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DESIGN AND IMPLEMENTATION OF REAL TIME AND HISTORY MULTI-VIEW TREND DISPLAY SYSTEM

Abstract

Facing so many complex and interrelated monitoring means, the Internet of things system needs to access a variety of sensor devices, and it is necessary to comprehensively display a large number of multi-source heterogeneous sensing data.

The existing situation system of the Internet of things can access multi-source heterogeneous sensor equipment, but the information displayed by the system lacks relevance. The system only provides single information from multiple data sources and cannot display the comprehensive information after fusing multi-sensor data. The system lacks in-depth understanding of the target, only through one or two separate sensing means to get a glimpse of the leopard, lacks the display of target portrait information from the perspective of time and space, is difficult to mine the deeper threat criterion information behind the monitoring real-time alarm information, and lacks in-depth understanding of the essence of various alarm events and dangerous behaviors, This leads to a deviation in the overall understanding of regional protection issues. The system's cognition of the target is lack of space, and can not show the characteristics of regional flow and hot spot density of the target from the perspective of space. Moreover, the technology used in the existing system can only meet the needs of a display mode of real-time monitoring. This mode only emphasizes the real-time display of situation information and ignores the query and playback of historical data. Therefore, the research on an architecture supporting real-time historical double display mode is an inevitable requirement for the development of dynamic potential system.

This paper designs and implements a real-time history dual display mode situation presentation system based on spatio-temporal paradigm. The system accesses multi-source heterogeneous perception data, carries out real-time situation monitoring and historical data playback in time dimension based on target information atlas and multi-dimensional data view, and carries out coarse-grained and global target tracking interpretation and target portrait in spatial dimension based on GIS services. The results of situation system simulation experiment show that the system can effectively display the correlation degree between different equipment data, interpret and recognize the target from a spatial perspective, present the situation in a dual display mode combining real-time and history, and use the buffered batch loading algorithm to achieve low delay and efficient historical playback effect, Finally, the feasibility and effectiveness of the system designed in this paper are verified by functional and system testing.

Keywords situation display and control Internet of things knowledge map big data visualization

DESIGN AND IMPLEMENTATION OF REAL TIME AND HISTORY MULTI-VIEW TREND DISPLAY SYSTEM

ABSTRACT

The Internet of Things technology has brought a lot of convenience to regional situation monitoring and greatly improved the efficiency of decision-making. Facing complex and interrelated monitoring methods, IoT systems need to access a variety of sensor devices.It is necessary to comprehensively display a large number of multi-source heterogeneous sensing data.

The existing work can access multi-source heterogeneous sensor devices and display the sensing data of different devices on different visual interfaces. However, the information displayed by the system lacks relevance, and it is difficult to clarify the relationship between different device data, and it is impossible to display comprehensive information after merging multi-sensor data. Moreover, there is few work that meet the needs of query and playback of historical data.

The existing IoT situation system can access multi-source and heterogeneous sensor devices and display the perceptual data of different devices on different visual interfaces. However, the information displayed by the system lacks the correlation degree, the data of different devices are completely separated on the visual interface, the system only provides a single information of multiple data sources, it is very difficult to clarify the relationship between the data of different devices. Unable to display integrated information after fusion of multi-sensor data. The system lacks the depth of understanding the target, only through one or two kinds of

perceptual means, only through a single way of perception, the lack of spatio-temporal view of the image of the target information display, unable to explore the surface of the monitoring systemThe deeper information of hidden threat criterion contained in the phenomenon of target threat lacks a deep understanding of the nature of various alarm events and dangerous behavior which leads to the deviation of the overall cognition of the regional protection problem. Because of the lack of spatial characteristics, the system can not display the regional flow and hot spot density of the target from a spatial perspective. And the technology used in the existing system can only meet the demand of real-time monitoring a display mode, which only emphasizes the real-time display of situation information, ignoring the query and playback of historical data. Therefore, it is an inevitable requirement to develop situation system to study an architecture that supports real-time history dual display mode.

This paper designs and implements a real-time historical dual display mode situation system based on space-time paradigm. The system accesses multi-source heterogeneous sensing data, performs real-time situation monitoring and historical data playback based on target information graph and multi-dimensional data view, and performs coarse-grained and global target tracking interpretation and target portrait based on GIS service. . The results of the situational system simulation experiment show that the system can effectively display the correlation between different equipment data, and has a deep presentation of the target threat criterion information. It can also recognize the target from a spatial perspective, and display the situational data in a dual display mode combining real-time and history, and use the buffered batch loading algorithm to achieve low-latency and high-efficiency historical playback during playback. The system designed is feasible and effective.

KEY WORDS situation control internet of things knowledge graph big data visualization

catalogue

The first chapter is introduction

1.1 background and significance of the subject

Nowadays, with the increasing development of Internet of things technology, a large number of multi-source heterogeneous sensors are connected to the Internet of things system. The goal centered IOT situation system needs to access a variety of sensor devices, and it is necessary to comprehensively display a large number of multi-source heterogeneous real-time sensing data. In addition, a large amount of multi-dimensional historical information of targets is stored and accumulated, which brings the demand for historical target situation display. The multi-dimensional information of target history often has the attributes of time dimension and space dimension at the same time, which requires the target situation system of the Internet of things to have the ability of time slice snapshot playback of historical data and large-scale spatial location rendering at the same time. In view of the new demand for the target situation display of the Internet of things, the existing situation system has exposed many capability blind spots and technical defects:

(1) The information displayed by the existing Internet of things target situation system is lack of relevance. Although multi-source heterogeneous devices are accessed, the data display of heterogeneous devices is fragmented and fragmented. The system only provides single information of multiple data sources, so it is difficult to clarify the relationship between data of different devices. At the same time, there is no correlation between the data of different devices, so the comprehensive information after fusing multi-sensor data cannot be displayed.

(2) The existing target situation system of the Internet of things lacks spatial cognition of the target. The system only monitors the real-time behavior characteristics of the target from the perspective of time, overemphasizes the time attribute of the target, ignores the information contained in the historical spatial data of the target, and cannot display the characteristics of regional flow and hot spot density of the target from the

perspective of space.

(3) The existing target situation system of the Internet of things lacks historic cognition of the target. The system only does simple monitoring, can not integrate the results of real-time monitoring to form the long-term situation monitoring information of the target, and lacks mining and analysis of the long-term situation monitoring information of the target. Even if a small amount of description information of target behavior characteristics is obtained through mining, it can not support the real-time determination of target behavior.

(4) The existing display mode of IOT target situation system has limitations. The technology used in the system can only meet the needs of a display mode of real-time monitoring. This mode only emphasizes the real-time display of situation information and ignores the query and playback of historical data. At present, there is an extreme lack of a situation system architecture supporting real-time historical dual display mode.

In order to solve the above problems, after investigation, this subject found that using the method of combining real-time and history, real-time situation monitoring and historical data playback are carried out based on the target information map, and target tracking, reading and target portrait are carried out based on GIS (Geographic Information System) service. Finally, a real-time history dual display mode target situation system based on space-time paradigm is formed.

Based on the above background, this topic has made the following plans: this topic studies and implements a multi view IOT situation display and control system based on target information map and the combination of real-time and history. The system will combine IOT and cloud GIS technology, and take the target as the core to associate, integrate, mine and analyze a variety of monitoring data, So as to form target information atlas and multi angle data view, and finally realize target situation visualization based on spatio-temporal paradigm and big data visualization technology combining real-time and history..

The IOT target situation presentation system has the following advantages: in terms of real-time monitoring, it uses the target information map and multi angle view to show the relationship between different equipment data of the same monitoring target, and presents the target comprehensive data after associating the short-term description information of various means and different dimensions to the same target, It also shows the alarm transition process and threat criterion information obtained after mining and analyzing the long-term behavior characteristics of the target. In terms of spatial analysis, the system tracks and interprets a single target from a spatial perspective based on GIS services, displays the spatial historical information of the target, such as migration, hot spots and honeycomb, and displays the portrait information of the target in combination with the long-term motion trajectory and historical behavior characteristics of the target. In terms of system architecture, the system proposes a buffered batch data loading algorithm, which can query and playback the historical data according to the panorama, area, event and other modes from the perspective of time, forming a system design scheme of real-time history dual display mode, which not only displays the real-time data transmitted from the sensing layer to the application layer, but also displays the historical data according to the panorama, area Event and other modes for query and playback.

1.2 research content

Based on the above background, this subject aims to design and realize a multi view IOT situation display and control system combining real-time and history, and takes regional protection monitoring as the application scenario, and studies the technical scheme of real-time monitoring, history playback, tracking interpretation and target portrait using GIS technology and big data visualization technology. The main research contents of this subject are as follows:

(1) Design and construction of overall function and service architecture of the system

Based on multi-level storage system for multi-dimensional data, Internet of things access service and real-time computing and history mining service, the system constructs a multi view Internet of things target situation display system combining real-time and history. Real time service and historical service have diversified data interaction and clear service boundaries, which realizes a service-oriented system architecture in which real-time historical service data are produced, consumed, cohesive and autonomous.

(2) Research and implementation of real-time target monitoring and historical playback based on target information atlas and multi data view

The multi-dimensional data of the same target must be obtained by multi-device monitoring of the region. After data association, fusion, mining and analysis of the multi-sensor data of the detected target, the target information map and target perception, behavior, characteristics and threat data view with intelligence data can be formed. According to the fused data and data analysis results, the graphical system can provide users with real-time perception, behavior characteristics and threat criterion analysis data view display of multi-target, and can also play back the history of buffered batch data loading for multi-target in the ways of panorama, area and event. For example, the historical track, alarm events and abnormal records of a specific area in the past month. According to the target information atlas and multi data view, a detailed, necessary and friendly real-time and historical graphical display is the main research content of this subject.

(3) Research and implementation of target tracking interpretation and target portrait based on GIS Service

The multi-dimensional perception, behavior and characteristic data of the same target are persistent. In the data warehouse for long-term storage, the historical data view of the target in the space-time dimension can be obtained through the query of the data warehouse. With the help of GIS technology and big data visualization technology, the spatio-temporal data of the target can be tracked and interpreted, which can provide users with information about the migration situation, hot spot distribution area Alarm cellular view, such as the migration track of the target within one month, the thermal distribution map of the stay area within one year, etc. Target portrait is to distinguish the differences of target behavior, characteristics and events into different types, extract typical features from each type, give descriptions such as identification and statistical elements, and form a target prototype, that is, target information labeling, analyze these features, mine potential value information, and abstract the feature panorama of a target. Target portrait is the basis for solving the monitoring problem, and can help security monitors find the targets that really need attention. The tracking and interpretation of the target and the display of the target portrait are the key research contents of this subject.

(4) Design and component implementation of real-time and historical dual display mode of situation presentation system

The system uses component architecture to separate the functional modules and view expression of real-time monitoring mode and historical playback mode, and separates the consumer from the service through components to realize the binding of details, so as to avoid the destructive modification of the service to the consumer. The responsibilities of real-time and historical services are controlled by the boundary, and the service context is gradually divided to realize the decoupling and isolation between real-time monitoring services and historical playback services. The application program interface between real-time service and historical service is exposed through component signal publish and subscribe mode, so as to realize seamless service switching and service interaction between real-time monitoring service and historical playback service. By combining component-based system with real-time monitoring and history playback services, a real-time history dual display mode target situation presentation system with high cohesion and low coupling seamless switching is constructed.

1.3 paper organization

The design and implementation of multi view situation presentation system combining real-time and history is divided into six chapters. The summary of the chapters is as follows:

The first chapter is the introduction, including the subject background and difficulties faced by the target situation system of the Internet of things, and introduces the research content of this paper and the current problems raised by the subject background solved by this system.

The second chapter is the introduction of related technologies, mainly explaining the basic technical contents used in this paper

The third chapter is the overall design of the situation presentation system, which designs the overall system architecture, system function architecture, system service architecture, system component architecture, upstream and downstream data flow and overall process of the system.

The fourth chapter is the space-time paradigm design and component implementation of the situation presentation system. It mainly discusses the design principles from the perspective of time paradigm and space paradigm, and discusses the component implementation of the system.

The fifth chapter is system testing and verification, which mainly tests the function and performance of the system, so as to verify the feasibility and effectiveness of the system.

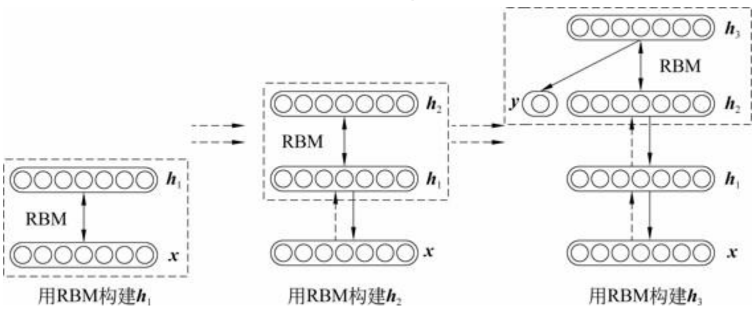
The sixth chapter is the summary and prospect, summarizes the work contribution of this paper, and looks forward to the future system development and evolution from the perspective of group perception and spatial paradigm.

Chapter II introduction to related technologies

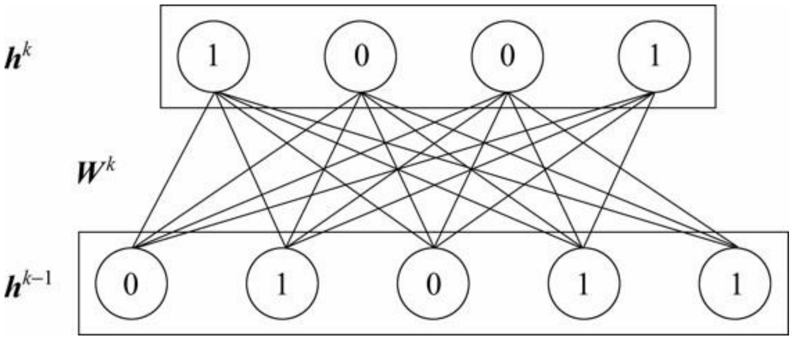
2.1 semi supervised learning and deep confidence network

The number of target threat degree data including labels collected in this system is very small, but it contains a large number of unlabeled data including various behaviors and events of the target. Therefore, semi supervised learning, which uses a large amount of unlabeled data and a small amount of labeled data to build a better classifier, has become a better choice. Classical semi supervised learning methods include self training, collaborative training, three group training, regenerative model, graph algorithm and direct push support vector machine.

This system designs a semi supervised learning situation estimation model based on active learning deep confidence network. Deep confidence network is a neural network model including many hidden layers. It extracts input information layer by layer for unsupervised learning and uses fixed labels to fine tune the supervised learning of the whole network, which makes it more suitable for semi supervised learning. Figure 2-1 shows the structure example of DBN (deep brief network). This layer by layer construction method is realized by a called restricted Boltzmann machines. It is a two-layer cyclic neural network. Each node of the output layer is symmetrically connected with each node of the input layer. After training layer by layer with greedy unsupervised learning method, the original features at the bottom of the deep architecture are combined into more compact high-level features.



1Figure 2-1 structure of deep confidence network



2Figure 2-2 structure of restricted Boltzmann machine

2.2 target tracking micro network model and convolution layer

The training model of convolutional neural network for target tracking, detection and recognition provides video tracking service for the system. The common convolution layer design and common networks in convolutional neural network for target tracking are as follows.

2.2.1 grouping convolution layer and depth separation convolution layer

The input of the packet convolution layer is divided into G groups according to the number of channels. Each group convolutes independently. The results are connected together as the output. The output channel is used as the input of the packet convolution layer. Then it is divided into three groups of three times three standard convolution layers. The information communication within the group is smooth and different packets are independent of each other.

The extreme case of the packet convolution layer is the deep separation convolution layer. The number of packets is equal to the number of input channels. Each channel is independently integrated into a part for convolution. The final result is to aggregate the output between each independent channel. The number of packets is equal to the number of channels, and there is no information flow between channels.

2.2.2 squeezenet network and mobilenet network

The characteristic of squeezenet network model is miniaturization. Its design method is to use one by one standard convolution layer to replace three by three standard convolution layer, and replace a large number of complex convolution layers, which greatly reduces parameters and calculation. The squeeze layer is used to reduce the number of channels of 33% standard convolution layer, carry out down sampling delay and ensure large activation resolution.

The first one by one standard convolution layer in the squeezenet block compresses the number of input channels to 1 / 8 and transmits them to the three by three standard convolution layer. After the upper and lower standard convolution layers are expanded by four times, they are connected, which is equal to the number of input channels. The ratio of the number of parameters of one by one standard convolution layer and three by three standard convolution layer in block is 1:3, and the calculation ratio is 1:3.

Mobilenet is a mobile oriented micro network, which is committed to the miniaturization and rapidity of the network. It is composed of three by three depth separation convolution layer and one by one standard convolution layer. The three by three depth separation convolution layer greatly reduces the amount of calculation of three by three standard convolution layer, and the one by one standard convolution layer supports data interaction between channels. The structure is efficient, and the efficiency is improved several times by using the scheme instead of the standard convolution layer at the expense of small performance degradation.

The network contains width multiplier and resolution multiplier parameters. The width multiplier parameter multiplies the number of channels in all layers by a width factor, and the model and calculation are compressed to square times of the factor. The resolution multiplier multiplies the input resolution by this factor, so that the resolution of all layers becomes factor times, the model size remains unchanged, and the amount of calculation decreases by factor square times. The depth model is better than the width model.

2.3 introduction to spring boot

The system uses spring boot as the server, uses lightweight spring application initialization and construction development process, does not need complex configuration template, uses a large number of default preconfiguration, and can carry out rapid server iterative development.

Spring uses embedded Tomcat to develop the server-side micro framework with the concept of convention greater than configuration. It uses starter POMS (project object models) to improve the efficiency of configuration and build the project in a concise way. The server does not need XML file configuration, but uses javaconfig to integrate other development projects.

2.4 MVVM architecture

The system realizes the front-end view data decoupling through MVVM (model view ViewModel view model) architecture. MVVM architecture is the basis of system componentization.

MVVM aims to use the data binding function in WPF (Windows Presentation Foundation) to better promote the separation of view layer development from the rest of the mode by deleting almost all GUI (graphical user interface) codes from the view layer. Instead of requiring user experience developers to write GUI code, they can use framework markup language and create data bindings to the view model written and maintained by application developers. The separation of roles allows interaction designers to focus on user experience requirements rather than programming business logic. In this way, the hierarchy of applications can be developed in multiple workflows to improve productivity. Even if a developer works on the entire code base, the proper separation of views and models is more efficient.

MVVM mode attempts to obtain the two advantages of separation of functional development provided by MVC (model view controller). At the same time, it makes use of the advantages of data binding and the framework of data binding to approach the pure application model as much as possible. It uses binders, view models, and data checking capabilities of any business layer to validate incoming data. The result is that models and frameworks drive as many operations as possible, eliminating or minimizing application logic (such as code hiding) that directly manipulates the view.

2.5 react framework and componentization

The system uses react framework to realize the isolation of real-time service and historical service with the help of component idea, and determines the boundary between real-time service and historical service, so that they can switch services seamlessly.

React builds the UI (user interface) in a componentized way rather than a common template. Component is not a new concept. It is the encapsulation of an independent function or interface to achieve the purpose of reuse or loose coupling between UI and business. The react framework uses a simplified component model, but more thoroughly uses the concept of componentization. React framework realizes the isolation of view functions through components, and realizes component autonomy, component isolation and component decoupling.

As a UI framework, react inevitably has the interaction of elements on the interface. In order to improve performance, react introduces the concept of virtual DOM (document object model) when operating page interaction. Virtual DOM is a DOM model re implemented with JavaScript in react. It has little relationship with the native DOM, but draws lessons from some concepts of the native dom. Because unnecessary complexity is reduced, the result of practical verification is that the performance of virtual DOM is much higher than that of native dom. The DOM built in react based development is carried out through virtual dom. In the operating environment of react, firstly, various views adaptively render a lot of data. When the data state is transferred, the DOM tree produces DOM diff (difference) changes, and finally the changed part of DOM diff is updated through the state transfer function. React will merge the DOM changes in the same event loop, but will compare the DOM changes at the beginning and end, ignoring the DOM changes in the intermediate process. Although the DOM tree is rebuilt every time the data changes, the operation performance of virtual DOM is very high. In this way, when using react, developers no longer need to care about the update of DOM elements on the page when the data changes, but only about the actual effect of the page in each data state.

2.6 big data visualization technology

According to the data type, big data visualization technology can be divided into two categories: big data visualization technology based on time paradigm and big data visualization technology based on spatial paradigm.

2.6.1 big data visualization time paradigm

Time attribute widely appears in various data, such as ship sailing time, microblog publishing time and so on. From the visual perspective of visualization technology, the big data visualization method based on time paradigm can be classified into location-based time paradigm big data visualization method and location-free time paradigm big data visualization method.

The location-based time paradigm big data visualization method uses the absolute position of data points on the time axis to represent time information. The timeline can be linear (position or length) or circular (angle). On the linear time axis, the absolute position of each data point corresponds to an exact time. Therefore, the distance between data points (or the length of a line segment on the axis) can be used to represent the span of time. Similarly, on the circular time axis, we can determine a specific time according to the radian of each data point, and use the angle from two points to the center of the circle to define the length of the time segment. If the location of the data point has been used to represent other attributes, we can also choose the visualization method without location. For example, when the time attributes of data points show discrete characteristics, color, size, shape and texture will support the effective visualization of data for time attributes. When the time attributes of data points have the characteristics of aggregation, data points with the same time attributes can be wrapped in the same closed area through regional visualization [1,2,3].

Based on the above basic time paradigm big data visualization methods, visualization researchers have proposed a series of visualization methods for time analysis. Due to the linear and cyclic characteristics of time, big data visualization methods for time analysis can be roughly divided into two categories: big data visualization methods for linear time and big data visualization methods for periodic time.

Among the visualization methods of linear time, line graph and stacked graph are the most common. The line chart allows users to easily observe and compare the absolute values of multiple time series, while the stacked chart is suitable for observing the sum of multiple time-varying series values and their accumulation.

The visualization of periodic time is often used to analyze periodic human activity data and urban environment data. Among them, the most common visualization method is to use the circular timeline. It divides a certain time range (such as 24 hours) according to a certain granularity, aggregates data values according to time attributes, and finally arranges these aggregated data along the radial direction. For example, the color depth of each ring in the radial direction indicates the activity heat of the ship at different times of the day. Big data visualization of periodic time has been widely used in big data visual analysis.

2.6.2 big data visualization space paradigm

Spatial attributes are an important part of urban data. There are three visualization technologies for spatial attributes: point based visualization technology, region based visualization technology and line based visualization technology.

Point based visualization technology allows users to intuitively see the location information contained in the data. Line based visualization methods are usually used to analyze urban big data based on traffic network, such as traffic trajectory data. A common track visualization method is to connect the sampling points in the track records in chronological order, and display the additional information on the line segment connecting the data points with the help of visual methods such as the color or thickness of the line segment.

Region based visualization technology can solve the above visual confusion to a certain extent. In region based visualization, we divide the space according to explicit rules (such as administrative region and urban functional region), and aggregate the non location attributes of data points through location attributes. At the same time, we can also use many visualization methods to show the flow between regions, which will help to observe the data characteristics within and between regions. However, when the regions are densely distributed and the flow relationship between regions is complex, the method of using line segments to encode the flow between regions will cause serious visual confusion because the line segments block each other. We can adopt edge binding, matrix based visualization method and symbol based visualization technology to clearly display the flow data between regions without affecting the expression of location information [4,5,6].

2.7 NoSQL database

The multi-level storage system for multidimensional data in this system uses NoSQL (not only SQL) database.

2.7.1 column database

Column family storage is modeled according to Google's BigTable. The data model is based on sparse tables. Its rows can have any number of columns and contain keys that provide natural indexes. There are four common components of column family. The simplest storage unit is the column itself, including a name value pair. Any number of columns can form a super column, which gives a name to a group of ordered columns. Columns are stored in rows. When a row has only columns, it is called a column family. When a row includes super columns, it is called a super column family.

Column family database is aggregate storage, which is not suitable for large-scale query of related data. Each line of it represents a specific and indispensable entity. Each row provides a nested hash structure.

2.7.2 diagram database

Some graph databases use native graph storage, which is specially optimized for storing and managing graphs. However, not all graph databases use native graph storage, and some of them serialize the graph data and save it to the relational database. The native graph database is not very dependent on the index, because the graph itself provides a natural adjacency index. In the native graph database, the links attached to the nodes naturally provide direct association to other nodes we are interested in. Graph query uses this feature to traverse the graph, which makes the execution efficiency of the operation extremely high. It can traverse millions of nodes per second.

