, the equipment data, platform data and environmental data are retrieved layer by layer, and the required data are analyzed, and finally the initialization operation of the system is completed.(3) Simulation result data: It mainly records the important data generated in the process of simulation operation and saves it in the database. After the simulation is completed, the specific evaluation results can also be saved in the simulation result database.As shown in Table 1:

Table 1 Big Data of Simulation System

Simulation operation data	Operational scenario data	Simulation result data
The simulation model and the evaluation model are called.	System initialization operation	Simulation operation

3.1 Specific Design of Big Data for Radar Electronic Countermeasure Simulation System

3.1.1 Classification of radar data

As far as the structural design of radar data is concerned, it has a very direct relationship with the actual classification mode of radar. In the classification of modern radar, there are many specific classification methods. According to the technology and system, it can be divided into pulse compression radar, continuous wave radar and pulse radar. According to the tactical use, it can be classified into warning guidance radar, early warning radar and gun aiming radar. It can also be classified according to the type of scanning and the type of antenna. In addition, in the process of classification, different anti-jamming work forms produced by specific radar models need to be considered, which also needs to be changed and updated appropriately when designing radar data [4-5].

3.1.2 Radar data design for different objects

For radar system, its main structure is transmitter subsystem, antenna subsystem, signal processing subsystem, receiver subsystem and terminal subsystem. The performance and parameters of each part are very different. Therefore, data tables should be established for different objects. In this way, the representation of object data can be effectively simplified, the development of the system is simpler and more convenient, and the expansibility and maintainability of the system are effectively improved.

4 Application of Big Data in Simulation System

The radar electronic countermeasure simulation system is mainly composed of radar simulator system and target, interference and environment simulator system. Taking radar simulator and target, jamming and environment simulator as examples, the application of database technology in it is explained below.

4.1 the establishment of various databases

In radar simulator system and target, interference and environment simulator system, relevant system databases and special databases should be established in advance, including:A. Radar database B. Target database C. Clutter database D. Jamming database

The radar database is mainly used to store the main performance parameters of various radars, such as radar model, manufacturer, working system, working frequency and signal processing mode. The radar database is indexed by working system, working frequency and signal processing mode, which provides the basis for analog radar and reconnaissance and identification radar. The target database is used to describe the target's trajectory, motion characteristics and electromagnetic characteristics, including target position, target speed, motion mode and motion model, and target RCS[6-7].The data in the clutter database is used to simulate environmental clutter. Because the calculation of environmental clutter is complex, it is difficult to calculate it in real time. Therefore, a clutter database is established according to different tracks, types of ground objects or sea surface conditions for the use of environmental simulators. The jamming database is divided into jamming countermeasure database and jamming pattern database. The traditional decision-making methods of radar jamming command are basically empirical decisions. On the basis of radar reconnaissance and identification, commanders make command decisions according to their own relevant knowledge and combat experience through analysis and judgment. The environment faced in modern warfare is becoming more and more complicated and rapidly changing, which makes it difficult for commanders to effectively formulate jamming plans for targets in a short time. Using modern computer technology and combining artificial intelligence and expert system technology, a jamming countermeasure library can be established, which provides decision basis for radar jamming decision system (RJDSS). The jamming pattern library is a data collection of jamming types and corresponding jamming parameters, such as distance towing (towing distance, towing speed, etc.), speed towing (towing range, towing speed, intermittent period, etc.), aiming narrowband jamming (bandwidth, modulation form, duty cycle, etc.) and broadband suppression jamming (eight-frequency flicker (frequency flicker period, etc.)[8].To establish an interference pattern database, we must first determine which main data of electronic interference are stored. According to the design requirements of jamming system, firstly, the jamming attribute data table is established, which consists of three columns: jamming style number, suppressed jamming principal value and deceptive jamming principal value, and the format is all $ NUMBER. Then two data tables of suppressed interference and deceptive interference are established. The suppressed jamming data table is composed of columns such as jamming principal value, jamming attribute, jamming signal bandwidth and jamming signal center frequency, and the formats are # and varchar2 (size) respectively. Deceptive interference data table consists of interference principal value and interference form table columns. Interference forms are divided into distance towing, speed towing, frequency

flashing, etc., and the format is varchar2(size); Finally, the data tables of distance towing, speed towing and frequency flicker are established, which contain interference names and interference parameters, and the formats are varchar2 (size) and number (10,2) respectively. In this way, a complete interference pattern data can be realized through the above data table, and it is convenient for data modification, addition and deletion.