2.8 summary of this chapter

This chapter introduces the basic knowledge of the corresponding technologies involved in the design and implementation of the system, reviews its basic contents, and makes theoretical preparations for the introduction of the overall design and implementation. NoSQL database is the preparation of multi-level storage system for multi-dimensional data, and react framework, componentization and MVVM architecture are the basic preparation for the design of situation presentation system. The target tracking network model and semi supervised learning lay a theoretical foundation for the training of video target tracking and situation estimation model. Big data visualization provides a theoretical basis for the overall spatio-temporal paradigm design pattern of this paper.

The third chapter is the overall design of situation presentation system

This chapter will design the architecture, services, functions, components, data flow and overall process of the situation system from an overall perspective.

3.1 system architecture design

3.1.1 System Architecture Overview

The overall architecture of the system includes IOT sensing equipment, data service platform, multi-level storage system for multi-dimensional data and situation presentation system. The system architecture is shown in Figure 3-1.

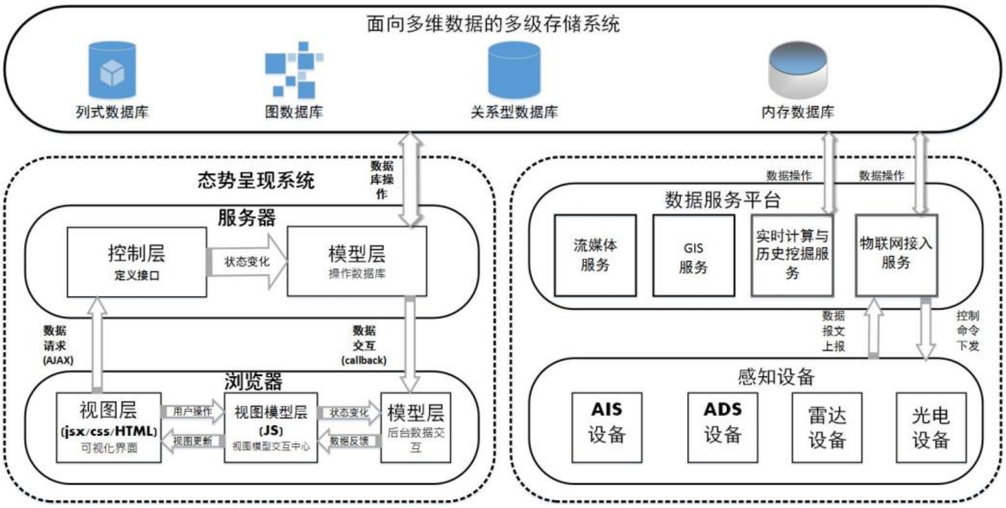


Figure 3-1 architecture of multi view situation presentation system combining real-time and history

This topic focuses on the multi view situation presentation system combining real-time and history. Based on the application scenarios of all-weather security target real-time monitoring, target identification and tracking, characteristic behavior extraction and behavior threat analysis, this paper realizes the real-time situation monitoring and historical data playback based on the target information map, and the target tracking and interpretation and target portrait based on GIS services.

This method involves multi-level computing, storage and visualization technologies: at the target device monitoring and sensing level, sensing devices with large range, low precision and low power consumption and photoelectric tracking devices with fast return and slightly high power consumption are used to sense all targets within the monitoring range, and the perceived data payload after protocol analysis is reported to the storage system through the Internet of things access service.

At the level of target feature extraction and threat analysis, an off-line and real-time target cumulative recognition framework is used to mine the deep value-added information and semantic intelligence information of the target, form the target information map through a series of feature extraction and behavior analysis algorithms, and obtain the target threat analysis model through explicit rule judgment or in-depth learning model training, Finally, a multi angle data view of target perception, characteristics, behavior and threat is formed according to the degree of data processing from low to high;

At the target situation visualization level, component-based and big data visualization technologies are used to display the results of association, fusion, mining and analysis of multi-sensor information in a combination of real-time and history. The results of multi-sensor data mining include target information atlas and multi angle data view. It also shows the potentially valuable semantic content of target tracking interpretation and target portrait [7,8,9].

We access the data payload through the Internet of things data access service, complete the target feature extraction and behavior analysis through the data service platform, and store the target information map and multi angle data view through the multi-level storage system. Finally, the task results of the above levels are integrated through the situation presentation system, and the real-time target monitoring, identification and tracking, characteristic behavior extraction, behavior threat analysis and situation visualization are completed by combining real-time and history. The system structure is as follows:

1) IOT sensing device

Internet of things technology has brought many complex and interrelated monitoring means to regional situation monitoring. The system needs to access a variety of sensor devices to form a large number of multi-source heterogeneous sensing data. These data are the basis of the Internet of things system, including the original sensing information such as target orientation, longitude and latitude, radial velocity, tangential velocity and distance, Sensor equipment is the producer of information, and the information generated is the raw materials for data analysis, calculation and mining. After the equipment produces the original perceived information, the protocol management, data payload extraction, message distribution and other processes are reported to the multi-level storage system through the Internet of things access service, and the user can issue control commands to the equipment through the Internet of things access service according to the real-time reported data, so as to perform specific regional protection tasks.

2) Data service platform

Data service platform is a distributed integrated collaborative computing system, including Internet of things access service, real-time computing and history mining service, GIS service and streaming media service.

The Internet of things access service is actually a distributed sensor access and resource management middleware. After the sensing device is connected, first configure the basic parameters, and then complete the protocol encapsulation, protocol analysis and protocol adaptation. The access service will temporarily cache the data, and use the priority based task scheduling method to persist the cached sensing data, Finally, the sensing layer and the application layer are connected to realize the access of sensing resources and obtain multi-source heterogeneous original sensing data.

Real time computing and history mining service is a target cumulative recognition framework based on real-time computing and off-line mining. The real-time computing part performs space-time registration, trajectory correlation and data fusion on the real-time original perceptual data. Firstly, it finds the correlation relationship of multi-source heterogeneous data of the same target detected by many different sensing means, Multiple means of the same goal and perceptual data of different dimensions are associated to the same goal. Then, the long-term motion trajectory and historical fragmented data of the target formed by the integrated real-time calculation results are parallelized offline mining and analysis, and the attribute feature information and target behavior information of the target itself (passing area, times of tampering and camouflage, alarm behavior, etc.) are obtained through feature extraction and behavior analysis algorithms, For the extracted target behavior feature information, the threat analysis data view of the target is obtained through a series of explicit rules that can be understood by people and the implicit threat model trained by the machine through the deep learning method. The above calculation process finally forms the target information map containing the target perception, feature, behavior and threat data view through the process of data accumulation and repeated iteration. Real time information acts on historical data mining, and the target information map obtained by historical mining can in turn serve target real-time monitoring, calculation, analysis and visualization. This framework is a dual computing mode iterative target cumulative recognition system constructed by the idea of combining real-time and history.

Streaming media service is a video service system connected to photoelectric video equipment and equipped with video monitoring, real-time tracking and target recognition and detection. It can access a variety of photoelectric devices and store monitoring video files in real time, provide real-time video stream by reverse proxy, and detect and track the specific targets selected in the field of view.

GIS service is a localized service tool integrating offline map publishing, geospatial data rendering and point, line and area layer data visualization. It can use WMTs (web map tile service Tile Map Service) to publish tile map services, present GIS maps under different coordinate system standards on the browser interface, render the location, direction, speed and other information contained in the perceived view of the target on the map, and present migration, hotspot and cellular views in combination with big data visualization technology, Assist in presenting the comprehensive situation of the target area as a whole.

3) Multilevel storage system for multidimensional data

The system adopts a set of multi-dimensional and multi-level storage scheme for Internet of things data, which can store a series of perception, characteristics, behavior and threat data views derived from the process of production and consumption. It can also use the method of native graph storage to store the target information map, not only storing specific data elements, but also storing the associations between elements, The index free adjacency method is used to ensure the efficiency of traversing the associated data.

In this storage system scheme, the first level storage uses a relational database to store the perceived data analysis results of the Internet of things access service. After the sensor adapter in the access service publishes the data payload to the message middleware, since the persistence module of the access service subscribes to the topics of all sensor parsing results, the persistence module will request to join the relational data connection pool and finally complete the persistence of the original sensing data. It also provides underlying data support for device display and control and original perceived data view in real-time data monitoring, and provides consumption data raw materials for real-time computing and history mining services, so as to facilitate feature extraction and threat behavior analysis.

The secondary storage uses the column data warehouse that supports large-scale parallel data processing to realize distributed storage, and has high availability, scalability and strong scalability. Because the columnar database has better data addition characteristics, it can store target centered data more flexibly. According to the way that each fusion normalization target is stored as a table, the new targets obtained through data association and mining can be flexibly stored in the columnar database as the storage database of multi-dimensional data, which has no strict restrictions on column data, That is, the content of rows can be continuously expanded, and new columns can be added at any time to realize horizontal and vertical data table expansion. The content of a single multi-dimensional target fusion information table can reach the scale of billions of rows, which meets the needs of the situation presentation system for the dual display mode of combining real-time and history, and is more conducive to storing the target features obtained by real-time computing and history mining services Need for behavior, threat, and data views.

The third level storage uses the index free adjacency method of the original graph database to store the target information map, and constructs the target feature, behavior and threat data view. The index free adjacency in the native graph database means that the associated nodes are physically pointing to each other in the database, which will bring great performance advantages when traversing and querying large-scale associated data. Using the graph scheme, the performance can be improved by one or even several orders of magnitude, and its delay is much smaller than that of aggregation batch processing, Because the query execution time of graph database is only proportional to the size of the traversal graph that meets the query conditions, rather than the size of the whole graph. However, with the continuous increase of data sets, the performance of traditional relational database in processing join (join intensive) queries becomes worse. The graph database can store the results of feature extraction and behavior analysis algorithms, and build the target information map iteratively according to the threat analysis results and criteria predicted by the threat analysis model, which can more flexibly meet the needs of target cumulative identification and historical data sorting mechanism.

4) Situation presentation system

The situation presentation system combining real-time and history is implemented based on B / S (Browser / server) mode.

The server of the system refers to the background service running in the lightweight web container. It uses the spring boot framework for deployment, and uses spring MVC in the spring framework framework system as the core running module. The backend uses ORM / OGM mapping to map the graph data and batch view data in the target information atlas and multi angle data view to the backend model layer, and loads the batch data to the browser through the interface defined by the backend control layer.

The browser side of the system adopts a component-based architecture. Based on react framework and ant design as UI design language, a visual interface with seamless switching real-time history dual display mode is constructed. The browser uses MVVM mode to separate the view and model, and there is a clear boundary between the view and model, so as to realize the characteristics of view self adaptation to batch data. MVVM uses binders, view models, and data checking capabilities of any business layer to validate incoming data. The result is that models and frameworks drive as many operations as possible, eliminating or minimizing the application logic that directly manipulates the view.

3.1.2 multi level storage system for multidimensional data

The storage system designed in this paper is actually applied to monitor the land and sea conditions around the area, multi-source heterogeneous sensor equipment, such as temperature and humidity sensor and AIS automatic identification system. After producing the original sensing data, the original data message is connected to the system through different transmission modes such as TCP, HTTP and UDP, Through the Internet of things access service, the data payload is extracted through technical means such as protocol management, protocol hot plug and protocol analysis, and then the parsed data is stored in the relational database mysql.

After real-time calculation and historical data mining, the original perceptual data integrates and correlates the data of different dimensions of each target, and forms the long-term movement track of the target, the attribute feature information of the target itself and the target behavior information (passing area, number of tampering and camouflage, alarm behavior, etc.) The data associated and integrated information such as feature behavior data view is stored in non relational column database.

For the extracted target behavior feature information, threat analysis is carried out through a series of models trained by explicit rule judgment and in-depth learning methods. With the continuous accumulation of various perceptual data, the above data association algorithm is used for incremental updating. The above calculation process is finally integrated into target perception, feature, behavior For the target information Atlas of threat data view, the final generated target information atlas is stored in the graph database. For the perceptual data index on the new association, it needs to be added in the graph database, while for the wrong association caused by incomplete information in the early stage, it needs to be deleted in the graph database. When all kinds of perceptual data accumulate to a certain threshold, The system will constantly update the multi angle data view in the graph database [10,11,12,13].

This paper adopts the modular design idea to design the storage system architecture. Each module has problem pertinence and pays attention to the relevance and unity between modules. The multi-level storage system designed in this paper includes the following modules:

（1） Raw sensing data storage module

The original perception storage module mainly provides supporting data for equipment display and control and linkage, and is the raw material for extracting target feature behavior and threat analysis. It is the starting point of the whole multi-level storage system. The module stores the data payload reported by multi-source heterogeneous sensing devices, supports fast data transaction processing, and provides original sensing data materials for subsequent modules.

（2） Data synchronization integration module

The data synchronization integration module is the link between the original sensing data storage module and the multi-dimensional data storage module. It can synchronize the data stored by the original sensing data module to the distributed storage cluster and ensure a high data transmission speed without causing great pressure on the original sensing storage transactions. And complete the cleaning of the original data, and adopt the principle of non synchronization, non integration and resource saving for invalid data and garbage data. The module also extracts and integrates various scattered original perceptual data into the complete fusion data of the target dimension, and divides the regional dimension, which is integrated, targeted and efficient.

（3） Multidimensional data storage module

The multi-dimensional data storage module stores the target multi-dimensional features, behaviors and threat data views after data cleaning, integration and mining. It has a scalable and flexible storage mode and meets the requirements of real-time monitoring, historical playback and tracking interpretation for large-scale multi-dimensional data query. The column database is used to store the target centered multi-dimensional data view after associating and integrating the original perceived data. According to the way that each fusion normalized target is stored as a table, the target centered data can be stored more flexibly, and can be expanded horizontally and vertically in the data table. The scale of a single data table reaches more than one billion rows, Millions of columns, which meets the needs of the situation presentation system for the dual display mode of combining real-time and history, and is more conducive to storing the target features, behaviors and threat data views obtained from real-time computing and history mining services.

（4） Target information map storage module

The target information map storage module uses the index free adjacency method of the original map database to store the target information map, and constructs the target feature, behavior and threat data view. Graph database embraces connection. The index free adjacency in the original graph database means that the associated nodes point to each other in the physical sense in the database. The fine-grained connection and general connection are more suitable for iterative graph calculation and incremental development, more suitable for the smooth evolution of graph data model, and constantly discover new targets and new dimensional feature behavior views, Form a new node and new contact diagram. The graph database can store the results of feature extraction and behavior analysis algorithms, and build the target information map iteratively according to the threat analysis results and criteria predicted by the threat analysis model, which can more flexibly meet the needs of target cumulative identification and historical data sorting mechanism.

Figure 3-2 shows the functional module division of the storage system in detail.

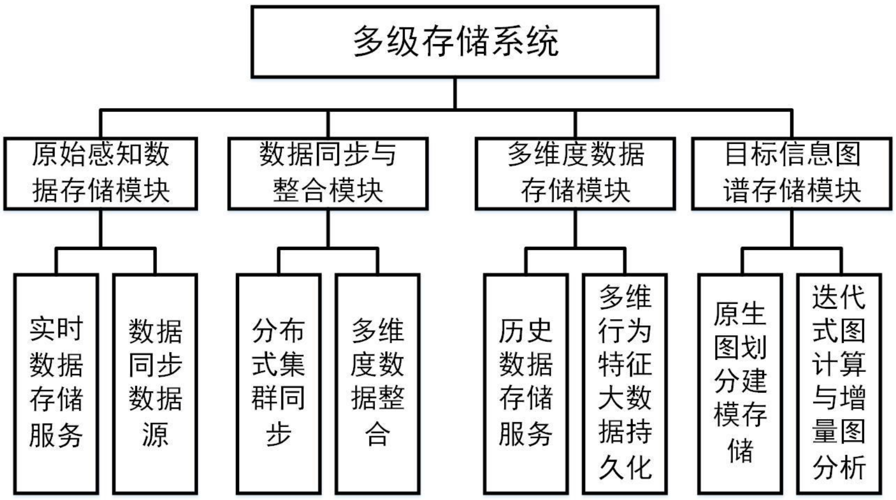


Figure 3-2 functional modules of multi-level storage system

The overall technical architecture of multi-level storage designed according to the functional module division of the storage system is shown in Figure 3-3.

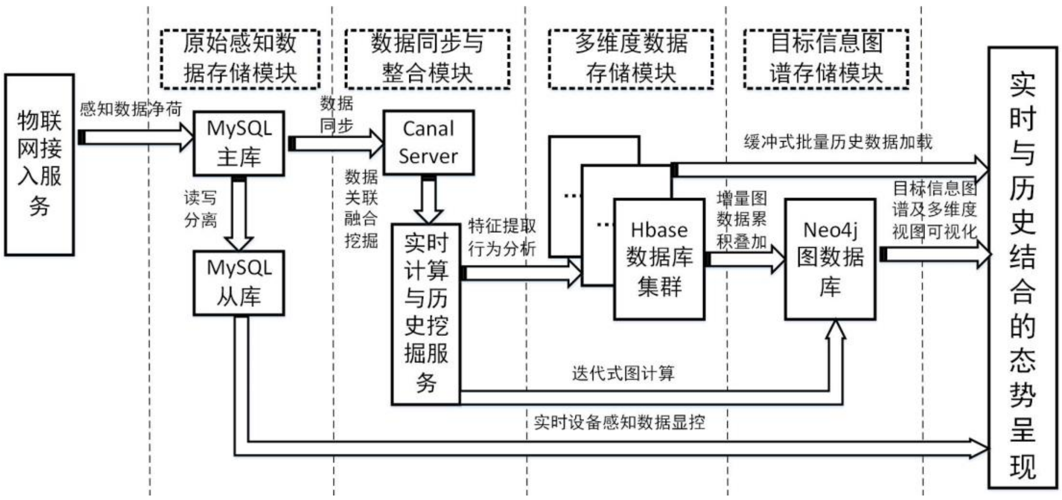


Figure 3-3 overall technical architecture of multi-level storage system

In the original perception data storage module, MySQL is used to store data, and the master-slave architecture is used to realize the separation of reading and writing, the canal is used to realize data synchronization, the real-time computing and history mining services are used to realize the data association and fusion between the target dimension and the regional dimension, and the characteristic behavior analysis and threat analysis model are trained to associate, fuse, analyze The mining results are stored in HBase database cluster to provide buffered batch spatio-temporal historical data loading service for historical data playback and tracking interpretation. When the accumulated perceptual data index of various devices accumulates to a certain value, it will trigger the target feature discovery and behavior analysis algorithm, so as to

The original target information atlas is constructed. The target information atlas is stored in the map database neo4j. The construction process requires multiple iterations, which is formed through the incremental superposition of historical perception data and the iteration of historical data combing mechanism. The atlas fragments are continuously integrated and improved, and the false associations caused by information asymmetry in the early stage are deleted, So as to reduce the asymmetric risk in threat behavior analysis.

In order to store multi-dimensional and multi regional target fusion information flexibly, HBase non relational database is used in this paper. HBase is a column oriented distributed storage system with real-time read-write performance and good support for random access of large-scale data sets. The bottom layer of HBase stores data in the way of key value pairs and does not strictly control the column information of data. It can expand rows and columns for the multi-dimensional information of the target. A single table can be expanded to the scale of billions of rows and millions of columns.

HBase is the most important storage medium, which is mainly divided into two parts. The first part is to store the geographic information and characteristic behavior attribute information of all targets, such as target length, width, longitude and latitude, heading, equipment alarm information, etc. The database takes time as the basic unit to divide the motion state of the target, takes the unique characteristic identification of the target as the row key value pair, and uses the time column to distinguish the states in different periods. The time column is determined by the starting timestamp of the target motion track. The second part is the information of storage area dimension. The database divides multiple key areas for the monitoring area in advance, and designs a storage table for each key area to store the spatio-temporal perception information of all targets in the area.

Neo4j is a native graph database. The native graph data storage structure is inherently scalable. After using neo4j to model the target information graph, you can also add different kinds of new links, new nodes, new labels and new subgraphs to the existing graph structure without worrying about breaking the existing query and graph functions. Through the incremental superposition of perceived data and iterative graph calculation, The data of a target's characteristics, behavior and threat analysis view will be more and more abundant. The fine-grained and general links in the target information map will be continuously improved, and the scale of the map will be larger and larger.

Neo4j uses an index free adjacency engine with native processing capability, in which each node maintains its reference to adjacent nodes. Therefore, each node is represented as the micro index of its nearby nodes, which is much less expensive than using the global index, which means that the query time is independent of the overall size of the graph, and it is only proportional to the size of the searched partial traversal graph that meets the query conditions, which shows that the graph database provides an efficient solution to the query of large-scale related data.

3.1.3 interface design

This section will discuss the design scheme of the server interface of the situation presentation system. The back-end interface is the bridge connecting the browser end and the multi-level data storage system. The real-time target multi-dimensional data view and target information map are transmitted to the front-end through the back-end interface, which provides data support for the real-time situation monitoring mode. In the historical data playback mode, the interface controls the pre loading of large quantities of data, and realizes buffered batch data loading Rendering and playback. In the tasks of tracking, interpretation and target portrait, the large batch of target spatial perception information transmitted by the back-end data provides a basic data set for big data visualization.

The interface of the system adopts the spring boot framework to integrate spring data neo4j and spring data Hadoop. POJO (plain ordinary Java object) is used to model large-scale graph data, column family data mapping and embedded driver, and the standard curd (create update retrieve delete) method is called through the repository interface provided by SDN / SDH to flexibly operate HBase and neo4j.

The interface of server operation graph data is implemented by spring data neo4j, which uses OGM (object graph mapping object graph mapping) to convert domain objects and graph data. Using this transformation mechanism, when modeling objects, we can establish a mapping relationship between objects and graph data as long as we use some simple annotations. SDN provides an intelligent management mechanism for OGM mapping and enhances the performance of accessing database. This is mainly reflected in two aspects: on the one hand, when an application uses and modifies an object, it does not need to directly operate on the database. It only connects to the database when saving the object. On the other hand, when saving an object, other objects associated with the object can be saved accordingly.

The server uses the repository interface of SDN to realize persistence and design data interface access. By simply inheriting the SDN repository interface, you can perform standard curd operations. At the same time, you can customize the methods according to the specification and standard of the interface to realize the query design like using the query language. All methods will be implemented intelligently by Sdn. User defined cypher query statements can be used in the interface through annotations. This is also realized by the mapping mechanism of OGM, and the query has high efficiency through OGM optimization, that is, it provides good performance. Through cypher query language, complex query interfaces can be designed to support a variety of business requirements. SDN also provides an implicit transaction management mechanism, that is, implicit transaction management can be used for every operation of the database, including finding data, saving data, etc. Through implicit transaction management, each transaction is automatically committed.

The interface for the server to operate the column family database is implemented by spring data Hadoop. The interface is mainly composed of template class and Dao (data access object) class. The interface models the persistence layer of the database table, uses the template class to complete the configuration and initialization of HBase, and can query the column cluster information and display the callback information. Use the data access object class to add, delete, modify, query and other database operations. You can insert the specified row in the table, specify the column cluster, and specify the data in the column. The data access object interface after service encapsulation can process the specific business logic, and finally realize batch request buffer data, spatial trajectory location data, and multi angle data View service requirements.

3.1.4 component communication mechanism and state transition

The system uses the idea of componentization to realize the dual display mode situation presentation of real-time history combination. Components are classified according to the relationship between each other, mainly including independent components and inherited components. Inherited components refer to that the basic elements inside components are inherited from other external components, and there is an inheritance relationship between inherited components and other external components. Elements inside independent components are independent and mutually exclusive relative to other external components, and there is no correlation with other components.

Before inheriting components, there is an inherited communication mechanism, which can communicate component status, attributes, data and functions through the inheritance relationship between components. The internal data flow of components with inheritance relationship has two basic modes: internal and external component data flow mode and parallel nested component data flow mode.

The first mode of inherited component communication mechanism is the internal and external component data flow mode. The internal component uniformly inherits and transmits the attributes, prototypes, States, functions and states of the external component to the internal component through the inheritance relationship, so as to realize the data flow from the external component to the internal component, The external component uses the inheritance relationship to call the state transition function of the external component through the internal component to realize the data flow from the inside of the component to the outside of the component.

The second mode of inheriting the component communication mechanism is the parallel nested component data flow mode. When two components become the internal components of the same external component at the same time, the two components become parallel nested components. Because two parallel nested components have a common external component, Parallel nested components can modify the state of external components by calling the state transition function of external components. After state transition, external components finally transfer data, attributes, States, functions and other parameters to another parallel nested component by using inheritance relationship, so as to realize the data flow between parallel nested components.

The component inheritance communication mechanism is shown in Figure 3-4.

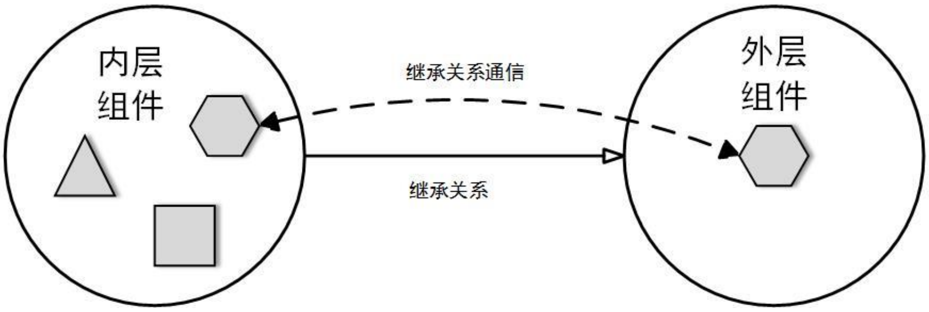


Figure 3-4 communication mechanism of componentized inheritance component

Independent components have the properties of high cohesion and low coupling, and there is no inheritance relationship between components. The communication between components requires the help of third-party communication components such as signal broadcaster. The component that first publishes the message publishes the information datagram with a certain topic through the state transfer function and trigger inside the component, After receiving this message, the signal broadcaster broadcasts and communicates with all independent components connected to the signal broadcaster. The signal targeting independent component extracts the datagram payload of the corresponding topic by subscribing to the information of the topic, so as to realize the data flow between independent components. The communication mechanism between independent components is shown in Figure 3-5.

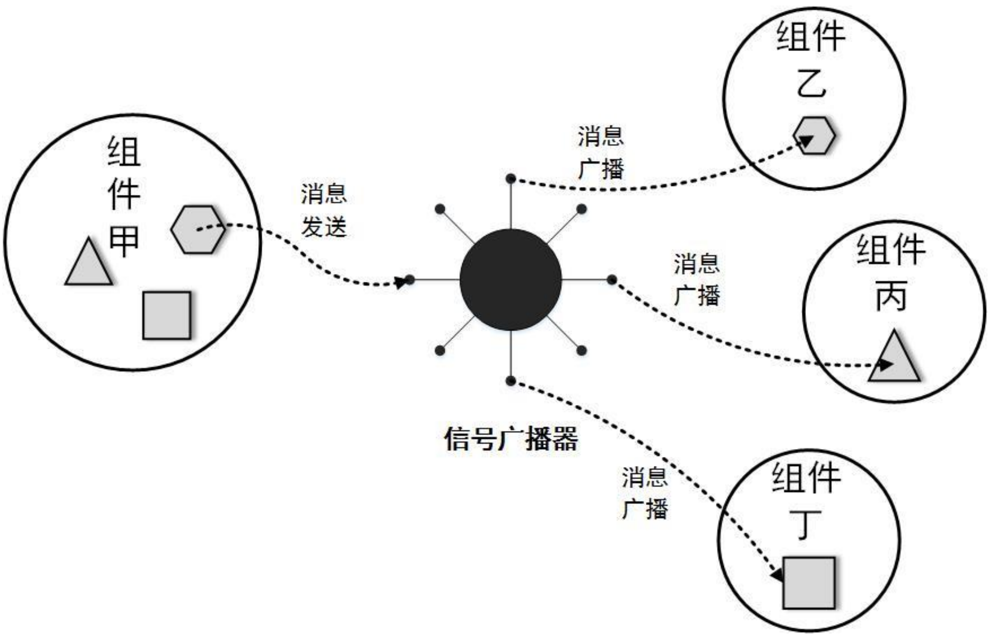


Figure 3-5 communication mechanism of componentized independent components

The reason why componentization can achieve low coupling and high availability is that components are functionally independent logical units. Each component contains a micro state machine. The state transition mechanism in the component state machine connects the component view, component data and component logic to finally complete the core functions of the component. The componentized state transition mechanism is shown in Figure 3-6 [14,15,16,17].

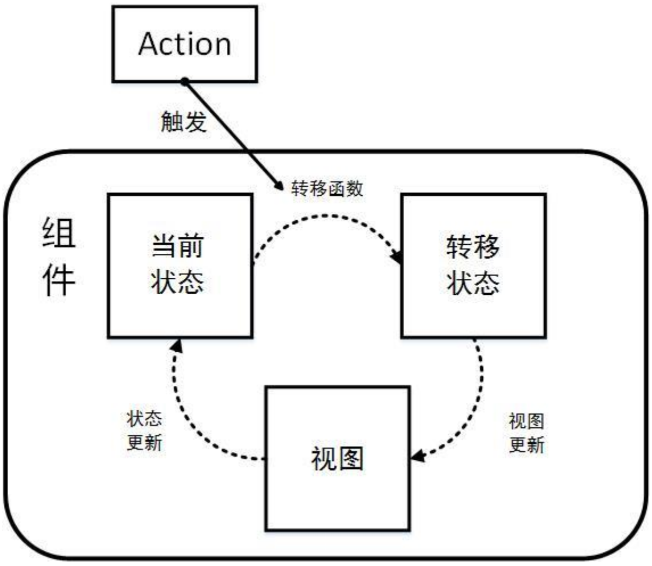


Figure 3-6 component state transition mechanism

The user's operation on the component triggers the transfer function through the trigger. The transfer function calculates and generates the transfer state of the component according to the state of the current component, and generates the transfer state data. The data causes the view update after logical processing, and the current component state changes after the view update. The production starting point of all data in the component is logical processing. A view in the component needs a logical processing area to realize interactive operation. Therefore, the logical processing area and the view are one-to-one relationship, and a view update and interaction only process part of the data. Therefore, the view, logic and data are one-to-one relationship under the state machine transfer mechanism, This one-to-one correspondence within components greatly reduces the coupling and improves the cohesion.

The component communication mechanism has the characteristics of one-way data flow, the data flow direction is clear and controllable, and is controlled by the state transition mechanism. Therefore, the component communication mechanism is an architecture that is easy to abstract, configurable, state controllable and highly reusable.

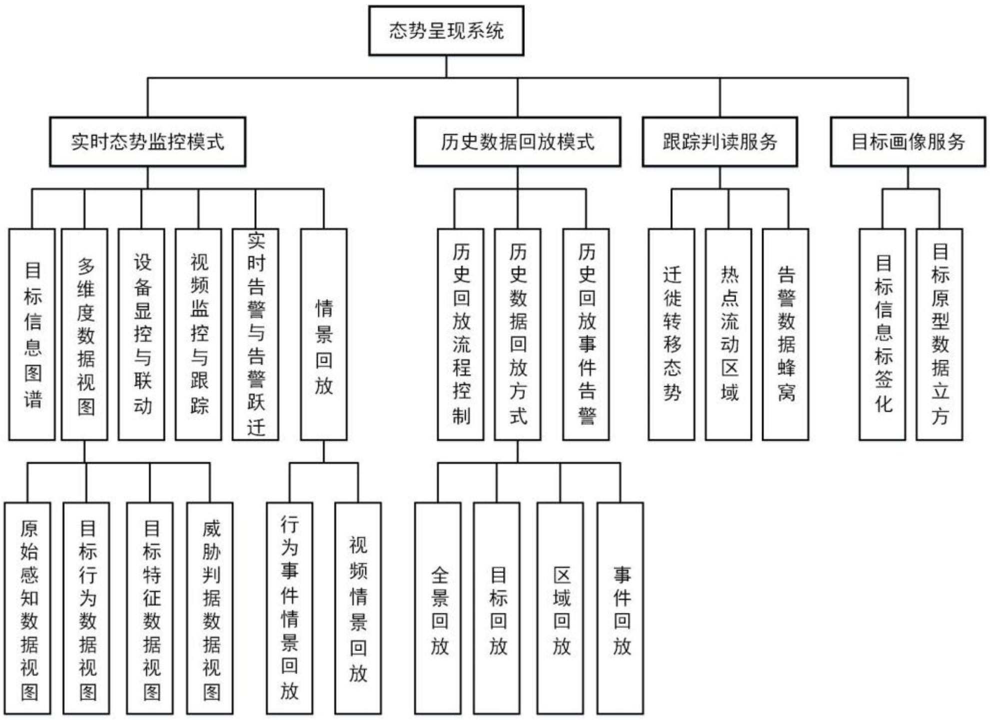
3.2 system function structure design

The multi view situation presentation system combining real-time and history is based on the actual needs of all-weather security target real-time monitoring, target identification and tracking, feature behavior extraction and behavior threat analysis. It realizes real-time situation monitoring and historical data playback based on target information atlas, and interprets target tracking and target portrait based on GIS service.

The system realizes target oriented security situation management and control, and realizes multi-level target calculation, storage and visualization with the combination of real-time and history. The functional structure of the system is divided vertically into three levels: target equipment monitoring and perception layer, target feature extraction and threat analysis layer, and target situation visualization layer.

At the target equipment monitoring and sensing level, the system uses the Internet of things access service to report the perceived data payload after protocol analysis to the storage system, and uses photoelectric tracking equipment to perceive all targets within the monitoring range; At the level of target feature extraction and threat analysis, the deep value-added information and semantic information of the target are systematically mined, and the multi angle data view of the target is formed through feature extraction and behavior analysis algorithms; The target threat analysis model is obtained through explicit rule judgment or in-depth learning model training. Finally, a target cumulative recognition framework combining offline and real-time is used to form the target information map, and the target perception, characteristics, behavior and threat are updated incrementally; At the target situation visualization level, the tracking and interpretation of the target and the target portrait are realized through the big data visualization technology, and the results of association, fusion, mining and analysis of multi-sensor information are displayed in a combination of real-time and history.

The functional structure design diagram of situation presentation system is shown



in Figure 3-7.

Figure 3-7 functional structure of situation presentation system

The system is divided horizontally into four parts: real-time situation monitoring mode, historical data playback mode, tracking interpretation and target portrait. The real-time monitoring and history playback mode presents the target multi-dimensional data view and target information map with the seamless switching real-time history dual display mode, following the time dimension paradigm. Tracking interpretation and target portrait service is to comprehensively present the target data cube by using GIS service, grid aggregation, migration, heat and other visualization methods, visualize the target and follow the spatial dimension paradigm.

The display content of real-time situation monitoring mode is mainly divided into two categories. The first category is the information of equipment real-time display and control, linkage, alarm, tracking and identification. Dynamic detection information display, real-time track drawing and detection range rendering for real-time synchronous refresh of equipment dynamic and static data. The second type is to display the results of historical data analysis in real time. After mining and analysis, feature extraction and behavior pattern analysis, the long-term motion trajectory of the target formed by the target real-time monitoring equipment can obtain the description information and knowledge map of target features, behaviors and threats, so as to serve the detection and identification of real-time targets and the presentation of the overall threat situation. This model reflects the core design idea of combining real-time and history. It not only shows the real-time device perception information, but also shows the historical target analysis data obtained from the real-time perception data payload after long-term historical data association and mining. The real-time situation monitoring mode includes the following sub functions:

1）Multidimensional data view

Multi dimensional data view is the target rich semantic data obtained after comprehensive situation assessment of police and bank according to target feature extraction, behavior analysis algorithm and threat discriminant analysis model. According to the degree of data processing, it can be divided into original perception data view, target feature data view, target behavior data view, target identification and threat level data view.

The original perceptual data view shows a variety of original perceptual data centered on the target, and shows the perceptual data of multi-source heterogeneous data related to the same target. Taking the data fusion between AIS information detection equipment and civil radar as an example, the original perceptual data view presents the longitude and latitude information, ship name, equipment distance, radial velocity, azimuth and other information of the same target detected by AIS equipment after data association and fusion. Due to the large amount of original perceptual data, which exceeds the storage space limit of the traditional database, the original perceptual data view can be stored in the distributed column oriented database. When the perceptual data continues to accumulate, the number of horizontally expanding storage nodes can meet its storage space requirements. The index can be stored in the graph database. The graph database stores the target and various perceptual data indexes and their relationship, which reflects the goal centered storage concept.

The target characteristic data view presents the attribute characteristics of the target itself. The characteristics of the target are mainly divided into two categories. The first category is information, which contains the target detailed information data perceived by the detection equipment, such as target size, aspect ratio, color, nationality, velocity, angular velocity, electromagnetic band and other information; The second category is the sign category. The sign data is unique, such as MMSI (maritime mobile service identification code) number and flight number information detected by AIS information detection equipment. This sign is unique. It can be used to associate and integrate the multi-dimensional information of the target, so as to realize the effect of revitalizing a network with one sign. The sign features are also fixed. The sign information is a steady-state feature that is not easy to change. It stably represents the state of the current detection target. For example, the micro Doppler characteristics of the target can clearly show the time-varying frequency distribution of the structural components. These two kinds of feature data can be calculated from the original perceptual data by feature extraction algorithm. For example, the features such as target color and aspect ratio can be extracted through image enhancement, segmentation and Binarization in image processing. At the same time, the size of the target can be extracted in combination with the ranging function of the camera. For the features such as speed and angular speed of the target, spatio-temporal data processing related technologies can be extracted based on AIS or radar. The final target feature data is stored in the graph database as an entity and becomes the target feature data view [18].

The target behavior data view stores the behavior information of the target, mainly including the historical passing area of the target, the number of tampering or camouflage, etc. these information can be calculated from the original perception data through the behavior analysis algorithm. For example, for the historical passing area, the protection area can be artificially delimited, and then the relevant algorithms for ship entry and exit can be used for statistical analysis. The number of tampering or camouflage can be analyzed and counted through the retrieval and comparison of the target information map. Specifically, when the electromagnetic or AIS senses the target at the same time, the historical AIS data of the target can be obtained by retrieving the target information map through electromagnetic means. At this time, the current AIS information of the target can be compared with the historical AIS information, Judge whether the target has AIS information tampering behavior. The behavior data of the target is updated with the continuous accumulation of perceptual data, which can help us explicitly analyze the target threat. The final target behavior data is stored in the graph database as an entity and becomes the target behavior data view [19].

The target threat criterion data view stores the results of target identification and threat analysis. This information is based on the following three layers of data (original perception data, target feature data and target behavior data) through explicit rule judgment or deep learning model training prediction. For human understandable threat judgment, threat analysis can be carried out according to the set rules in combination with the target behavior data view. For example, when the number of times the target enters the protection area exceeds the set threshold, it is considered that the target is a threat. For targets that cannot be analyzed through rules, it is necessary to use deep learning to train and predict the threat analysis model. At this time, the original perception data, target characteristic data and target behavior data can be used as inputs, the known threat level can be used as output, and the feedback mechanism of deep learning can be used for continuous training to obtain the threat analysis model, When a new target appears, all kinds of perception, characteristics and behavior data of the new target can be used as input to predict its threat level through the model.

2）Target information Atlas

The target information atlas shows the correlation of multi-source heterogeneous data of the same target detected by a variety of different sensing means. For example, when electromagnetic spectrum, radar, AIS detection equipment, photoelectric video and other equipment detect a target at the same time, there will be horizontal, vertical and oblique relationships between the perceived detection data of the equipment. There is a horizontal correlation between the perceptual data of the same target and different devices at the same time and place. There is a longitudinal correlation between the perceptual data detected by the same target and the same device at different times and at the same place. The perceptual data detected by different devices at different times and places of the same target have an oblique relationship. The target information atlas presents the target information network structure of multi-dimensional equipment data of the same target through horizontal, vertical and oblique series and repeated iteration, from point to tree and from tree to network.

3) Real time and historical target scenario playback

The target scenario playback is divided into two functions: behavior event scenario playback and video scenario playback. The behavior event scenario playback is based on the seamless service switching of real-time history to realize the data scenario playback of alarm behavior and regional behavior.

Video scenario playback is based on streaming media service, and the streaming media player is used to playback the video scenario recorded by photoelectric equipment.

In the real-time situation monitoring mode, the target behavior data view presents the historical scenarios such as the behavior of entering and leaving the protection area and alarm events in the history of the target in real time. At this time, you can select the alarm event or regional behavior to be played back, and seamlessly switch services through the real-time and historical dual display mode, One click switch from high-dimensional real-time situation monitoring mode to historical playback service. Behavior event scenario playback is based on the idea of combining real-time and history. It is the correlation between real-time mode and historical mode. The idea of using historical events and behavior scenarios to assist real-time monitoring is to realize high-dimensional, one click real-time situation monitoring scenario playback based on real-time history seamless service switching.

Video scenario playback is based on the back-end streaming media service. In the process of real-time situation monitoring, for the playback requirements of the historical storage monitoring information of the target photoelectric video equipment, the streaming media player is used to playback the current interface of the target historical scenario video. From the perspective of video monitoring, with the idea of combining real-time and history, we can play back the target historical video scene while monitoring the target photoelectric video stream information in real time, so as to realize the real-time situation monitoring of the combination of real-time video monitoring from the perspective of video and historical scene video.

4) Equipment display control and linkage

The perception data of the equipment connected to the situation presentation system needs to be visualized in real time, and the user can issue real-time control commands to the equipment according to the real-time alarm and monitoring information of the current equipment to realize the control of the equipment. The sensors connected in the system can have the ability of linkage, cooperate with the capabilities of various equipment, reduce the intermediate links of the task and improve the efficiency.

Equipment display and control is to dynamically visualize the real-time perceived dynamic data reported by the current equipment, and can also remotely control the equipment in the system browser interface to realize the real-time issuance of control commands.

Through the forwarding function of message middleware, the equipment linkage organically combines the sensors with scattered positions and different structures, so as to complement the advantages of each sensor, jointly complete the accurate detection and evidence collection of targets, and realize the equipment linkage functions such as radar photoelectric linkage and AIS photoelectric linkage. Equipment linkage also simplifies the manual operation process and reduces the complexity of the system.

5) Video surveillance and tracking

By accessing the real-time decoded video stream provided by streaming media service, the system uses multimedia monitoring means and photoelectric video monitoring equipment with fast video return and slightly high power consumption to monitor and track the target in real time. The streaming media player is used to realize high-efficiency real-time video display under the condition of occupying less system resources, and the single target real-time tracking of photoelectric video equipment is realized by combining the target tracking algorithm with the control command of photoelectric equipment.

6) Real time alarm and alarm transition

The real-time alarm function of the situation presentation system provides real-time target alarm service through multi-sensor real-time sensing data and a series of multi-level real-time alarm discrimination explicit rules and abnormal data detection algorithms. Once an alarm event occurs to the target, the target rendering mark will update the rendering color in real time according to the target alarm level, It will flash at different frequencies according to different alarm degrees, so as to intelligently and visually represent the equipment alarm fault and target alarm information.

The alarm transition process of the system is actually a detailed display of the calculation process of the target threat criterion. The alarm level of the target is not static, and is not the static result obtained according to the dangerous behavior and alarm events. It is developmental and dynamic. The alarm level of all targets is normal when the data is just warehoused, that is, there is no threat. In the process of long-term monitoring, the threat continues to increase due to some dangerous behaviors and alarm events. For example, the target enters and exits the monitoring and early warning area as a non cooperative target in a certain period of time, The threat level is raised to a mild warning, and the AIS malicious tampering event occurs in a certain period of time, which further improves the threat level and produces an alarm transition.

The historical data playback mode is to playback the target perception, characteristics and behavior data accumulated by long-term real-time equipment monitoring with regional behavior, alarm events, full information and multi-dimensional time dimension historical data. Historical playback is divided into three functions: historical playback process control, historical playback mode selection and historical playback event alarm. The playback process control function mainly includes buffered batch target data loading and speed control. The system provides four query playback modes of historical playback: panoramic, multi-target, area and event, and will automatically pause and pop up alarm notification when playback to the time node containing key alarm events and important behavior information of the area, Guide the stop of key event information, fast forward frame by frame playback or skip key event information. The following is a detailed description of the historical data playback subfunction:

1) Historical data playback process control

The process control of historical data playback includes buffered batch data loading and speed control. During historical playback, the system will load historical playback buffer frame data in batches at regular intervals. The system will buffer multiple frames of data at one time. Each frame includes the fusion perception data of all monitoring targets at the current playback time, which reduces the system burden, reduces the redundant network flow, and greatly increases the fluency of historical data playback.

The historical playback speed is controlled by the acceleration and deceleration buttons. When the acceleration or deceleration button is clicked, the system will modify the playback magnification. The greater the speed factor, the greater the time difference between the fusion perception data recorded in two frames, and the faster the actual playback speed, so as to realize the control of historical playback speed.

2) Historical data playback mode selection

Historical data playback provides four playback methods according to the needs of query conditions. According to the playback requirements of full target information, overall situation and large-area full environment, the system provides panoramic playback mode, which plays back the full information of all targets in the selected time period frame by frame according to the loss of time dimension. According to the playback requirements of historical perception information in the determined single target and multi-target detailed time period, the system provides the way of target playback, and plays back the historical data in the specific time period of time dimension for the selected special single target or multi-target. For the playback requirements of spatial area division and historical events in the protection area, the system provides area playback mode to playback the historical data in a specific period of time in a specific protection area or any vector area drawing with the mouse. According to the playback requirements of alarm events and abnormal data detection, the system provides event playback mode, and performs event playback in specific time period for historical equipment alarm, target behavior alarm, camouflage alarm and other events.

3) Historical data playback event alarm

When fast forward is played back to the time node containing key alarm events and important regional behavior information, the pop-up alarm notification will be automatically suspended, and you can choose to stop fast forward playing frame by frame or skip events. At this time, the target rendering flag will update the rendering color according to the target alarm degree, and flash at different timing frequencies according to the alarm degree, showing the historical playback alarm events and target alarm information.

The target tracking interpretation service is to display and replay the historical data of the target in the spatial dimension with the spatial big data visualization method. Real time monitoring and historical data playback are based on time, local and fine-grained display, while target tracking interpretation is based on spatial and global coarse-grained display. The sub functions of target tracking interpretation are as follows:

1）Migration and transfer situation

After data sampling, key track frame extraction and historical track query, the system displays the spatial migration and transfer situation of the selected specific single target in a specific period of time, and displays the historical static space-time information of the target migration track. The events, regional behaviors and alarm information in the process of target migration are rendered on the visual interface with high-density and scalable charts.

2）Hot spot flow area

For the area where a single target often appears, the system renders the density of target spatial location data and area access frequency in the form of thermal map through color band, establishes a buffer for each spatial discrete location data point of a single target in a specific period of time through kernel density analysis method, and uses progressive gray band to fill from inside to outside and from shallow to deep, In the area where the buffer intersects, the gray values are superimposed on each other, and the hotter this area is. The superimposed target spatial position gray information is mapped into the color band as an index, so that the relative density and weighted density of target thermal points are displayed from cold color to warm color.

3）Alarm data cell

The system uses grid aggregation graph to show the distribution and statistical characteristics of spatial data of target alarm events and behaviors. Based on the grid aggregation algorithm, the spatial area is divided into nested multi-level, and each grid cell has the statistical information of target alarm events.

Target portrait service is to distinguish the differences of target behaviors, features and events into different types, extract typical features from each type, give descriptions such as ID and statistical elements, form a target prototype, that is, target information labeling, analyze and statistically mine potential value information for these features, and establish a target data cube, Abstract the feature panorama of a target. The target portrait can help the security monitor find the target that really needs attention, analyze, count and mine the potential value information, so as to predict the next action of the target to a certain extent. The target portrait includes the following sub functions:

1）Target information tagging

The system obtains the target feature information through a series of algorithms or rule mining or directly obtains the target feature information according to the behavior data, and labels it. The feature has a certain timeliness or half-life, and the labels obtained at different times need to be weighted. The perceptual characteristic tag of the target includes nationality, length and width, ship type, destination, rotation rate, radial speed, electromagnetic frequency, actual heading, etc. the target behavior attribute tag includes access to the protection area, alarm, haunting area (in the form of longitude and latitude), ship status and event type (regional problems, personnel falling into the water, abnormal speed, excessive steering, continuous approach to the island, abnormal size, abnormal state, abnormal ship name), residence time in the protection area, nearest distance to the island, etc.