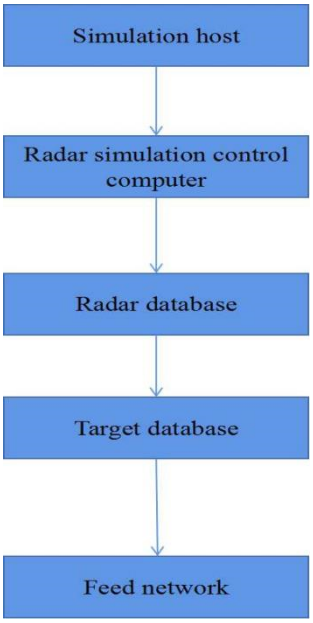

Figure 1 Radar simulator system structure

4.2 Application of various data

The function of radar simulator is to simulate radar signals with different systems, different operating frequencies and different signal processing methods, and to evaluate the jamming effect of the jammer under test on different radars. The overall block diagram is shown in Figure 1. When the simulation host gives the simulation radar form and target trajectory code, the radar simulation control computer reads the radar database and target database to generate corresponding radar signals and related control data. The radar signal generated by the control simulator is provided to the measured jamming transmitter (machine) for analysis, and the generated radar simulation target signal is synthesized with the jamming transmitter (machine) signal and environmental clutter signal and sent to the radar data processing computer for data processing, and then the relevant target parameters are sent to the simulation host for jamming effect evaluation.

The system frame of target, jamming and environment simulator is shown in Table 2. This kind of system is mainly used to evaluate the anti-jamming performance of the tested radar. The target simulator is used to simulate the target characteristics of different target types and different target tracks; The environmental simulator is used to simulate environmental clutter such as ground clutter and sea clutter. The jamming simulator determines the radar type and radar system parameters through the receiving antenna and radar reconnaissance identification

system, and the radar jamming decision system applies corresponding jamming. When the system works, the target type and track code are given by the simulation host, and the target simulation control computer reads the relative position and speed of the target from the target database, calculates the distance to the radar and Doppler frequency shift (fa), and controls the distance simulation unit and the direct digital synthesizer (DDS) respectively. At the same time, the RCS parameters of the target are read from the target database, and the power is calculated by radar equation, target fluctuation model and antenna pattern to control the program-controlled attenuator (ATT). The receiving system transmits the received radar signal to the radar reconnaissance and identification system, which matches the measured data with the radar database to get the specific parameters of the radar, and then the radar jamming decision system (RJDSS) selects the appropriate jamming combination from the jamming countermeasure database. Finally, the interference control computer reads the parameters of interference from the interference pattern database to control the interference generation. In addition, the environmental simulation control computer controls the digital quadrature modulator (DQM) to generate clutter signals by reading the target track parameters in the target motion database and the environmental clutter parameters in the index clutter database to realize environmental simulation [9-10].

Table 2 System Structure of Target, Interference and Environment Simulator

Database Management System (DBMS)	Target simulator control computer	Radar detective	Interference control computer
Target database	Radar database	Radar signal reception	Interference database
Target battle train	Target simulation unit	receiving antenna	Jamming antenna

5 Conclusion

For the actual design of radar countermeasure simulation system, it is a very detailed and complicated process. As the basis of simulation system design, the specific structure of big data design will have a direct impact on the expansibility and overall performance of the whole system. However, in the current design of radar electronic countermeasure simulation system, the actual design method is relatively simple, and there is still a lot of work to be studied in depth. Therefore, the database design must be completed for different objects, so as to effectively improve the application effect of big data in radar electronic countermeasures simulation system.

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