2）Target prototype data cube

Target portrait is not only to extract the behavior characteristics of the target and give the target a type or prototype, but also to display the information of the prototype itself, that is, some historical behavior and threat alarm data about this kind of target in the intelligence database we have established, which realizes the establishment of a data cube for these characteristics, analysis, statistics and mining the potential value information of the target prototype To a certain extent, we can predict the next action of this target. Suppose that we have achieved electromagnetic control, a target is labeled with UHF Communication, but it does not trigger any alarm events and does not produce dangerous behavior temporarily. However, most of the historical targets of this kind of high-frequency communication are targets with high threat level, so we can make some changes to the current target To a certain extent.

3.3 system service structure design

The system adopts a service-oriented architecture combining real-time and history. From the perspective of service interaction, the whole system, real-time services and historical services act as service producers and consumers. Specifically, the multi angle data view service and target information map service of real-time monitoring mode are the service consumers of history mining services, and history mining services provide features Behavior and threat analysis data is the producer of services; in the historical data playback service, it is the service consumer of real-time access services, and the real-time access service of the Internet of things is the service data producer.

The services of the system are cohesive. According to the difference between real-time monitoring and historical playback services, the service boundary is determined. The component-based abstraction layer is used to ensure that the relevant business codes are put together. There is a certain boundary between real-time and historical services, which is flexible. If a real-time or historical service component in the system is unavailable, but does not lead to cascade failure , then other components of the system can operate normally, and the service component ensures the existence of the service boundary.

Real time services and historical services are autonomous. Real time historical services communicate through network calls, which strengthens the isolation between services and avoids tight coupling. Both real-time and historical services will expose

API (Application Programming Interface) , services communicate through APIs. Modifying and deploying a service does not affect other services.

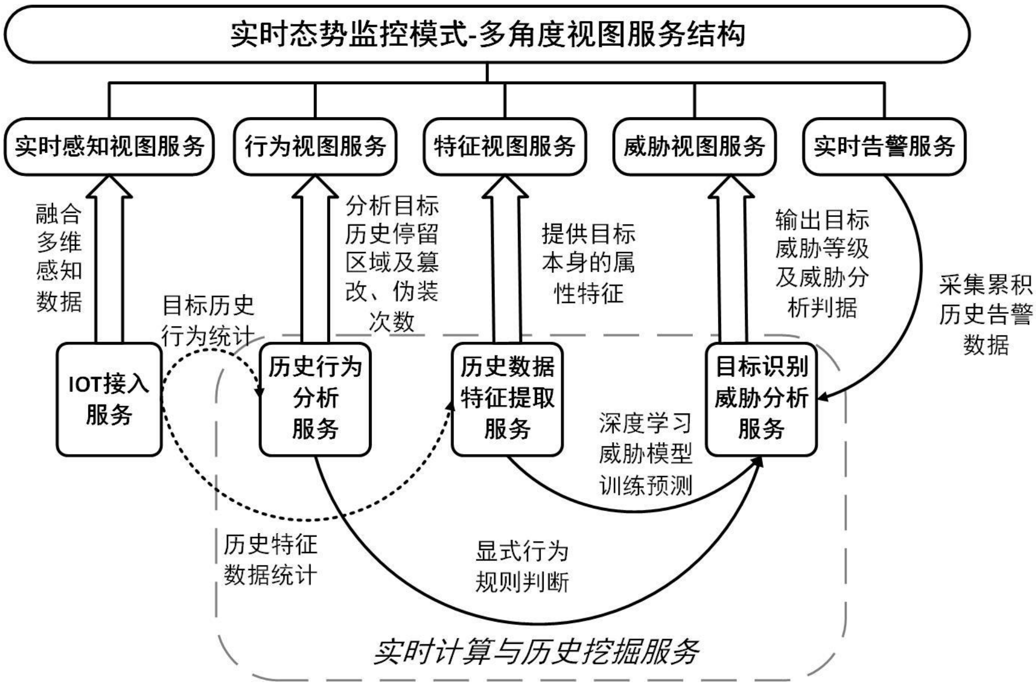


Figure 3-8 multi angle view service structure of real-time monitoring mode

The multi angle view service of real-time situation monitoring mode is composed of perception data view, behavior perception data view, feature perception data view, threat perception data view and real-time alarm service. From the perspective of service interaction, they are consumers of IOT access service and real-time computing and history mining service. IOT access service produces target original perception data The data is consumed by real-time computing and history mining services through feature extraction, explicit rule discrimination, threat model training, etc., and the target behavior, feature and threat data views are produced again. Finally, these secondary production data are consumed by multi angle view services, showing the multi-dimensional information view of the target. The multi angle view service structure of real-time monitoring mode is shown in Figure 3-8 As shown in.

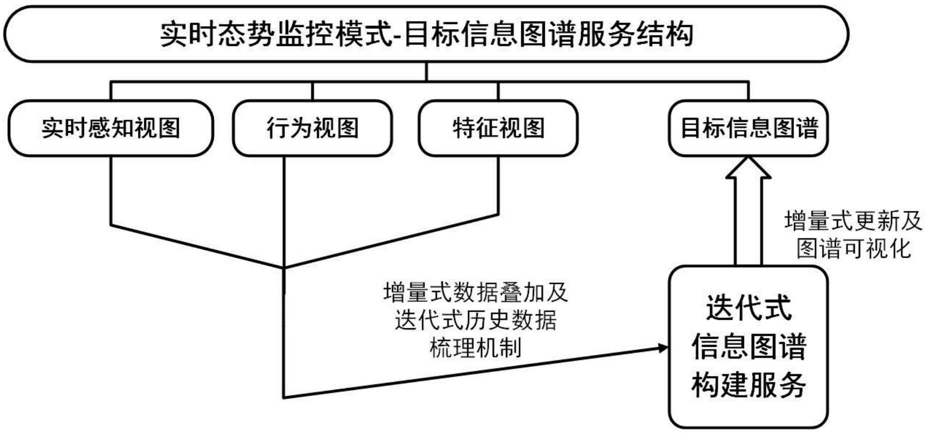


Figure 3-9 target information map service structure of real-time monitoring mode

The real-time situation monitoring mode target information map service target information map shows the horizontal, vertical and oblique correlation of multi-source heterogeneous data of the same target detected by a variety of different sensing means. When all kinds of sensing data accumulate to a certain threshold, it will trigger the incremental data superposition and historical data sorting mechanism and iterative information The atlas construction serves the continuous consumption perception, behavior and feature view data, so as to continuously update the feature and behavior information in the target information atlas, and continuously integrate, delete and update the atlas fragments in each period. The target information atlas combines spatio-temporal data, environmental information and target information to present the same target multi-dimensional equipment data through horizontal, vertical and oblique series, The target information network structure is iterated repeatedly, from point to tree and from tree to network. The target information map service structure of real-time monitoring mode is shown in Figure 3-9.

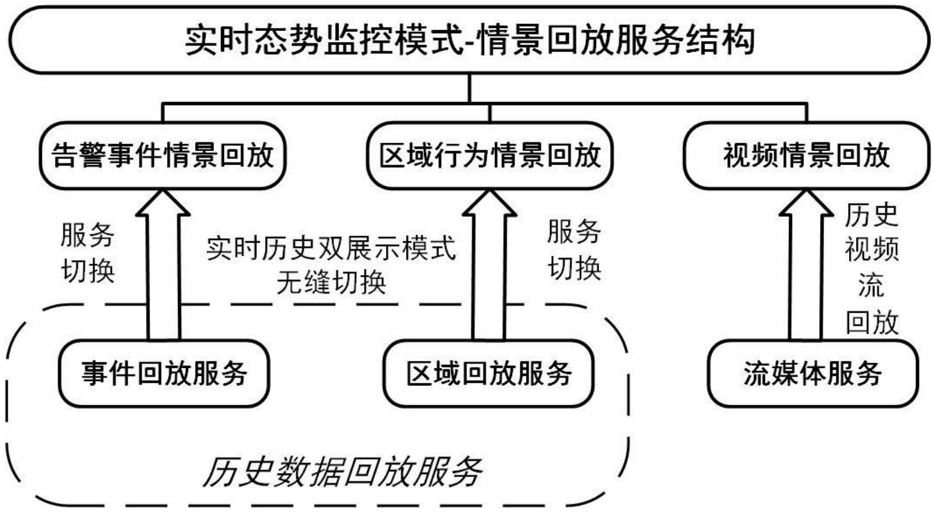


Figure 3-10 scenario playback service structure of real-time monitoring mode

The real-time situation monitoring mode scenario playback service is composed of alarm event scenario playback, regional behavior scenario playback and video scenario playback services. Through seamless service switching between real-time and historical dual display modes, one click switching from high-dimensional real-time situation monitoring mode scenario playback service to historical playback service. Here, the real-time monitoring mode scenario playback event behavior The scene playback service is the service consumer, and the historical data playback service is the service data producer. This one click real-time historical service switching method reflects the association between real-time mode and historical mode, and the idea of service interaction of real-time history combined with historical events and behavior scenarios to assist real-time monitoring. Video scene playback is based on back-end streaming media services from the perspective of video monitoring With the idea of combining real-time and history, it can play back the target historical video scene while monitoring the target photoelectric video stream information in real time, so as to realize real-time video monitoring from the perspective of video and real-time situation monitoring combined with historical scene video. The scenario playback service structure of real-time monitoring mode is shown in figure 3-10.

The equipment service in real-time situation monitoring mode is composed of four services: equipment display and control, equipment linkage, video monitoring and target tracking. The Internet of things access service exposes the application program interface of uplink data message and control command for the equipment service, and the streaming media service exposes the application program interface of video stream access and photoelectric equipment control for the equipment service, so as to finally realize multi transmission The cooperative linkage between sensors and devices integrates various data to complete the equipment detection and monitoring of the target. The equipment service structure of real-time monitoring mode is shown in Figure 3-11.

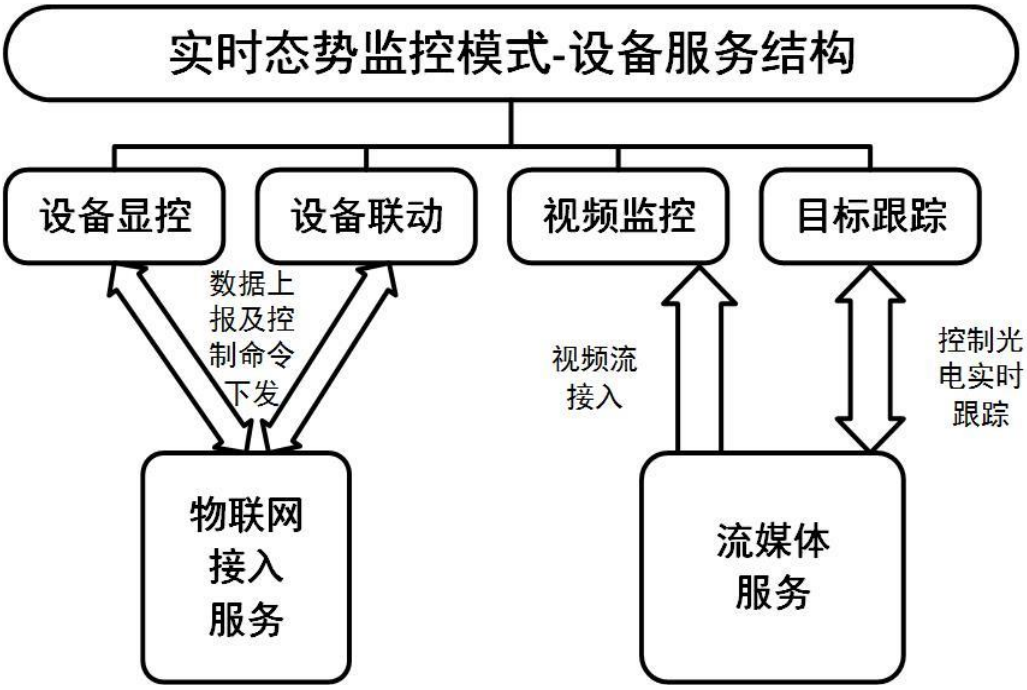


Figure 3-11 equipment service structure in real-time monitoring mode

The historical data playback service includes four service modes: event playback, area playback, target playback and panoramic playback. The historical data playback service consumes the data of the historical data storage service through buffered batch data loading. The historical playback service will regularly load the historical playback buffer frame data in batch, that is, one-time buffering includes the current playback of all monitoring targets The integration of batch frame data of perceptual data at playback time increases the fluency of historical data playback, reduces redundant network traffic and reduces the burden of the system.

The raw materials of the historical data playback service are provided by the historical data storage service. The data is stored in the real-time data storage service through the real-time access service of the Internet of things, and then the data association and integration of the target dimension and the regional dimension are realized through the real-time calculation and historical mining service. The characteristic behavior analysis and threat analysis model training are carried out to associate, integrate and analyze the data . the mining results are stored in the historical data storage service to provide buffered batch spatio-temporal historical data loading function for the historical data playback service. The structure of the historical playback service is shown in Figure 3-12.

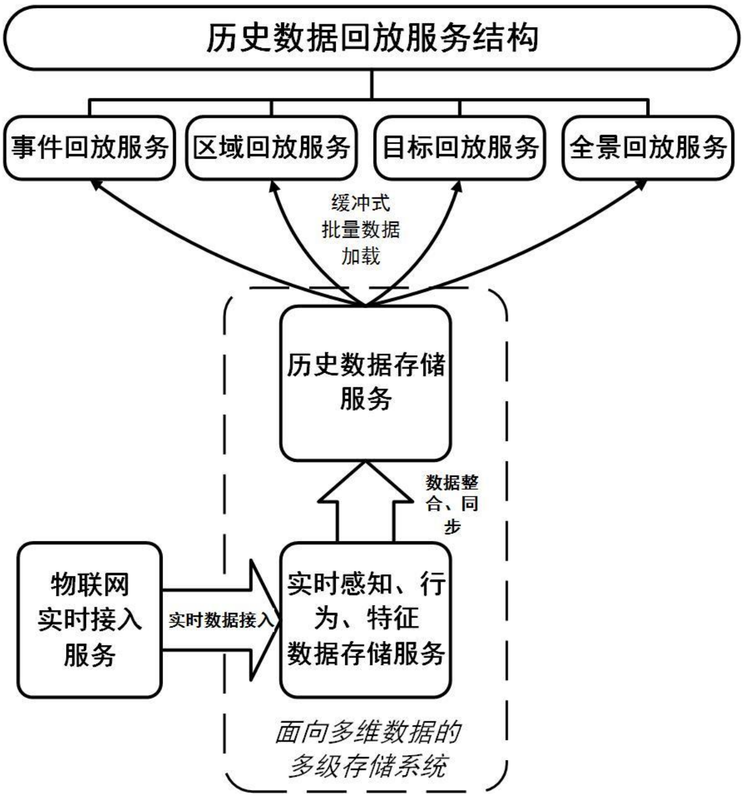


Figure 3-12 history playback service structure

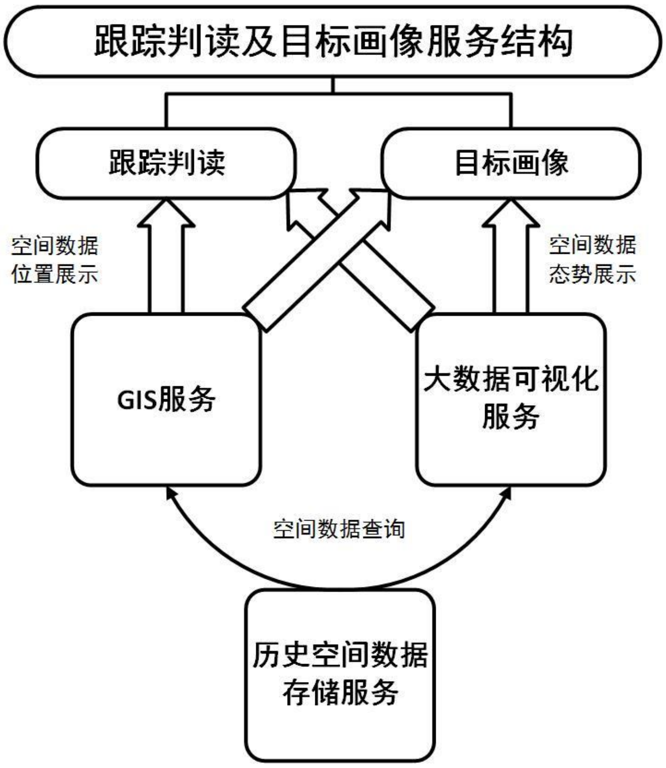


Figure 3-13 tracking interpretation and target portrait service structure

Tracking and interpretation service mark tracking and interpretation service is to visualize the historical data of the target in the spatial dimension with the spatial big data visualization service. The tracking and interpretation of the target has the characteristics of spatial, global and coarse granularity. It is the service data consumer of the historical spatial data storage service, reporting the spatial historical track, single target area access frequency and regional target The police events are displayed on the map by means of migration transfer map, thermal map and grid aggregation map respectively. The tracking interpretation and target portrait service structure is shown in Figure 3-13.

3.4 system component structure design

The situation presentation system uses a component-based architecture to split and reorganize multiple functional modules, so as to separate component boundaries and responsibilities. The situation presentation system makes requirements scene and visual expression component, so as to realize component isolation, component reuse and component autonomy, so as to split the complex system into micro component elements for deployment and maintenance. Components have a variety of attributes, and their status reflects internal characteristics Componentization is standard, and the component systems in the system should meet unified design standards to form a unified suite library. Componentization is composite, and targeted business services can be provided between components through certain arrangement and composition. This service depends on the communication, assembly and nesting between different components. The functions of each component are independent , it does not depend on other components, and its logic is independent of other components. Componentization increases the reusability and flexibility of the system, improves the system design, and improves the development efficiency.

The system adopts the top-down nested component design mode to represent the situation presentation system of the whole real-time history dual display mode as an overall system component. After the overall system components are divided according to the regional characteristics, the internal components of the overall system are composed of control area components and view area components. The component area division is shown in Figure 3-14.

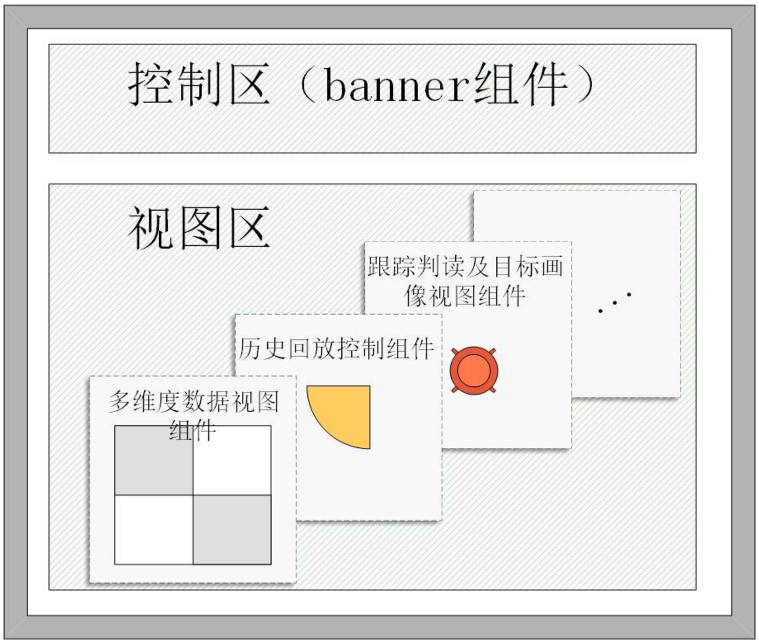


Figure 3-14 component area division

The control area component is mainly responsible for the core control and interaction functions of the system service, and is responsible for the service startup, service termination and service switching functions of real-time situation monitoring mode, historical data playback mode, tracking interpretation and target portrait. Due to the component-based design architecture, each service can operate independently and will not affect each other. For example, the system can perform real-time monitoring At the same time of target situation monitoring, the historical behavior and historical events of the current target are replayed. The two services are isolated and will not affect each other. Therefore, the control area components have the characteristics of high cohesion and low coupling.

The view area component is responsible for the visualization of all services of the system, such as the presentation of target marker nodes in the real-time situation monitoring mode, the flashing and rendering of target marker alarms, the drawing and rendering of thermal map, migration map, cellular map, multi-dimensional data view and target information map in the tracking and interpretation service, etc. in addition, the view area component can be visualized Interaction, such as speed control in historical data playback mode, alarm event frame by frame data playback interaction, etc.

The overall detailed component architecture of the system is shown in Figure 3-15.

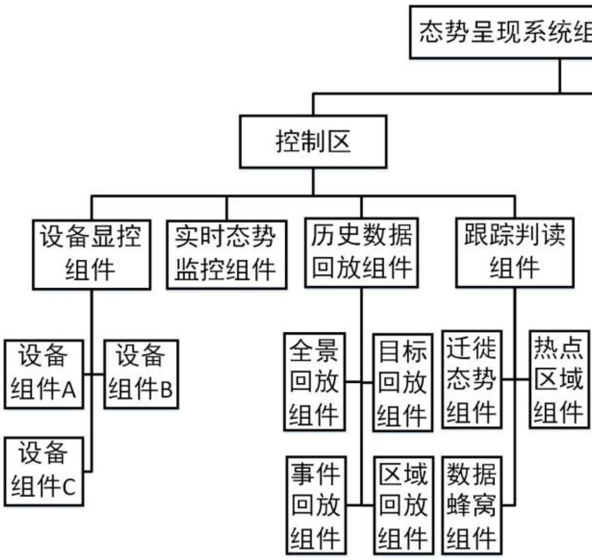


Figure 3-15 system component architecture

The component architecture of the situation presentation system is divided into two area components, the control area component and the view area component. The control area component is composed of four components: equipment display and control component, real-time situation monitoring component, historical data playback component and tracking interpretation component. The view area component is composed of multi angle view component, historical playback process control component and historical playback pop-up view component It is composed of target video tracking component, GIS view component, tracking interpretation and target portrait view component.

The equipment display and control components in the control area components include the detection equipment components in all systems, which are responsible for the start and termination functions of each equipment service. The real-time situation monitoring component uses the mouse event to control the system to enter the real-time situation monitoring mode. After the real-time monitoring mode service is started, it notifies the multi angle data components in the view area to start through the independent component communication mechanism Multi dimensional data view service. The historical data playback component is composed of panoramic playback component, target playback component, event playback component and area playback component. Each component represents a startup mode of historical data playback service. The historical playback service is started according to a specific mode, including batch data index preloading, view area component communication and view area component Rendering and other processes. After the historical playback service is started, notify the historical playback process component and the historical playback pop-up view component through the signal broadcaster for pre rendering, and start the batch data buffer visualization process of the historical playback service. The tracking interpretation component controls the start and termination of the migration situation, hot areas and data cells in the tracking interpretation service. Through mouse events After starting the tracking interpretation service, notify the GIS view components in the view area to visually render the migration map, thermal map and grid aggregation map through the component-based communication mechanism.

The multi angle data view component in the view area component is composed of target information map component, target characteristic data view component, target behavior event data view component and target threat analysis component. It mainly displays the target characteristic behavior, threat analysis and perceived data of the multi angle view of a specific target selected by mouse events, and can perform one click scenario playback To realize seamless switching of real-time historical services. The historical playback process control component mainly provides buffered batch data loading visualization, playback process and speed control services. The historical playback pop-up view component provides historical data playback event alarm service. When fast forward playback to the time node containing key alarm events and important regional behavior information, the pop-up alarm will be automatically suspended Notice that at this time, the target rendering mark will update the rendering color according to the target alarm degree, and flash at different timing frequencies according to the alarm degree, showing the historical playback alarm events and target alarm information. The tracking interpretation and target portrait view component mainly carries out the corresponding view rendering tasks, and the GIS map component is responsible for big data visualization and tile map rendering Dyeing service.

3.5 system data flow design

Uplink data flow is the process that the original perceived data is produced from the Internet of things equipment, and finally realizes data visualization through IOT access service, message middleware, relational database, real-time computing and history mining service, column and graph database, component rendering and state transfer of model, controller and view layer of situation presentation system. System uplink data flow chart As shown in Figure 3-16.

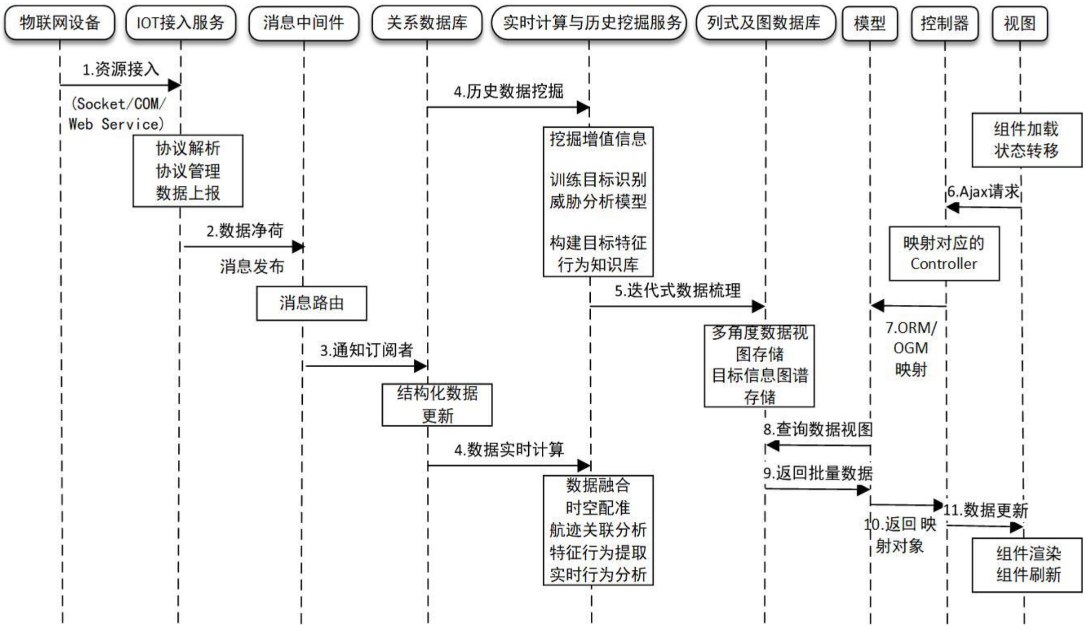


Figure 3-16 system uplink data flow chart

1) Multi source heterogeneous IOT sensor equipment resources connect the original data message of IOT sensor to IOT access service through socket, com or web service.

2) The Internet of things access service produces the original perceived information from the original equipment, performs protocol analysis, protocol management, data payload extraction, message distribution and other processes, and publishes the data message to the message middleware with a certain topic.

3) After collecting the corresponding message tree published to the message space, the message middleware caches the message in the message queue. The cached message in the message queue is published to the relational database subscribed to the message through message routing, and the relational database updates the structured data in real time.

4) The real-time computing part of the real-time computing and history mining service finds the correlation between multi-source heterogeneous data of the same target detected by a variety of different sensing means after space-time registration, trajectory correlation analysis, feature behavior extraction, real-time behavior analysis

and data fusion of the real-time original perception data, Multiple means of the same goal and perceptual data of different dimensions are associated to the same goal. In the history mining part, the long-term motion trajectory and historical fragmented data of the target are parallelized for off-line mining and analysis. The attribute feature information and target behavior information of the target itself are obtained through the feature extraction and behavior analysis algorithm, and the target identification threat analysis model is trained to mine the semantic value-added information of the target and build the target behavior knowledge base.

5) After repeated iteration, incremental calculation and data accumulation, the target behavior knowledge base formed by real-time computing and history mining services forms a target information map containing target perception, characteristics, behavior and threat data views, and stores the multi angle view and target information map in the column and graph database respectively.

6) After the situation presentation system component is loaded and the component state is transferred, AJAX asynchronous data communication is initiated to request batch data view.

7) After data preloading and other calculations, the controller uses ORM / OGM mapping method to obtain batch data objects.

8) In graph database and column database, use database statements to query the node and relationship information in multi-dimensional data view and target information atlas.

9) Batch data returned from graph database and column database are captured by situation system model layer.

10) Returns batch view data mapped to normal Java objects from the model layer.

11) POJO objects are parsed into JSON format by the controller, and self adapted view component updates and view component rendering are performed.

The downlink data flow starts from the user interface control, passes through the view layer, controller, message middleware and IOT access service, and finally sends the control command to the Internet of things equipment to realize equipment display and control and linkage, target tracking and equipment alarm. The system downlink data flow chart is shown in Figure 3-17.

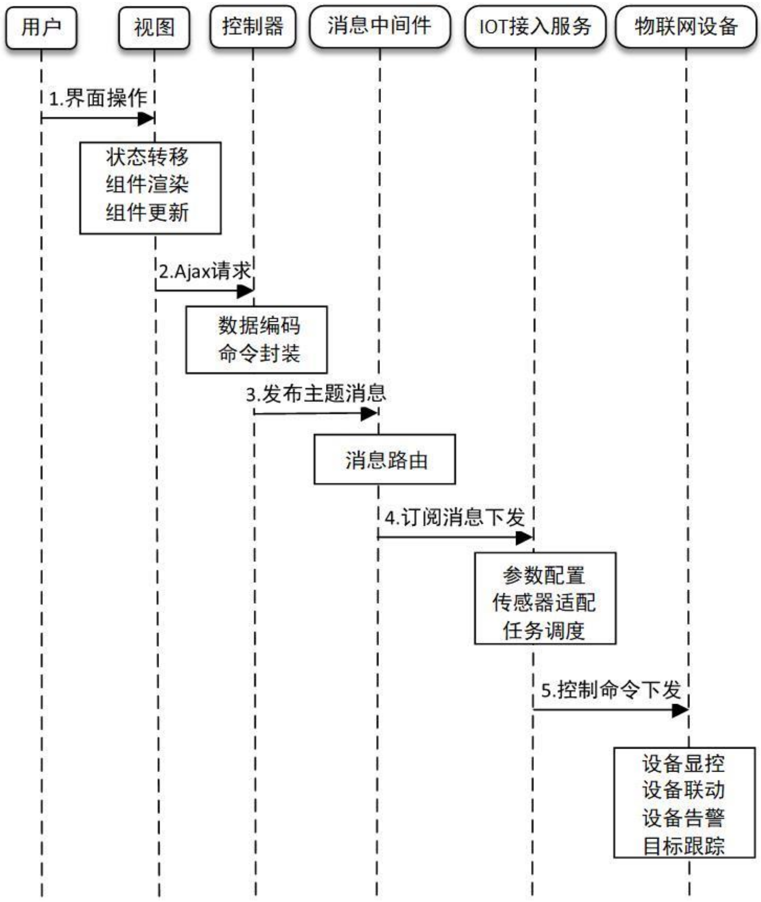


Figure 3-17 system downlink data flow chart

1) By operating mouse events, users can make view components perform state transition, component rendering and component update.

2) After state transfer, component rendering and component update, the view layer uses Ajax to initiate asynchronous communication, and transmits the control command message to the controller through the asynchronous communication mechanism.

3) The controller encodes the control command and encapsulates the command according to the agreed protocol. Publish the control command message to the message middleware according to the specific topic

4) After receiving the message, the message middleware publishes the message to the buffer queue, and then notifies the IOT access service subscribed to the topic.

5) After protocol stack parameter configuration, sensor adaptation and task scheduling, the Internet of things access service sends the control command to the corresponding equipment to realize equipment display, control and linkage, target tracking and real-time alarm.

3.6 overall system process design

The multi view situation presentation system combining real-time and history is divided into three types of process operations: real-time situation monitoring process operation, historical data playback process operation, tracking interpretation and target portrait process operation.

The real-time situation monitoring process is shown in Figure 3-18.

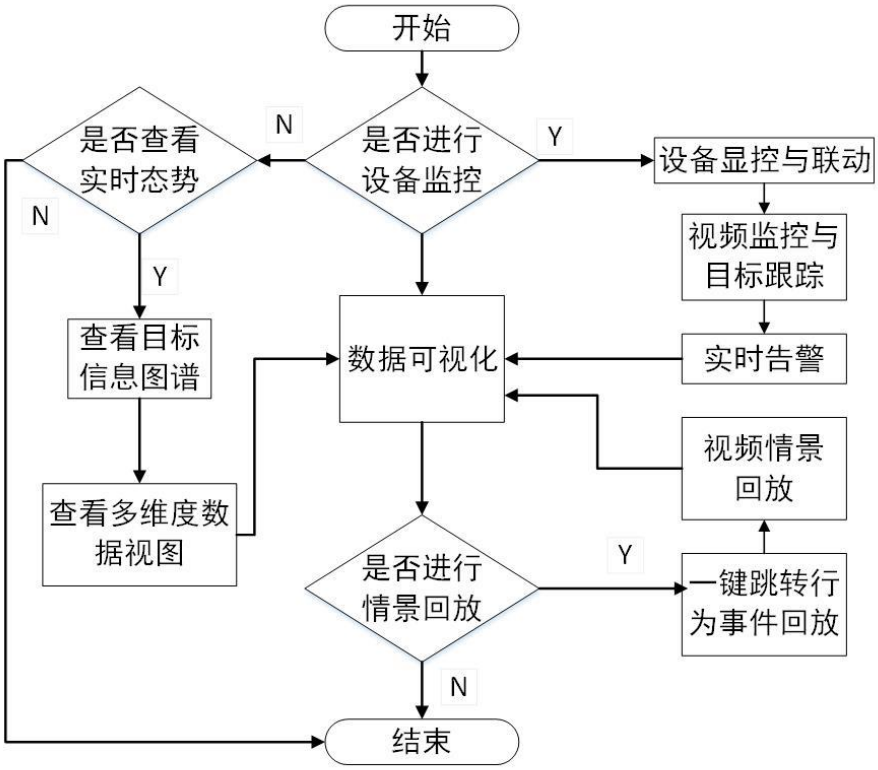


Figure 3-18 system real-time situation monitoring flow chart

After starting the real-time situation monitoring mode through the mouse event, the user selects whether to carry out the equipment display and control. If the equipment display and control is carried out, select a specific equipment for the equipment display and control and linkage function, and then call the photoelectric video monitoring and target tracking function through the equipment linkage, so as to visualize the static, dynamic and real-time alarm data of the target. If the equipment display and control is not carried out, the user needs to choose whether to turn on the real-time situation monitoring mode. After starting the real-time situation monitoring, first view the target information map, then view the multi-dimensional data view, and finally visualize the target multi view data. After viewing the target behavior event data view, the user needs to choose whether to play back the scene, First, select the specific events and behaviors that need scenario playback, then click one button to jump to switch the real-time history service, open the scenario playback control interface, select video scenario playback, and finally visualize the data.

The system historical data playback flow chart is shown in Figure 3-19.

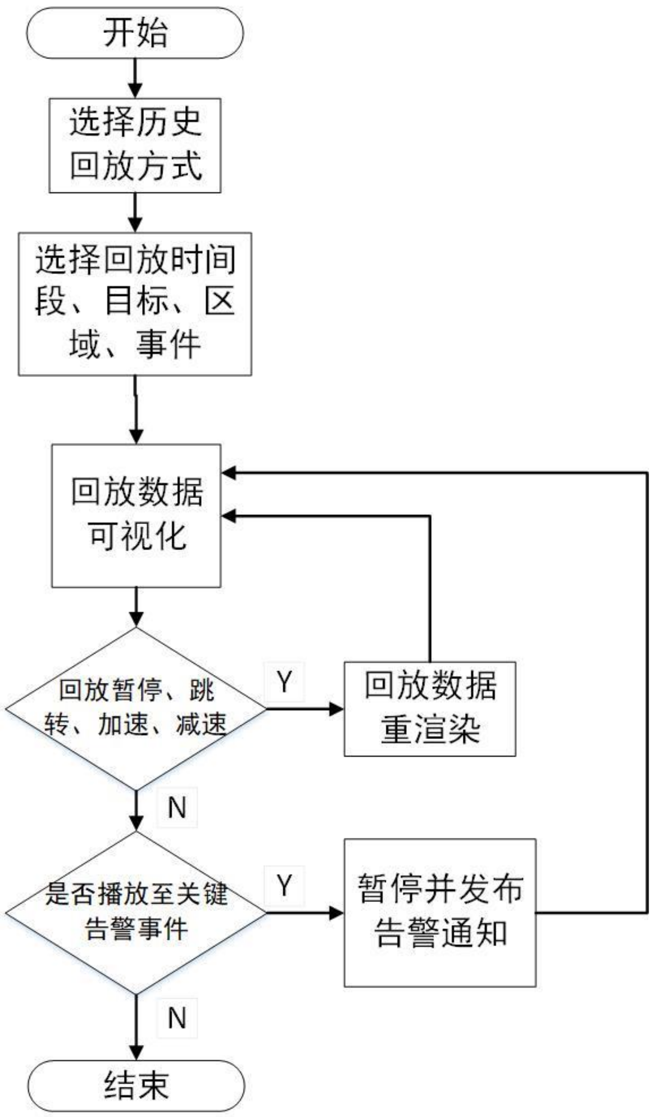


Figure 3-19 system historical data playback flow chart

After the system starts the historical data playback mode, first select one of the historical data playback modes of panorama, target, area and event according to the specific historical playback requirements, then select the playback time period, target, area and event according to the specific playback mode, and then open the historical playback control interface for playback data visualization, In the process of playback, if you drag the progress bar through the mouse event or click the pause, accelerate and decelerate buttons to control the playback process, the playback data will be re rendered at the corresponding control time point. If you playback to the time node containing key alarm events and important regional behavior information, the alarm notification will be automatically suspended and pop up, At this time, the target rendering flag will update the rendering color according to the target alarm degree, and flash at different timing frequencies according to the alarm degree, showing the historical playback alarm events and target alarm information.

The flow chart of system tracking interpretation and target portrait is shown in Figure 3-20.

First, select whether to carry out tracking and interpretation service. If target tracking and interpretation is carried out, you need to select a specific target and a specific time period. The system samples the spatial data of the target in the time period, and then selects to display the target migration situation, target thermal area and target data cell in turn. For target portrait, you need to use mouse events to select a specific target, and then view the target feature distribution map and the visualization effect of target data prototype cube.

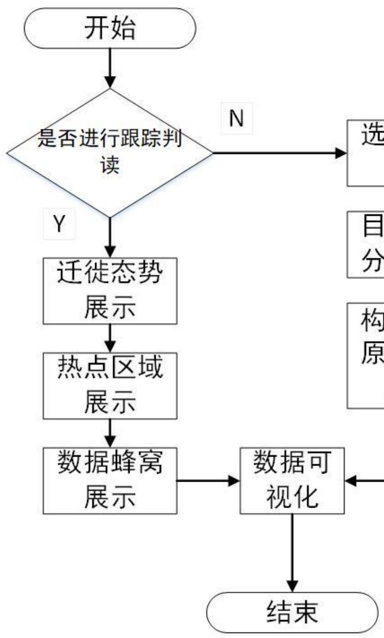


Figure 3-20 flow chart of system tracking interpretation and target portrait

3.7 summary of this chapter

This chapter describes in detail the overall design scheme of multi view situation system combining real-time and history. Firstly, this paper analyzes the overall architecture of the situation presentation system, summarizes the system architecture, then introduces the multi-dimensional multi-level storage system, and then summarizes the interface design and component communication mechanism. Then, the functional structure of the system is designed, and the whole system is divided from the perspective of function. Then it expounds the service structure of the system, and expounds the design idea of the combination of real-time and history from the perspective of service interaction. Then it designs the whole system using the top-down component architecture, explains the component structure and the specific functions of each component, then explains the upstream and downstream data flow of the system, and finally summarizes the overall process of the system.

The fourth chapter is the spatio-temporal paradigm design and component implementation of situation presentation system

In Section 3.2, this paper introduces the functional structure of the situation presentation system. The situation system is divided according to functional modules, as shown in Figure 3-7. In section 3.7, this system describes that the visual interface is realized by component architecture, and the component architecture of the system is shown in Figure 3-15. The system uses time paradigm to design real-time situation monitoring mode and historical data playback mode, and uses space paradigm to design target tracking interpretation and target portrait service. Next, the design method and component implementation scheme of each function of the system will be introduced one by one according to the system function structure and component structure in combination with the system space-time paradigm design scheme and component implementation method.

4.1 time paradigm design and component implementation of situation presentation system

According to the design scheme of time paradigm, the situation presentation system is divided into real-time situation monitoring mode and historical data playback mode. Both real-time situation monitoring and historical data playback are based on the time dimension. With the passage of time, the real-time or historical comprehensive situation is displayed by the method of multi-dimensional data view. The situation presentation based on time paradigm emphasizes localization and detail. For each subdivided time segment, it can achieve omni-directional, no dead angle and fine-grained display. Realize rapid and accurate cognition of the comprehensive situation from the perspective of time.

4.1.1 design and component implementation of seamless switching dual display mode

The dual display mode combining real-time and history adopts the component architecture, and the components have cohesion. The component abstraction layer is used to ensure that the relevant business codes are put together. There is a definite boundary between real-time and historical services, which has a certain elasticity. If a real-time or historical service component in the system is unavailable, but does not lead to cascade failure, other components of the system can also operate normally, and the service component ensures the existence of the service boundary.

The dual display modes are isolated. The real-time monitoring mode and the historical playback mode have the characteristics of low coupling. The two modes will not affect each other. They can not only display the situation information of the two modes respectively, but also play back the historical behavior and historical events of the current target while monitoring the real-time target situation.

The dual display mode service activation area is set in the system control area component, and the functions of starting, switching and terminating the dual display mode are realized through the drop-down menu component and mouse events. The structure of the control component to realize the dual display mode is shown in Figure 4-1.

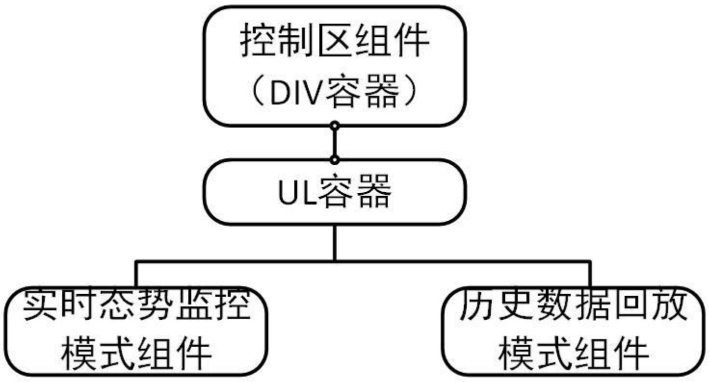


Figure 4-1 structure diagram of dual display mode components for seamless switching

The control area component is mainly responsible for the core control and interaction functions of system services, and is responsible for the service startup, service termination and service switching functions of real-time situation monitoring mode and historical data playback mode. The control area component is actually a div container. The child elements in div container are arranged horizontally by setting the float assignment of CSS attribute. When the layout mode of the element is set to the float value, the element will automatically float left or right according to the size of the container. If the size of the container is large, the element will continue to float to the next row until the size of the container in the row has enough space.

The drop-down function of the control area component can be activated by mouse events. The drop-down pop-up component vertical collection menu function is realized through the pseudo class attribute of CSS: hover. After the element in div container generates a mouse over state activation event, the element generates a state transition. The transition function activates the: hover pseudo class attribute of the element, and the vertical component collection menu will pop up under the element in the mouse pointer area. When the mouse stops hovering and leaves the element, the element will no longer have the pseudo class attribute, that is, the hover pseudo class attribute will be cancelled, and the drop-down vertical component collection menu will disappear.

The control area component itself does not have the function of data visualization. It is a container. The internal components of the container are responsible for the specific functions of real-time situation monitoring mode and historical data playback mode, service startup, service switching and service termination, and use the component signal broadcaster to initiate communication to other independent components in the view area to realize information interaction. The process of real-time history dual display mode switching of control area components is shown in Figure 4-2.

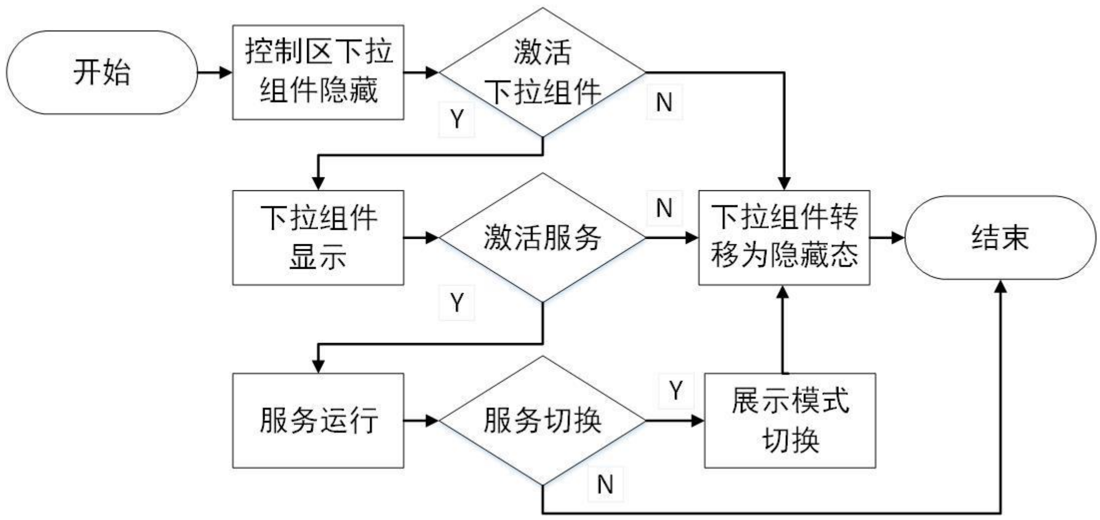


Figure 4-2 dual display mode switching flow chart

The drop-down component menu in the control area is hidden by default. When the mouse generates the movement activation time, the component state changes, and the state transfer function activates its: hover pseudo class attribute to render the vertical drop-down component menu. The user uses the drop-down component menu to activate the service and start the real-time situation monitoring mode or historical playback mode, When the service starts running, the user switches the service and continues to activate or terminate the service in the drop-down component menu, which can realize the seamless and low coupling service switching of real-time history dual display mode. The two modes will not affect each other, and the historical behavior and historical events of the current target can be played back while monitoring the real-time target situation.

4.1.2 design and component implementation of real-time situation monitoring mode

4.1.2.1 implementation of multi-dimensional data view component

The multi-dimensional data view component is a tree nested component set. It can show a variety of original target centric perceptual data that can be stored in a distributed column oriented database. According to the degree of data processing, the multi-dimensional data view component has the function of displaying multi views such as original perception data view, target feature data view, target behavior data view, target identification and threat level data view. The multi-dimensional data view component is built by using the react framework and following the ECMA (European Computer Manufacturers Association) 6.0 standard. The outermost layer of the component is the div container, which is loaded with a card component built using ant design UI design language. The contents of the card component are nested with tabs components, which contain four data view sub components. Therefore, the multi-dimensional data view component is a tree component with five levels of inheritance and nesting. The component structure of multi-dimensional data view is shown in Figure 4-3.

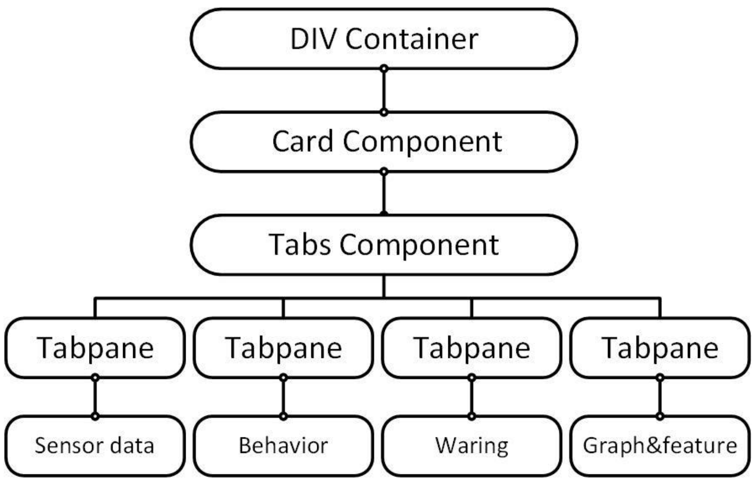


Figure 4-3 component structure of multi-dimensional data view

The card component in the multi-dimensional data view is a basic card container. It carries the text, list, graph and paragraph forms of presenting perception, behavior events, characteristics and threat data, and constructs an overview view skeleton. The tabs component is used inside the card component to provide a flat large content storage and display area for perception, feature, behavior and threat views, so as to ensure the cleanliness and panel of the view. As a card type tab, tabs component provides a function that can be closed at the top of the container, and the closing function can be rewritten to realize signal interaction with other components. It also has the function of standard line view switching, which can enable smooth, smooth and line switching of perception, behavior events, features and threats. As a content panel component, tabpane accommodates specific multi data view sub components.

The multi-dimensional data view component uses the activekey as the key value of the currently activated tab component, which stores the status of the currently activated tab component. If the currently activated view component changes, the user switches the components, such as changing from the original perception view component rendering activation status to the behavior event data view component rendering activation status, At this time, the multi-dimensional data view component re renders the active view by rewriting the componentdidupdate method and componentwillupdat method in the react framework in combination with the callback function onchange of the tabs component. For example, after the component linearly switches from the threat criterion data view to the original perceived data view through the dynamic drawing of the switching panel, The latest original perceived data of the target will be retrieved to ensure the real-time performance of the data displayed on the component panel of the multi-dimensional data view. In the next few sections of this chapter, we will introduce the implementation of the internal sub view components of each multi-dimensional data view.

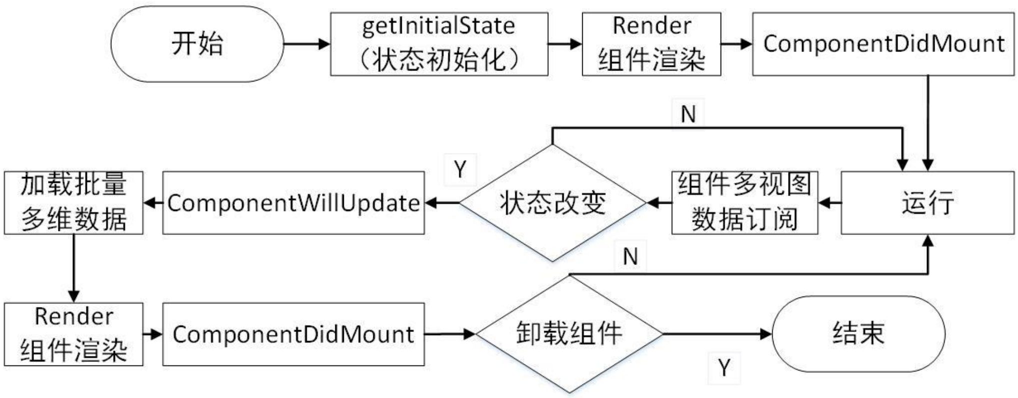


Figure 4-4 multi dimension data view component life cycle

The perception, feature, behavior and event data flow in the multi-dimensional data view component follows the system data flow mode shown in Figure 3-16. On the whole, it enters the multi-dimensional view component step by step from the production source of data, Internet of things equipment through access, message routing, data association, data mining, object mapping, front and rear communication and other processes.

From the perspective of component parts, the multi-dimensional perception, feature, behavior, event and threat data subscribe to the data requested periodically by the timer in real time through the component independent component communication mechanism shown in Figure 3-5. When the user generates a mouse event and clicks the target mark of periodic real-time rendering controlled by the timer, At this time, the target tag will send a signal to the signal broadcaster, communicate with the server at the same time, query the multi-dimensional information of the target stored in the database, and the multi-dimensional data view obtains the multi-dimensional data flow of the target information of the current mouse event by subscribing to the signal of the multi-dimensional data subject of the signal broadcaster, Through the adaptive rendering syntax of JSX language in the react framework, the data is distributed adaptively according to the different internal sub view components, that is, the adaptive matching of perception data flows to the original perception data view component, the adaptive matching of behavior event data flows to the event data view, etc.

After the data flows to the sub data view, the state of the sub data view component changes. The componentwillupdate method will be run according to the life cycle of the view component. Firstly, the batch multi-dimensional data will flow into the virtual DOM component adaptively. After calculating the fastest rendering method with the highest efficiency and less steps through the react virtual DOM component rendering update algorithm, The render function is used to render the real DOM, and the componentdidmount method is run to update the component view finally. In this way, a series of processes of multi-dimensional data from source to component, from component state change to component loading view, and finally to component rendering and updating are completed. The overall life cycle of multi-dimensional data view components is shown in Figure 4-4.

The static data loading of the view component starts from clicking the target node in the mouse event. At this time, the target tag sending will send a signal to the signal broadcaster and communicate with the server to query the multi-dimensional information of the target stored in the database. The component can directly obtain the target longitude and latitude, azimuth, radial distance, electromagnetic frequency band MMSI number and other original perception information are used to render the original perception data view. At the same time, the target tag under the control of the timer will send signals to the multi-dimensional data view component through the Ajax callback function to obtain complete multi-dimensional data. The static data loading algorithm in the multi-dimensional data view is shown in Figure 4-5.

Algorithm 1 Heterogeneous Dimension Static Data Loading

Input:

The Identification of current selected target I.

The State of current selected target state change S.

Output:

The matrix Sensor data D.

The matrix Feature data F.

The matrix Behavior and Event data B.

The matrix Warning data W.

The matrix Graph data G.

```
Create a heterogeneous dimension Static Data heap H;
while (S == True) do
  Subscribe sensor data messagge M := getSubscribeSensorMessage(H);
  D := getSensorDataMatrix(H, M);
  Create a connection C to database;
  if (getMulti − dimensionDataElement(H, C)! = null) then
    F := getFeatureDataMatrix(H, C);
    B := getBehaviorDataMatrix(H, C);
    W := getWarningDataMatrix(H, C);
    G := getGraphDataMatrix(H, C);
    Return D F B W G;
  else
    Return D;
  end if
end while
```

Figure 4-5 multi dimension data view static data loading pseudo code

4.1.2.2 realization of target information map

The construction process of target information map needs many iterations, and incremental data superposition and historical data sorting mechanism are needed, that is, the map segments in each period are integrated. With the continuous accumulation of all kinds of perceptual data, the perceptual data indexes in the target information map are updated incrementally by using the above data association algorithm. The perceptual data indexes on new associations need to be added in the target information map, while the wrong associations caused by incomplete information in the early stage need to be deleted in the target information map, The aware data index and its association need to be deleted. When all kinds of perceptual data accumulate to a certain threshold, it will trigger the feature extraction and behavior analysis algorithm in offline computing, so as to continuously update the feature and behavior information in the target information map. The design and evolution mode of target information atlas is shown in Figure 4-6.

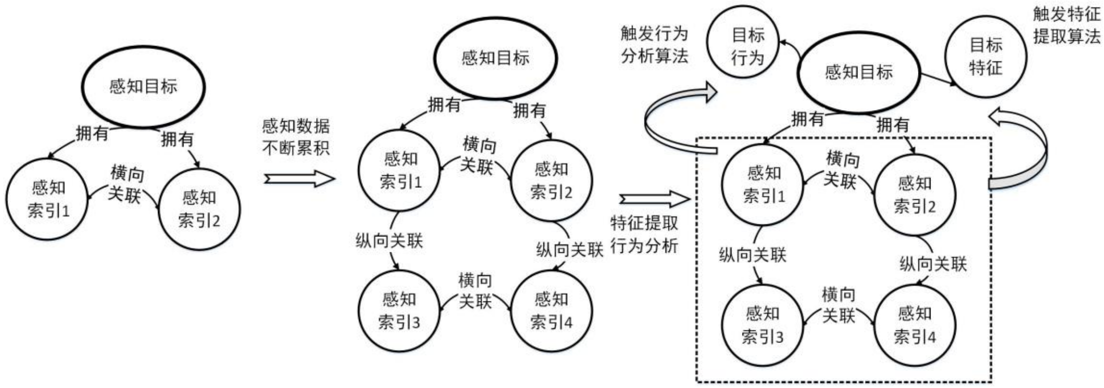


Figure 4-6 evolution model of target information map

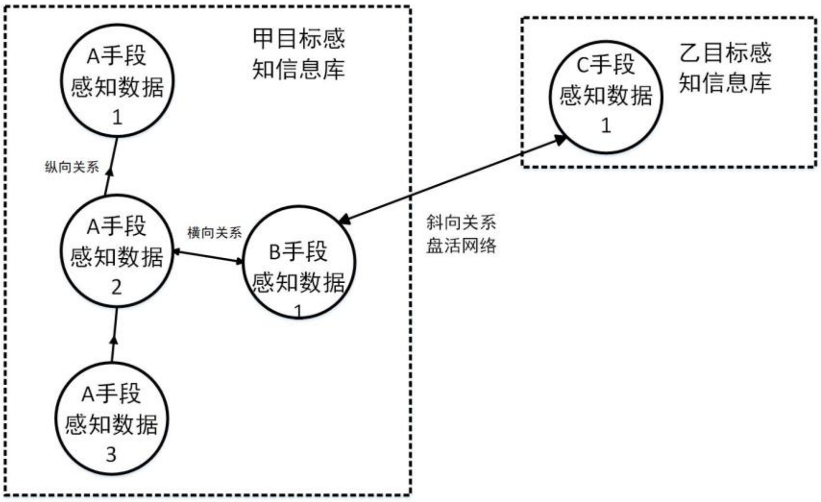


Figure 4-7 multi association relationship and network activation of target information map

The target information atlas shows the correlation between multi-source heterogeneous data of the same detection target. For example, when electromagnetic spectrum, radar, AIS detection equipment and other equipment detect a target at the same time, there will be a horizontal, vertical and oblique relationship between the perceived detection data of the equipment. There is a horizontal correlation between the perceptual data of the same target and different devices at the same time and place. There is a longitudinal correlation between the perceptual data detected by the same target and the same device at different times and at the same place. The perceptual data detected by different devices at different times and places of the same target have an oblique relationship. The target information atlas presents the target information network structure of multi-dimensional equipment data of the same target through horizontal, vertical and oblique series and repeated iteration, from point to tree and from tree to network.

The multi association relationship and network activation of the target information map are shown in Figure 4-7. It is found that the oblique relationship between different condensing subgroups in the overall large map of the target information map is the key to revitalize the structure of the whole target information network. For example, for a target, there is intelligence information in the system, including AIS, radar and other sensing devices. For target B found in the system, we can only find the perception of target B from the perception level of C means. If the data information perceived by means C of target B and the data information perceived by means B of target a are proved to be related and belong to the information that detects the same target, then we find the oblique relationship between target a and target B in the target information map, and we can associate target a with target B, which proves that target B is target plus. The two condensing subgroups are fused into a large group to revitalize the network. The oblique relationship between condensing subgroups helps to quickly and accurately recognize the target, and makes the multi-target information with too much miscellaneous information more intuitive and clear [20,21,22].

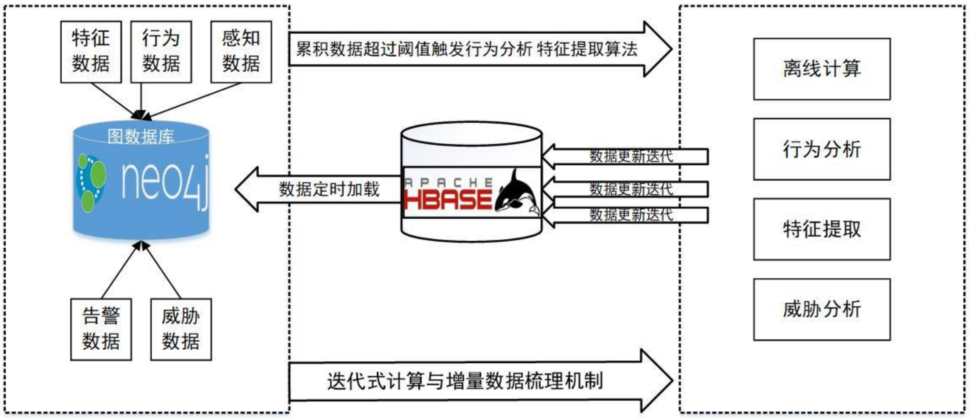


Figure 4-8 realization of target information atlas data storage

The realization of target information atlas data storage is shown in Figure 4-8. We store the target multi-dimensional information after off-line calculation, behavior analysis, feature extraction and threat analysis into the HBase column database. The graph database neo4j stores the target information map. Neo4j mainly stores the association relationship data between the target node and the target. With the continuous expansion of target information map, more and more target perception, feature, behavior data and target data with clear threat level label will be generated. When the target perception, feature and row data accumulate to a certain threshold, it will trigger the data mining algorithm in offline calculation, so as to update the HBase database and then update the whole target information map. For example, if the target is in the blacklist, on the one hand, the target information map will give an alarm, on the other hand, it will persist the perception, characteristics, behavior data and threat level of the target, so as to provide further target identification and threat model training for off-line calculation. When target identification and threat analysis cannot be clearly carried out, the trained threat analysis model can be used to predict the target threat level with target perception, characteristics and behavior data as input.

The target node of neo4j stores the row key index of the detailed multi-dimensional features, behaviors, events, threats and perceived data in HBase to facilitate the preloading of data query. When querying the specific multi-dimensional data view, first obtain the row key index from the node in neo4j, and then obtain the specific detailed data information from HBase. So as to realize the storage of target information map combining offline and real-time. The target information table is shown in table 4-1, and the original perceptual data storage in HBase is shown in Table 4-2.

Table 4-1 target information

<table>
<tr><td colspan="3">Table: 目标信息表</td></tr>
<tr><td>Row Key：</td><td colspan="2">MB ID</td></tr>
<tr><td>Family</td><td colspan="2">MB</td></tr>
<tr><td rowspan="3">Columns：</td><td>T1：</td><td rowspan="3">Value：不同的手段（AIS/Radar/光电），手段的 ID</td></tr>
<tr><td>T2：</td></tr>
<tr><td>……</td></tr>
</table>

Table 4-2 original perception information

<table>
<tr><td colspan="3">Table: AIS 航迹表</td></tr>
<tr><td>Row Key：</td><td colspan="2">MMSI 号+航迹起始点的时间戳</td></tr>
<tr><td>Family</td><td colspan="2">AIS</td></tr>
<tr><td rowspan="3">Columns：</td><td>T1：</td><td rowspan="3">Value：时间戳、经度、维度、速度、方向、关联的 Radar 航迹 ID 等</td></tr>
<tr><td>T2：</td></tr>
<tr><td>……</td></tr>
</table>

<table>
<tr><td colspan="3">Table: Radar 航迹表</td></tr>
<tr><td>Row Key：</td><td colspan="2">航迹起始点的 id</td></tr>
<tr><td>Family</td><td colspan="2">Radar</td></tr>
<tr><td rowspan="3">Columns：</td><td>T1：</td><td rowspan="3">Value：时间戳、经度、维度、速度、方向、关联的 AIS 航迹 ID 等</td></tr>
<tr><td>T2：</td></tr>
<tr><td>……</td></tr>
</table>

4.1.2.3 realization of equipment display and control linkage and perceptual data view component

The raw perceptual data view component is a collection of three-tier nested components. It completes the function of equipment display and control linkage, and the equipment detection and monitoring of the target. The perceptual data view component provides the display and control of target text information, visual video, image information and geographic marker information associated with the same target, and can jointly issue equipment control commands. From the outside, the original perceived data view component is actually a sub view component of the multi-dimensional data view component. From the inside of its components, the outermost layer is tabpane component, and the middle layer is collapse component and video monitoring component. The collapse component nested a table component including AIS and radar information. The video monitoring component is nested with a series of button components for docking photoelectric video equipment to complete the issuance of control commands.

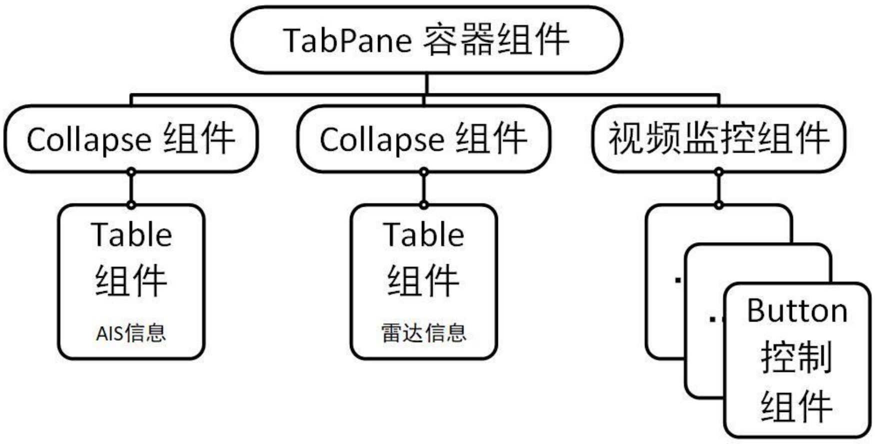


Figure 4-9 component structure of perceptual data view

Collapse component is a content area that can be folded and expanded. It contains AIS and radar table information, and can group and hide the information table to keep the panel clean. We use the table component to display a large number of structured AIS and radar frame structure information, and sort, search, page, custom operation and other complex behaviors of the structured perceptual information as needed. When the batch comprehensive perceptual data flows from the multi-dimensional data view to the perceptual view component through the self adaptation method, specify the corresponding AIS radar data information through the datasource attribute of the lowest table component of the perceptual view, and specify the header and column configuration information through the columns attribute to control the attributes such as column classname, alignment, default sorting, etc. through the table component, We can display the dynamic and static perception information such as radial distance, azimuth, radial velocity, longitude and latitude of the target in real time.

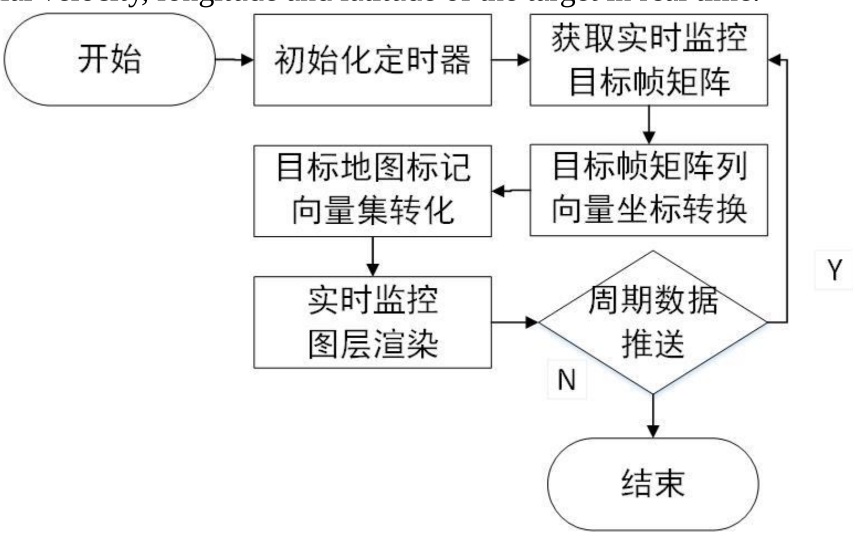


Figure 4-10 device display and control rendering process

The original perceptual location information of the target is rendered on the real-time target display layer of the map as a marker vector set through the SuperMap GIS service. The system periodically obtains the real-time monitoring target frame matrix through the data timer. Each behavior in this matrix is the original perceptual fusion information of the current target, including the perceptual information of all devices that can be associated with the target. After starting the real-time monitoring mode, first initialize the data timer, define its data request frequency, and perform the marker vector layer rendering task of each request cycle in the server callback function. At the beginning of the callback function, the marker vector layer of the real-time monitoring map must be clear to ensure the real-time rendering. After obtaining the real-time monitoring target frame matrix, start traversing each row of the matrix. In the process of traversing each row, extract the longitude and latitude information of each target, and use the supermap.marker class to create a marker marker marker marker object with corresponding longitude and latitude for each real-time target, After traversing the real-time monitoring target frame matrix, the obtained marker object is stored as a marker vector, and the marker vector matrix is added to the real-time monitoring layer to complete the rendering of the real-time monitoring layer. The rendering process of real-time monitoring mode device display and control is shown in Figure 4-10.

Algorithm 2 Realtime Dynamic Batch Position Frame Data Load and Render

Input:

The state of timer S. The matrix Batch Position data D.
The state of map type T. The static variable Φ.

Output:

The matrix render marker M. The matrix render vector V.

Create a batch data heap H; Inital record index E;
while $(S == True)$ **do**
  $clearHeap(H)$;
  while $(getCurrentIndexDataRecord(H, E)! = null)$ **do**
    get current index data record R:=$getCurrentIndexDataRecord(H, E)$;
    get current lontitude latitude L:=$getCurrentLontitudeLatitude(H, R)$;
    if $(T == EPSG : 3857)$ **then**
      get current lontitude L_{lon}=$getCurrentLontitude(L)$;
      get current latitude L_{lat}=$getCurrentLatitude(L)$;
      transform current lontitude coordinate;
      $\widetilde{L_{lon}}$=L_{lon}*Φ /180 ;
      transform current latitude coordinate ;
      $\widetilde{L_{lat}}$=ln(tan(πL_{lat}/180+/pi/2)*/2)*Φ/π ;
      $L \leftarrow (\widetilde{L_{lon}}, \widetilde{L_{lat}})$;
    end if
    M_E:=$(getTargetRenderSupermapMarker(H, L, E))$;
    $M \leftarrow M_E$;
    V_E:=$(getTargetRenderSupermapFeatureVector(H, L, E))$;
    $V \leftarrow V_E$;
  end while
  Return M, V;
  $RenderMartrixMarkerVectorLayer(H, M, V)$;
end while

Figure 4-11 dynamic position frame data loading and rendering algorithm

$L_l L_a L_{tl} L_{ta}$As shown in Figure 4-11 dynamic position frame data loading and rendering algorithm, in the process of display and control rendering of real-time monitoring equipment, real-time coordinate conversion needs to be carried out according to the type of current map. It is the longitude coordinate under WGS84: World geodetic system 1984, the latitude coordinate under WGS84 standard, the longitude coordinate under pseudomercator projection coordinate system, and the latitude coordinate under pseudomercator projection coordinate system. R is half of the circumference of the earth's equator. The conversion formula is as follows.

$$L_{tl} = L_l \times R \div 180 \tag{4-1}$$

$$L_{ta} = \ln(\frac{tan\left(\frac{\pi L_{la}}{180}+\frac{\pi}{2}\right)}{2}) \times R/\pi \tag{4-2}$$

4.1.2.4 design of target threat estimation model based on active depth confidence network

The multi-dimensional and multi-level database stores all the multi-source heterogeneous perception data and data sets of behavior, characteristics and alarms of the target. Because the perception, trajectory behavior, characteristics and alarm data sets of the target contain a large amount of unmarked data, the stored targets with threat behavior actually found alarms account for a small number, while some targets do not generate equipment alarms, But it is still a threat. In fact, its trajectory behavior and some characteristics are dangerous, but we can't find it through some mechanical explicit rules. When there are a large number of unlabeled data in this training set, and labeling them costs a lot of time and money, we need to use the semi supervised deep learning method to train the threat estimation model, and determine the most difficult data to label through the active learning method, Then use the selected multi-dimensional data marked with threat targets and all unmarked data to train the deep architecture. In the process of active learning, this deep architecture is constantly found to be the most difficult to distinguish whether there are threat targets, and label the threat analysis, so as to continuously carry out iterative training, Gradually improve the threat estimation ability of the active depth confidence network threat analysis model.

After sampling the perception, characteristics, alarm and threat data views of all targets according to time, take out the data of a time frame. Each target is represented by a vector. At this time, the target frame data matrix is:

$$\mathrm{X}=[x^1,x^2,\dots,x^{R+T}]=\begin{bmatrix} x_1^1 & \cdots & x_1^{R+T} \\ \vdots & \ddots & \vdots \\ x_D^1 & \cdots & x_D^{R+T} \end{bmatrix} \tag{4-3}$$

Where R is the number of training data, t is the number of test data, D is the number of feature dimensions of each target, where l labeled data are randomly selected from R target frame training data sets or actively selected by active learning method, so that s is the target index set that needs to be manually labeled from the training data set. Dimension target data is represented as follows.

$$X^L=X^R(S),\ S=[s_1,\dots,s_L]\ \ 1\le s_i\le\ R \tag{4-4}$$

Let C be the threat level category of situation threat estimation, and Y is the label data set corresponding to l labeled data, which can be expressed as follows.

$$Y^L=[y^1,y^2,\dots,y^L]=\begin{bmatrix} y_1^1 & \cdots & y_1^L \\ \vdots & \ddots & \vdots \\ y_C^1 & \cdots & y_C^L \end{bmatrix} \tag{4-5}$$

Each column of Y is a space vector, and the value with coordinate J represents the threat degree of class J.

$$\mathrm{y_j}=\begin{cases} 1\ \text{如果 x 属于第 j 个类别威胁程度} \\ -1\ \text{如果 x 不属于第 j 个类别威胁程度} \end{cases} \tag{4-6}$$

After the training of situation estimation model, when a new target time frame vector data is input into the mapping function from X to y, the active depth confidence network situation estimation model will give the threat degree prediction of this target.

$\mathrm{W}=\{w^1,w^2,\dots,w^{N+1}\}$ The network topology of active depth confidence network is shown in the figure. It is a fully connected and oriented multilayer neural network, including an input layer H0, n hidden layers H1 to HN, and the top is the output layer F. The parameters of the situation estimation model we need to train are. The architecture of active depth confidence network is constructed by restricted Boltzmann machines (RBM). RBM is a two-layer recurrent neural network, which connects random binary inputs and outputs through symmetrical weights.

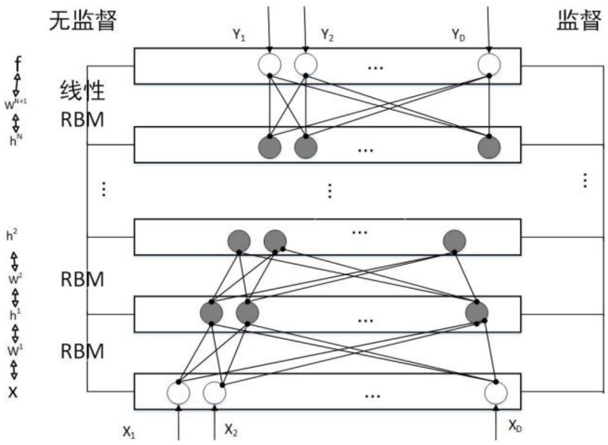


Figure 4-12 deep confidence network structure

In the active depth confidence network, the energy state formula is as follows.

$$\mathrm{E}(h^{k-1},h^k;\theta)=-\sum_{s=1}^{D_{k-1}}\sum_{t=1}^{D_k} w_{st}^k h_s^{k-1} h_t^k \\ -\sum_{s=1}^{D_{k-1}} b_s h_s^{k-1}-\sum_{t=1}^{D_k} c_t h_t \tag{4-7}$$

$\theta =$ （w, b, c)w_{st}^{k}Where is the parameter of the situation estimation model and the symmetric connection parameter between the unit s of the hidden layer HK-1 and the unit t of the hidden layer HK. The K interval is [1, n-1]. BS is the s-th offset in hidden layer HK-1, and CT is the t-th offset in hidden layer HK. DK is the number of nodes in layer K.

The probability of HK-1 occurrence is as follows.

$$\mathrm{P}\left(h_t^{k-1};\theta\right) = \frac{1}{Z(\theta)}\sum_{h^k}\exp(-\mathrm{E}(h^{k-1},h^k;\theta)) \tag{4-8}$$

The normalization constants are as follows.

$$Z(\theta) = \sum\nolimits_{h^{k-1}}\sum\nolimits_{h^k}\exp(-\mathrm{E}(h^{k-1},h^k;\theta)) \tag{4-9}$$

The conditional probabilities of HK-1 and HK are as follows.

$$\mathrm{p}(h^k|h^{k-1}) = \prod\nolimits_t p(h_t^k|h^{k-1}) \tag{4-10}$$

$$\mathrm{p}(h^{k-1}|h^k) = \prod_s p(h_s^{k-1}|h^k) \tag{4-11}$$

The probability that unit t is 1 can be expressed by the logic function as follows:

$$\mathrm{p}\left(h_t^k = 1|h^{k-1}\right) = sigm(c_t + \sum_s w_{st}^k h_s^{k-1}) \tag{4-12}$$

The probability that unit t is 1 can be expressed by the following logic function:

$$\mathrm{p}(h_s^{k-1} = 1|h^k) = sigm(b_s + \sum_t w_{st}^k h_s^k) \tag{4-13}$$

The logic functions are as follows.

$$\mathrm{sigm}(\eta) = 1/(1+\exp(-\eta) \tag{4-14}$$

By deriving the probability logarithm generated by the hidden layer, the difference between the expectation of data distribution and the m-th order of Gibbs sampling can be obtained. As shown below.

$$\frac{\partial logp(h^{k-1})}{\partial w_{st}^k} = \langle h_s^{k-1}h_t^k\rangle_{P_0} - \langle h_s^{k-1}h_t^k\rangle_{P_M} \tag{4-15}$$

The parameter wk can be adjusted by the following formula.

$$w_{st}^k = \vartheta w_{st}^k + \eta\frac{\partial logp(h^{k-1})}{\partial w_{st}^k} \tag{4-16}$$

After calculating wk, you can calculate the hidden layer formula after data X is input from H0, as shown below.

$$h_t^k(x) = sigm(c_t^k + \sum_{s=1}^{D_{k-1}} w_{st}^k h_s^{k-1}(x) \quad t = 1,2,\dots,D_k; k = 1,2,\dots,N-1 \tag{4-17}$$

Using normal distribution to initialize wk and then running gradient descent optimization method may bring crisis. Therefore, the active depth confidence network uses linear RBM to initialize the output layer parameter wn + 1, and the linear RBM is sampled from random variables subject to Gaussian distribution.

The value of the jth cell of F is a linear function, as shown below. This value is not iterated at this time.

$$f_{j,0} = c_j^{N+1} + \sum_i w_{ij}^{N+1} h_{i,0}^N \tag{4-18}$$

The state value of F is the value of F plus a random variable subject to normal distribution.

$$s_{j,0} = f_{j,0} + r \tag{4-19}$$

$s_{j,0} w_{ij}^{N+1}$The new value of unit I of HN is a logic function containing the sum of F state values, as shown below.

$$h_{i,1}^N = \mathrm{sigm}(b_i^N + \sum w_{ij}^{N+1} s_{j,0}) \tag{4-20}$$

The new value of the ith cell of F is as follows.

$$f_{j,1} = c_j^{N+1} + \sum_i w_{ij}^{N+1} h_{i,1}^N \tag{4-21}$$

Similar to RBM, the derivation formula of linear RBM is as follows.

$$\frac{\partial logp(h^N)}{\partial w_{ij}^{N+1}} = h_{i,0}^N f_{j,0} - h_{i,1}^N f_{j,1} \tag{4-22}$$

The WN + 1 initialization value is obtained by linear RBM training. At this time, the output layer f is as follows.

$$f_j(x) = c_j^{N+1} + \sum_{i=1}^{D_N} w_{ij}^{N+1} h_{i,1}^{N}(x) \quad j = 1,2,\ldots,C \tag{4-23}$$

The loss function of the output layer is as follows.

$$\mathrm{E(z)} = \exp(-\mathrm{z}) \tag{4-24}$$

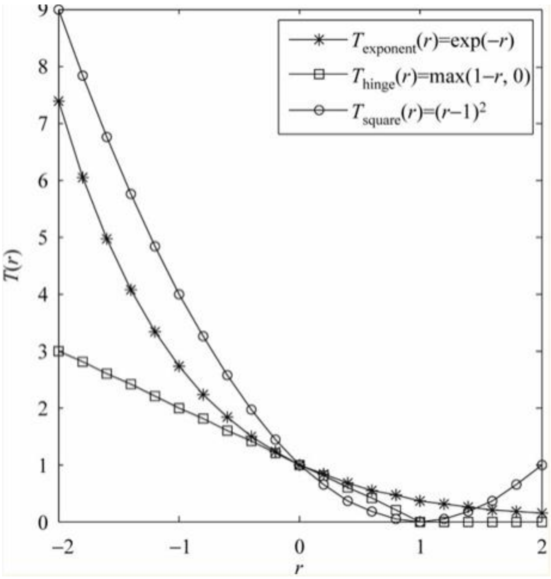


Figure 4-13 loss function

As shown in the figure, when R increases, tsquare increases with the increase of R, so the definition interval of the mean square error function loss function for the correct classification is very small, and too correct classification will be punished by the increase of classification error rate.

The optimization problem of exponential loss function is summarized as the following formula. In the supervised learning stage, the random gradient descent algorithm is used to optimize all the parameters of the whole deep architecture, and the random parameters in the unsupervised learning stage are replaced by the determined real probability.

$$\arg_f min \sum_{i=1}^{L} l(f(x^i), y^i) \tag{4-25}$$

$$\mathrm{l(f(x),y)} = \sum_{\mathrm{j=1}}^{\mathrm{C}} \mathrm{E}\left(\mathrm{f_j(x)y_j,}\right) \tag{4-26}$$

The frame data matrix X of the target includes the unlabeled target data pool XR and the initial threat target annotation data set XL. The deep architecture HN will determine which unmarked target in XR will be manually labeled. After that, the parameters of HN will be added with manual labeling and optimized with a new training set after active learning. After the target is mapped, the distance between the target and the class boundary in the unmarked data pool is as follows.

$$d^i = \left|h_1^N\left(x^i\right) - h_2^N\left(x^i\right)\right| / \sqrt{2} \tag{4-27}$$

Thus, the selected targets that need to actively label the threat degree are as follows.

$$\mathrm{s} = \{\mathrm{j}: d^j = \min(\mathrm{d})\} \tag{4-28}$$

In fact, the threat level of the target is determined by the location of the output of the deep architecture. By alternately using unsupervised learning and supervised learning training, the deep architecture of neural network is better adjusted and the threat discrimination analysis ability of threat estimation model is improved. After active learning, the deep confidence network becomes a model that provides the view of threat analysis data. The training algorithm is shown in the figure below.

Algorithm 1 主动深度置信网络态势威胁估计模型训练算法

Input:

数据集 X,(X^L, Y^L) 层数 N, 无监督学习迭代次数 Q
训练数据个数 R，测试数据的个数 T
服从正态分布的随机初始化参数空间 W
主动学习迭代次数 I
主动学习每次迭代选择的数据向量数 G

Output:

包含训练后参数空间 W 的深层架构

for $i = 1;i <= I$ **do**
  贪心无监督方法一层层构建网络;
  for $q = 1;q <= Q$ **do**
    for $k = 1;k <= R + T$ **do**
      计算非线性正向和反向状态;
      $p(h_t^k = 1|h^{k-1}) = sigm(c_t^k + \sum_s w_{st}^k h_s^{k-1})$
      $p(h_t^{k-1} = 1|h^k) = sigm(b_s^{k-1} + \sum_t w_{st}^k h_t^k)$
      更新参数和偏置
      $\frac{\partial logp(h^{k-1})}{\partial w_{st}^k} =< h_s^{k-1}, h_t^k >_{p_0} - < h_s^{k-1}, h_t^k >_{p_M}$
    end for
  end for
  使用线性 RBM 构建输出层
  基于梯度下降的监督学习
  在标注集 X_L 上最小化损失函数，更新参数空间 W
  选择 G 个最难区分的数据输入向量：$s = j : d^j = min(d)$
  添加选择的 G 个文档到标注数据集 X_L
end for
迭代进行 RBM 构建与无监督方法网络构建

Figure 4-14 network model training algorithm

4.1.2.5 realization of real-time alarm and threat data view components

The threat data view component is a three-tier nested tree component. It shows the data of target threat analysis view, which is divided into target threat level, target threat criterion and alarm transition process. Since the machine can not judge whether it is the enemy or me, it can only give confidence and criteria, and finally let people judge. The next layer inside the threat data view component is a card component, which is used as the component container. The lowest layer is the rate component and timeline component, which are used to display the target threat level, threat criterion and alarm transition process respectively. The component structure of threat data view is shown in Figure 4-15.

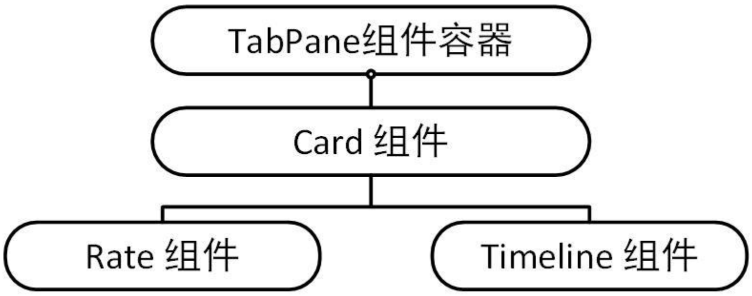


Figure 4-15 threat data view component structure

As the scoring component of the threat level of the target, the rate component can display the threat evaluation of the target. The timeline component is used to vertically display the alarm transition time flow information. The alarm transition process of the system is actually a detailed display of the calculation process of the target threat criterion. The alarm level of the target is not static, and is not the static result obtained according to the dangerous behavior and alarm events. It is developmental and dynamic. The alarm level of all targets is normal when the data is just warehoused, that is, there is no threat. In the process of long-term monitoring, the threat continues to increase due to some dangerous behaviors and alarm events. For example, the target enters and exits the monitoring and early warning area as a non cooperative target in a certain period of time, The threat level is raised to a mild warning, and the AIS malicious tampering event occurs in a certain period of time, which further improves the threat level and produces an alarm transition.

Whether the detection target is a small boat docked in a storm or a Caribbean Pirate in central and North America depends on our threat identification analysis of the target. We record the historical abnormal behaviors of the target, such as AIS silence, AIS camouflage and tampering, and form a blacklist of the target from the perspective of protection area, gathering area and other areas in combination with historical mining results, In terms of visualization effect, it is reflected in the use of timeline component for series connection on the time axis, that is, the historical dangerous behavior of the target is connected with the alarm transition process of anomaly detection and discovery algorithm, which is not only the process of target alarm transition, but also forms the threat criterion of the target.

In the real-time monitoring mode, once a real-time alarm event occurs to the target, the target rendering mark will update the rendering color in real time according to the target alarm level, and will flash at different frequencies according to the alarm degree, so as to intelligently and visually represent the equipment alarm fault and target alarm information. Figure 4-16 shows the real-time alarm flashing process.

The real-time alarm function of the real-time monitoring mode is realized through multiple timers. Firstly, the alarm timer and data timer are initialized. The alarm timer is responsible for the real-time color change rendering task of the alarm target mark and the function of flashing the alarm target at different frequencies. The data timer is responsible for the data request task of periodically sensing the data frame matrix. After requesting the sensing data frame matrix, the data timer extracts the targets with different alarm levels from the current real-time sensing targets, and then transmits all target sensing frame matrix data with different alarm levels to the corresponding alarm timer. The alarm timer will work at a frequency different from the data timer, that is, the alarm timer is not synchronized with the data timer, the working frequency of the alarm timer is an integral multiple of the data timer, and the higher the threat level of the alarm target, the faster the working frequency of the alarm timer, The alarm timer will render the target mark with different colors according to different working frequencies. The flashing function of the alarm target is realized by delaying half cycle rendering of the alarm timer, that is, in a working cycle of the alarm timer, half of the time is used to render the data and half of the time is used to hide the data mark, so as to achieve the flashing effect. Because the higher the working frequency, the higher the threat level of the alarm target, so as to achieve the higher threat level, The faster the alarm target map marker flashes. The real-time alarm flashing algorithm is shown in Figure 4-17.

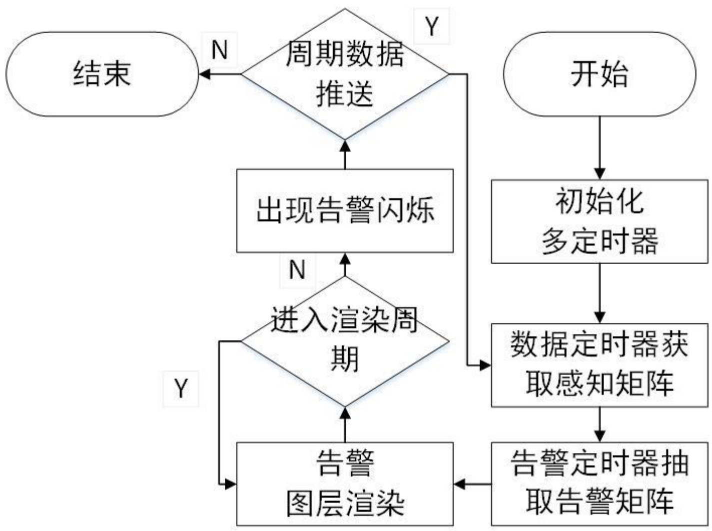


Figure 4-16 real time alarm flashing process

Algorithm 3 Realtime Warning Data Render Flicker

Input:
The state of warning timer S_w. The state of data timer S_d.
The waring timer array T. The waring level array A.

Output:
The matrix warning data W.

Create a data Heap H;
while $(S_w == True || S_d == True)$ **do**
  $clearHeap(H)$;
  if $(S_d == True))$ **then**
    get current data matrix $M{:=}getTargetData(H)$;
  else
    get current warning timer$T_c{:=}getCurrentWarningTimer(H, T)$;
    get current waring level $A_C{:=}getTargetData(H, A)$;
    while $(getNextWarningData(T_c, A_C, M)! = null)$ **do**
      get current waring level data $W_c{:=}getCurrentWaringLevelData(T_c, A_C, M)$;
      $W \leftarrow W_c$;
    end while
    Return W;
    $addWarningDatatoRenderLayer(W, H)$;
    $setTimeoutRenderWarningData(W, H, T, A)$;
  end if
  if $getTimeoutStateFlickerRender(T, A) == True$ **then**
    $FlickerRenderWarningData(W, H)$;
  end if
end while

Figure 4-17 real time alarm data rendering flicker algorithm

4.1.2.6 target behavior analysis based on probabilistic programming reasoning

The historical behavior of the target will be stored in the multi-level database, and their historical behavior will directly participate in the analysis of the real-time behavior of the target, so as to make decisions. Goal real-time behavior analysis is based on the principle of expected utility maximization, and considers the goal acceptability of behavior goals and the possibility of goal realization. When calculating the expected benefit value of behavior, we should consider the utility value of target behavior consequences to represent the target acceptability and the probability of behavior consequences.

$P_{STATE}P_{EXECUTION}(A|precondition(A))P_{EFFECT}(e|A)$We set the probability of behavior state as the uncertainty of behavior premise. Set as the uncertainty of behavior execution. Let it represent the probability of the result of behavior a when it is successfully executed.

$P_{EXECUTION}(A|precondition(A))P_{EFFECT}(\mathrm{e}|A)P_{EFFECT}(\mathrm{e}|A)$ Firstly, the calculation of target behavior state probability is introduced. Assuming that e is the target behavior evidence, if the state x observed under the target behavior evidence e, its probability is p (x|e) = 1. The target behavior we monitor will change the probability of the state associated with it. If it is observed that the target is executing or the target has executed execution behavior B, the probability of each premise of target behavior B is 1. If the target execution behavior is a, the probability of each result e of target behavior a is the product of its execution probability and its result probability. If the target execution behavior is a, the probability of each result e of behavior a is. Otherwise, the probability of occurrence of the target behavior state x is equal to the a priori probability value p (x) of X.

Calculation of target behavior probability value. Given the target real-time behavior evidence e, if it is observed that the target has performed behavior a, then p (x|e) = 1; If it is monitored that the target is executing behavior a, P (a|e) is equal to the execution probability of the target behavior. Otherwise, the probability of occurrence of the target behavior a is equal to the product of the execution probability of target behavior a and the probability of occurrence of each target behavior premise. The formula is as follows.

$$\mathrm{P(A|E)} = P_{EXECUTION}\left(A \middle| \begin{matrix} precondition(A) \times \\ \prod_{e \in precondition(A)} P(e|A) \end{matrix}\right) \tag{4-29}$$

The influence of the change of target behavior probability on the result probability of target behavior is as follows.

$$\mathrm{P\ P(e|E)} = \mathrm{P(A|E)} \times P_{EFFECT}(e|A) \tag{4-30}$$

o_iThe calculation of target behavior consequence probability and target expected utility value, the change of target behavior probability will affect the result probability of target behavior, and then affect the expected benefit value of target behavior. Let o be the target behavior consequence set of target behavior a, and one of the target behavior consequences is. Then:

$$P_{action}(o_i|\mathrm{E}) = \mathrm{P(A|E)} \times P_{EFFECT}(o_i|A) \tag{4-31}$$

The expected utility value of behavior a is calculated from the target behavior probability of each consequence of a and the target behavior utility value:

$$\mathrm{EU(A|E)} = \sum_{o_i \in o_A} \left(P_{action}(o_i|\mathrm{E}) \times Utility(o_i)\right) \tag{4-32}$$

$o_j o_j o_j o_j o_j o_j$Objective planning consequence probability and objective expected utility value. The change of target behavior probability has an impact on the target planning probability, and then affects the expected benefit of the whole target behavior analysis planning. Let OP be the consequence set planned for target behavior analysis, one of which is. Let {A1,..., AK} be a partial ordered set of target behaviors leading to consequences in target behavior planning. AK leads to the result of target behavior. The product of all target behaviors and evidence e caused in the target behavior planning, plus the result probability of the target behavior result, determines the occurrence probability of the target behavior result. The formula is as follows:

$$P_{plan}(o_j|\mathrm{E}) = (\prod_{i=1,\ldots,k} \mathrm{P}(A_i|\mathrm{E})) \times P_{EFFECT}(o_j|A_k) \tag{4-33}$$

The expected utility value of the target behavior planning is obtained from the probability of the consequences of each behavior planning in the target behavior planning and the utility value:

$$\mathrm{EU}(\mathrm{P}|\mathrm{E}) = \sum_{o_j \in o_p} (P_{plan}(o_j|\mathrm{E}) \times Utility(o_j)) \tag{4-34}$$

4.1.2.7 scenario playback and behavior event data view component implementation

The behavior event data view component is a four level nested tree component. The behavior event data view shows the behavior and alarm events in the historical passing area of the target in the current real-time monitoring mode. The component is essentially composed of two collapse components. Each collapse component contains a panel component to accommodate behavior event data. The panel component contains a table component and a button component to display behavior event data using a structured table and play back the behavior event scenario by selecting the latter key. The component structure of behavior event data view is shown in Figure 4-18.

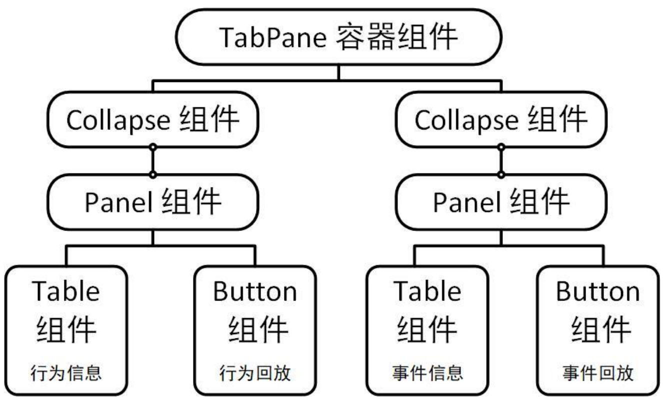


Figure 4-18 component structure of behavior event data view

In the real-time situation monitoring mode, the target behavior data view presents the historical scenes of the target's behavior in and out of the protection area and alarm events in real time. At this time, you can select the alarm events or regional behaviors that need to be played back, and conduct seamless service switching through the API (application programming interface) exposed by the historical playback service, One click switch from high-dimensional real-time situation monitoring mode to historical playback service. Behavior event scenario playback is based on the idea of combining real-time and history. It is the correlation between real-time mode and historical mode. The idea of using historical events and behavior scenarios to assist real-time monitoring is to realize high-dimensional, one click real-time situation monitoring scenario playback based on real-time history seamless service switching. Real time history services communicate through network calls, which strengthens the isolation between services and avoids tight coupling. The switching between real-time monitoring and historical playback services is shown in Figure 4-19.

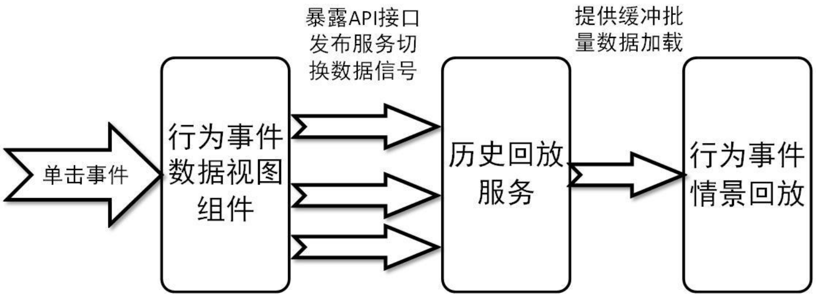


Figure 4-19 switching between real-time monitoring and historical playback services

In the process of viewing the behavior event data view, the component subscribes to the behavior event data of the selected target marker point. The data is directly pushed to the datasource attribute of the table component through self adaptation, and the target structured behavior and event information column name are set through the column attribute of the table component. Event information includes alarm event name, alarm event occurrence time and alarm target ID. The behavior information column includes the time to enter the region, the time to leave the region, the region code ID or the region longitude and latitude, the region residence time, and the behavior target ID. The table component performs real-time rendering and refreshing of the table component through the onchange callback function.

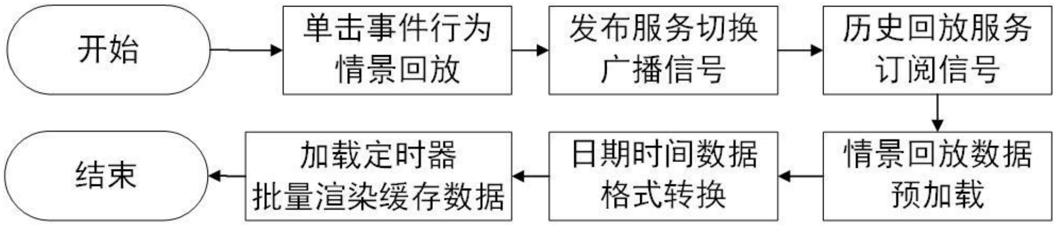


Figure 4-20 scenario playback service switching flow chart

When performing complex behavior operations such as selecting or canceling each line of specific events or target behavior records displayed in the table component, the onselect function in the table component is used as a callback to temporarily store the information of the currently selected recorded behavior events. When a click event is generated for the start playback button component, the button component will execute the onclick function, encapsulate the temporarily stored target behavior, event scenario record and key information into the component broadcast signal, and issue the service switching broadcast signal to the signal broadcaster. Because the historical playback service subscribes to the service switching signal topic, and the historical playback service exposes the API required for historical playback, using the API and passing the specified key space-time parameters can start the historical playback service to provide the buffer data and playback visualization scheme we need in batch. The key parameters required in the API exposed by the historical playback service include the mode of historical playback, the start and end datetime of historical playback (yyyy: mm: DD, XX: XX: XX format). The optional parameters include the area of historical playback, the event ID of historical playback, the target ID of historical playback, the target list, etc. The service switching process of scenario playback is shown in Figure 4-20.

When the history playback service receives the service switching topic signal it subscribes to, it first preloads the behavior and event playback data through the API. The preloading is divided into two steps. In the first step, the track aware data row key index in the start and end timestamp of historical playback stored in HBase is prepared in advance, and the idea of space for time is used. When specifically buffering historical batch data, the batch track row key index will be directly mapped to the specific object of the database for fast batch data query. The second step of preloading playback data is to preload the node basic information of alarm event and behavior key time frame, including the time position of alarm event and behavior key frame and its event behavior type code, identification, associated target ID, etc. After the scenario playback data is preloaded, the historical playback service first provides the preloaded basic information of alarm events and behavior key time frame nodes to the scenario playback control interactive component, which uses moment.js to manage the date and time, and converts the key time frame data in date format into an integer format position frame value representing the progress, Use the position frame value to make the progress slider component mark the key time frame node in red at the relevant position, and indicate the brief text information of alarm event behavior under the red mark. Finally, click the start playback button to load the timer and buffer the rendering cache data in batch to complete the scenario playback. The pseudo code of the above scenario playback service switching is shown in Figure 4-21.

Algorithm 4 Scenario Playback Service Switching

Input:

The state of playback mode S. The start date and time of scenario data O. The end date and time of scenario data E. The Identification scenario D.

Output:

The matrix playback batch data M.

Create a playback queue Q;
$publishServiceSwitchSignal(S, O, E, D)$;
Subscribe playback signal messagge $G := getSubscribePlackbackMessage()$;
$G \leftarrow S, O, E, D$;
$M \leftarrow preLoadEventInfo(S, O, E, D)$;
$waitingCallbackMessage()$;
transform date time format;
get transform start value $O_v := transformTimeFormat(O)$;
get transform end value $E_v := transformTimeFormat(E)$;
$setPlackbackState(O_v, E_v, M)$;
$StartPlayback(M)$;
Return M;

Figure 4-21 scenario playback service switching pseudo code

4.1.3 design and component implementation of historical data playback mode

4.1.3.1 buffered batch data loading

In order to realize historical data playback, the problems of data loading and speed control must be solved. In the historical playback mode, a buffered batch data loading algorithm is used to solve the problems of batch data loading and speed control in the buffered state. The buffered batch data loading algorithm is shown in Figure 4-22.

The algorithm creates a buffer queue Q to store the corresponding playback target information data each time. The index value of the queue is the offset (converted to seconds) of each frame data time relative to the starting frame time of batch data loading o. When the user clicks start, accelerates, decelerates or drags the progress bar, the click event is triggered and the timer is turned on, and then the current playback state is set to true. Next, record the current playback time, calculate the offset between the current time and the playback start time, and access the playback data according to the offset (getbufferqueueelement (Q, c)). If there is replay data, the system will replay the target information data (renderframedata (getbufferqueueelement (Q, c)) at the current time. If the data does not exist, the system will start to batch buffer all data in the next buffer time window (bufferbatchdata (O, e, D, R)). Finally, after the buffering is completed, it will play back the data of the current time and add the difference of adjacent frame time D, and wait until the next cycle time of the timer to re determine whether the current playback s state continues.

The historical playback speed is controlled by the acceleration and deceleration buttons. When you click the acceleration or deceleration button, the system will modify the playback magnification. A playback time unit is equal to the product of the playback magnification and the buffer time constant. By controlling the playback time unit, increase or reduce the time interval of batch loading data, so as to realize the control of historical playback speed.

Algorithm 5 Buffer Batch Data Loading Algorithm

Input:

The state of current playback S.
The start frame time of batch data loading O.
The end frame time of batch data loading E.
Play speed factor r.
The difference of adjacent frame time D.

Output:

The matrix Batch data M.

```
Create a buffer queue Q;
while (S == True) do
   get current time C := getCurrentTime();
   if (getBufferQueueElement(Q, C) == null) then
      while (getBufferQueueElement(Q, E) == null) do
         Q ← bufferBatchData(O, E, D, r);
      end while
      renderFrameData(getBufferQueueElement(Q, C));
      M := getBatchDataMatrix(Q, O, E);
      Return M;
   else
      renderFrameData(getBufferQueueElement(Q, C));
   end if
   C := C + D;
end while
```

Figure 4-22 buffered batch data loading algorithm

In the actual historical playback environment, we need to load the frame data requiring historical playback regularly. However, if each playback time node requests the target playback frame data at that time from the background, it will lead to I / O-Intensive data query, increase the system burden, bring a lot of redundant network traffic and reduce the fluency of historical data playback of the whole system, Reduced playback efficiency. In order to solve this problem, we adopt the method of regularly buffering batch data. In the buffering process, the system will buffer multiple frames of data at one time. Each frame includes the fusion sensing data of all monitoring targets at the current playback time, which reduces the system burden, reduces redundant network traffic and increases the fluency of historical data playback.

$T_i T_b$In the process of historical playback, the time of buffering batch data is very important for the playback effect. Assuming that the time required to buffer the i-th frame data in the process of buffering data is the overall time of buffering data, and W is the number of frames to be buffered, the time for buffering batch data once is shown in the formula.

$$T_b = \sum_{1}^{w} T_i \tag{4-35}$$

$T_{net} U_i \overline{T_b}$In the actual network environment, assuming that under the current stable network bandwidth, the theoretical time required for transmitting w frame data, the frame delay between transmitting two adjacent frames of data, and the average time for buffering a batch of data, the average time of buffering process is shown in formula (4-4).

$$\overline{T_b} = T_{net} + \sum_{1}^{w} U_i \tag{4-36}$$

$U_f U_l \left|U_f - U_{f-1}\right| \left|U_l - U_{l-1}\right| \gamma$In the actual network environment, the network delay and other network incentives are random. In order to approximate the average buffer time, a factor can be added to smooth the frame delay and delay fluctuation. The buffer time can be estimated by using the method that the historical value accounts for a large proportion and the current value accounts for a small proportion. It is assumed that it is the historical value of the frame delay at time f and the current value of the frame delay at time L, If l is greater than u, it is the historical value of delay fluctuation, the current value of delay fluctuation and the smoothing factor defined by us, then the average buffer time is shown in the formula.

$$\begin{cases} \overline{T_b} = T_{net} + \gamma U_f + (1-\gamma) U_l \\ +\gamma \left|U_f - U_{f-1}\right| + (1-\gamma)\left|U_l - U_{l-1}\right| \\ \left|\gamma - \frac{3}{4}\right| < \frac{1}{4} \end{cases} \tag{4-37}$$

For the effect of buffer time on playback, if the buffer time window is reduced, the playback fluency will be reduced; if it is increased, the playback delay will be increased. Therefore, the buffer time needs to be adjusted according to the network delay and delay fluctuation.

T_uFor the playback speed control problem, we control the time difference of fusion perception data records contained in two adjacent frames by controlling the speed adjustment factor. Assuming that it is the frame data time difference, speed is the playback speed factor, and C is the time constant defined by us, then the frame data time difference is shown in the formula.

$$T_u = speed \times c \tag{4-38}$$

The historical playback speed is controlled by the acceleration and deceleration buttons. When the acceleration or deceleration button is clicked, the system will modify the playback magnification. The greater the speed factor, the greater the time difference between the fusion perception data recorded in two frames, and the faster the actual playback speed, so as to realize the control of historical playback speed.

4.1.3.2 component implementation of historical data playback mode

The history playback component of the control area is actually a double-layer nested component, which is divided into panoramic playback component, area playback component, event playback component and target playback component. We can select different playback modes according to the query needs. The system supports four different playback modes: panorama, individual, event and region. The structure of the history playback component in the control area is shown in Figure 4-23.

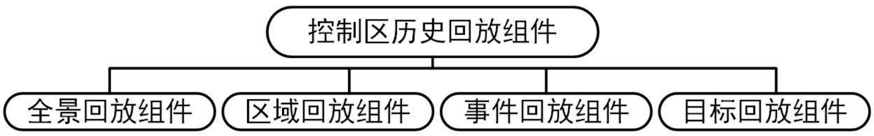


Figure 4-23 structure of historical playback component in control area

The component structures of the four historical playback modes are shown in Figure 4-24.

According to the playback requirements of full target information, overall situation and large-area full environment, the system provides panoramic playback mode, which plays back the full information of all targets in the selected time period frame by frame according to the loss of time dimension. The panoramic playback component of the control area consists of the model component and the Li tag. The Li tag is bound with the clickhandle function, which is responsible for opening the model dialog box component to start the history playback service. When the history playback has started, click the Li tag again to stop the history playback service, At this time, the timer used to render the batch cache data will be cleared and deleted by the clearinterval state transfer function to free up the JavaScript heap space, and then the historical playback marker vector rendering layer will be cleared to ensure that there are no historical playback data marker vector points on the map. The model component is a transaction processing dialog box container component. When the user needs to process transactions and does not want to jump to the page to interrupt the workflow, you can use modal to open a floating layer in the middle of the current page to carry the corresponding operations. The model component provides the selection of batch data query conditions before historical playback. The panoramic playback model component includes rangepicker component and two button components. There is an inheritance relationship between rangepicker component and datapicker component. Through it, you can select the start and end date format time period in yyyy: mm: DD XX: XX: XX format, which can be accurate to seconds. When you need to enter a date, you can click to select the start and end time, pop up the date floating layer panel, and select the start and end date of panoramic playback. The currently selected start and end date is stored through the onpanelchange callback function of the rangepicker component. After clicking the start playback button, the API interface of the historical playback service will be called to send the start and end time of the current playback and the playback mode code. The historical playback service will preload the data according to the current panoramic playback requirements. The preloading is divided into two steps. In the first step, the track aware data row key index in the start and end timestamp of historical playback stored in HBase is prepared in advance, and the idea of space for time is used. When specifically buffering historical batch data, the batch track row key index will be directly mapped to the specific object of the database for fast batch data query. The second step of preloading playback data is to preload the alarm event, behavior key time frame node event information, including the time position of the key frame and the coding of its event behavior type. After data preloading, the history playback service preloads the basic information of key time frame nodes at the componentdidmount stage of the playback process control component life cycle. Then, the panoramic playback is controlled through the historical playback process control component.

According to the playback requirements of historical perception information in the determined single target and multi-target detailed time period, the system provides the way of target playback, and plays back the historical data in the specific time period of time dimension for the selected special single target or multi-target. The target playback component is similar to the panoramic playback component, except that a transfer component is added to the model component. The transfer shuttle box component takes up more space and can display the target list to be played back. It can move elements in the left and right columns in an intuitive way to complete the selection of single target or multi-target. When the target playback component is selected, request all target ID numbers in the current target information base from the server, and use the datasource parameter to render the target ID data source to the source data column on the left. When the user selects the target to be played back, add the target ID to the target playback target column on the right, Use the targetkeys parameter to obtain the playback ID target set of the playback list on the right. Combined with the start and end time data obtained by the rangepicker component, you can search the target ID to be played back through the onsearch search callback function in the search box and shuttle it to the right column, Then, the history playback service is used to obtain the preloaded data and further realize the single or multi-target history data playback.

For the playback requirements of spatial area division and historical events in the protection area, the system provides area playback mode to playback the historical data in a specific period of time in a specific protection area or any vector area drawing with the mouse. A table component is added to the model component to display the name, range and threat degree of the currently divided protection area, which can be played back according to the planned protection area. In addition, a button component is added to draw an optional rectangular area through the supermap.rectangle class combined with the mouse event after clicking the event, and save its longitude and latitude coordinate points, Taking its coordinate point as a parameter, it requests the history playback service to query the buffered batch data of the spatial area dimension and preload the data through the API to further realize the historical playback of the regional data. Finally, the historical playback of regional data is controlled by the historical playback process control component.

According to the playback requirements of alarm events and abnormal data detection, the system provides event playback mode, and performs event playback in specific time period for historical equipment alarm, target behavior alarm, camouflage alarm and other events. A table component is added to the event playback component to display key events, which is similar to the scenario playback component in the real-time monitoring mode. The table component uses the paging mode to load all key alarm behaviors and events, and searches all key alarm behaviors and events in a period of time through the date index through the rangepicker component, Then select a specific event for historical playback.

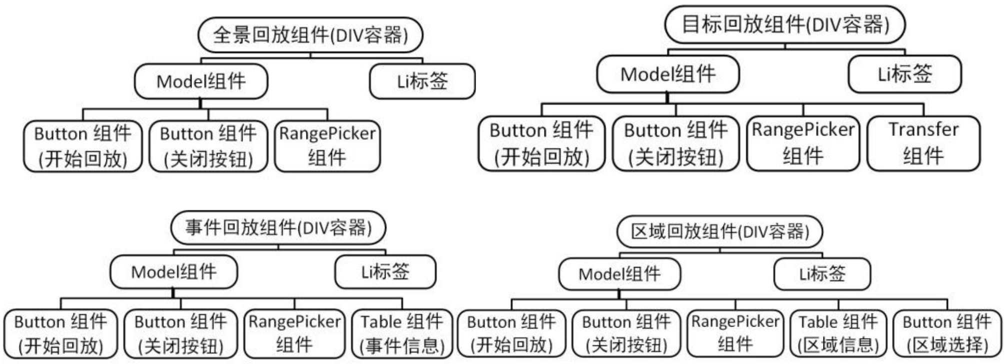


Figure 4-24 component structure of four historical playback modes

4.1.3.3 implementation of history playback process control component

The historical playback process control component is a three-tier nested component, which realizes the progress control of historical playback. After data preloading, the historical playback officially enters the playback progress process. The process control component can control the start, stop, pause, acceleration and deceleration of historical playback, and has a progress bar containing key frame information, which can drag the progress bar, Realize the actual playback process, forward update the progress bar and reverse control the playback process. The component can also display the playback progress, current playback time, current playback rate, buffer status and other informational data. The component is actually a div container, which uses the card component as the playback information container, including three button components as acceleration, deceleration and start stop buttons, and a slider component as the progress bar. The structure of historical playback process control component is shown in Figure 4-25.

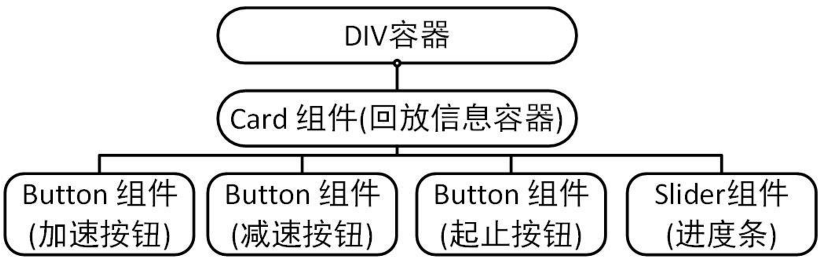


Figure 4-25 structure of historical playback process control component

The prototype of the slider component is actually a sliding input device, which can display the current value of progress and the range of progress. The user-defined range of values can be freely selected. The progress value it represents can be continuous or discrete. We designed a progress bar slider component that can display the playback progress of the time dimension, and set the step size to one second through its step parameter, that is, each sliding unit of the slider component is equivalent to one second of time, and the value of the corresponding slider is also increased by 1. There is a maximum playback interval for components with time dimension as playback progress. This playback interval is the start and end time of the overall playback returned after the playback data is preloaded. We need to use moment.js to calculate the difference between the start and end dates and times, Calculate the time difference between the start and end times, and convert the date time difference from the time in yyyy / mm / DD HH: mm: SS format to the time in seconds. Set the max parameter to take the time difference after conversion as the maximum upper bound of the value of the slider component, and set the Min parameter to zero as the lower bound of the playback progress.

The slider component uses the internal function of the tipformatter component to format the contents of the tooltip progress bar prompt. When dragging the progress bar, a prompt floating layer will be displayed above the progress bar slider to show the specific playback time of the current dragging progress. After dragging the progress bar slider, the onchange event will be triggered and the value value indicating the current progress of the progress bar slider component will be passed in, After the onchange event is triggered by dragging the progress bar, use the tipformatter function to convert the value representing the current progress value in seconds into the actual time in yyyy / mm / DD HH: mm: SS format with the help of moment.js, so as to obtain the drag progress time during dragging the progress bar slider, Use the drag progress time obtained from the conversion format to format the contents of the tooltip in the tipformatter function, so that the specific date and time corresponding to the current drag progress can be displayed along with the drag progress in the process of dragging the progress bar.

The slider component uses the scale mark marks as a label to display the key frame event behavior during playback on the progress bar. The scale mark is an object containing the scale position array, scale style and scale label content array. Its value is within the [min, Max] interval of the slider component. The key events after data preloading will be returned to the time data and event code code of the key event frame of the historical playback control process component, After receiving the preloaded key event frame data in the componentdidmount stage of the component life cycle, we use moment.js to convert the event frame time data into the value in seconds as the scale position array of the scale mark marks, assign the event code array as the scale content label array, and mark the scale label style as red, In this way, the rendering of key event frame nodes of progress bar is realized.

After the playback process control component completes the data preloading task in the componentdidmount stage of the component life cycle, the slider component will be initialized according to the preloaded data. Firstly, the value range and default value of the slider component will be initialized after date format conversion according to the playback start and end time, and then according to the preloaded key event frame data, Initialize the scale mark array of the historical playback process control component, initialize the content information in the card component, and use the data self adaptation method to directly change the information of the self adaptation variable in the component view, so that the component automatically displays the preloaded playback mode, start time, stop date and time, current playback time, current playback rate and other information, Finally, initialize the state of the internal state machine of the component, initialize the playback rate state to the normal rate playback state, initialize the buffer data time window, and finally complete the initialization of the playback process control component [22,23,24].

We use the buffered batch data loading algorithm for the rendering process of historical playback, and control the process of historical playback through the internal state machine of the component. The process control state of the component state machine is divided into three types. The first type of state is the playback state, which uses boolean type assignment to mainly control whether the current historical playback is in the playback in progress state or the playback suspended state, Or playback stop status. When the component is in playback in progress, the timer uses the buffered batch data loading algorithm for historical playback. The playback pause state is different from the playback stop state. From a functional point of view, after the playback is paused, click continue to continue the playback, and the data at the time of playback pause is still rendered on the map. You can view the playback target details at the time of pause by pausing playback. After playback is stopped, the historical playback layer will be cleared until playback is restarted. The second type of state is the speed state, which is responsible for controlling the current playback rate. The third type of status is playback progress status, which mainly controls the movement of the current playback progress slider. The constant variables in the playback process are playback request interval, buffer data time window and playback speed constant factor.

The playback process control component controls the buffered batch data rendering through the playback in progress state and playback pause state control of the state machine. After the component is initialized, it is in the playback pause state. At this time, the icon of the playback start and stop button is displayed in a triangular shape due to the playback pause state. When the playback start and stop icon is clicked, The playback pause state of the component state machine is transferred to the playback in progress state. This state transfer function will start the batch data buffer timer and alarm timer. The alarm target rendering of historical playback also has flicker effect. The implementation algorithm is the same as that of real-time alarm flicker rendering, and the method of multi timer rendering is also adopted, The batch data cache timer uses the buffered data loading algorithm to render the historical playback target frame matrix frame by frame. When the playback is in progress, the post playback start and end icon changes to the pause icon.

When the pause icon is clicked in the playback in progress state, the component state shifts from the playback in progress state to the suspended state. At this time, the clearinterval method is used to stop the batch data buffer timer and alarm timer in the mouse click event. Because the react framework uses the virtual DOM mode, the algorithm for calculating the minimum value of the virtual DOM diff is used to update the component view, Therefore, using the clearinterval function only in the click event cannot immediately pause playback rendering, because the timer will not be cleared immediately. You need to wait for the time of a component rendering cycle and wait for the specific steps of virtual DOM to calculate the view update difference. In order to achieve the effect of clicking the pause icon button to pause playback immediately, We use the componentwillreceiveprops and compontdidupdate phases of the component life cycle to stop the clearinterval batch data buffer timer and alarm timer, because the view change operation will inevitably enter these two component life phases, and stop the timer in advance in the componentwillreceiveprops and compontdidupdate phases, There is no need to wait for the virtual DOM to be loaded into the real dom. Because we only stop the timer when the playback is paused without clear layers, the data at the playback pause time is still rendered on the map. You can view the playback target details at the pause time by pausing playback. In this way, the progress and pause of playback can be controlled by changing the component state machine through a playback start stop button component. The control flow chart of historical data playback status is shown in Figure 4-26.

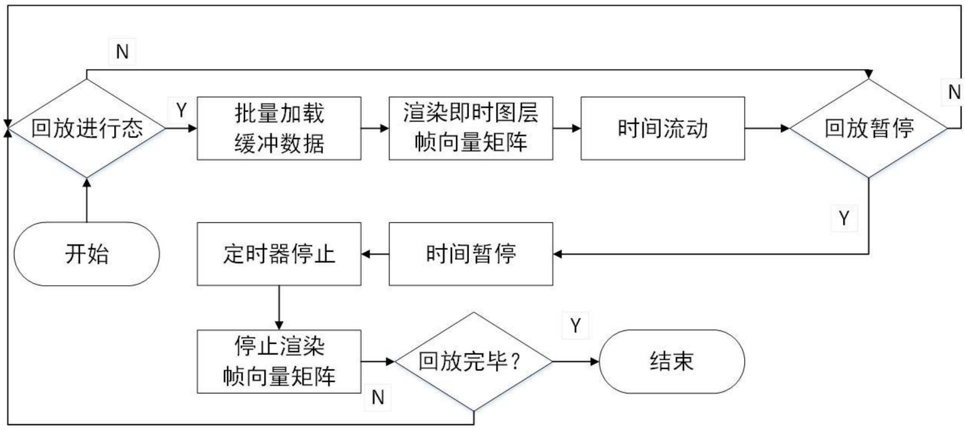


Figure 4-26 control flow chart of historical data playback status

While the slider component follows the buffer batch data loading algorithm to render the playback target, the progress bar slider will move according to the current playback progress. This is because each buffer batch data loading algorithm renders the historical playback frame data. After the data of each frame is rendered on the layer, The buffer data timer will encapsulate the time index of the time frame into the signal. The slider component will change the current progress value of the slider according to the time frame index by subscribing to the time frame index data. In this way, the slider progress bar slides according to a certain step with the progress of the timer. The buffer data timer timer and the current progress bar value essentially belong to the state of the process control component. Here, the value state of the progress bar cannot be changed through the timer, nor can it be processed through the component life cycle. Because the state update of react framework adopts the virtual DOM diff algorithm, if the silvalue state is changed through the timer, The changed state cannot be transferred in time, so the effect of the slider following timer cannot be realized. Here, the closed-loop self loopback communication method of the component is cleverly used. Through the timer state of the component, the component sends its own closed-loop signal and forces the component to update the component view, so as to realize the real-time sliding of the slider following timer. This shows that the forward component state sending signal causes the slider to change, and in turn, the slider can change the sliding state. The sending self loopback signal causes the time state of the component's current playback frame to change, so as to realize the timer timer to reuse the buffer batch data algorithm to cache the batch target playback data, and after dragging the progress bar, The timer re buffers the data, and the historical data playback will be played according to the progress after dragging. The self loopback communication mode of the process control component is shown in Figure 4-27.

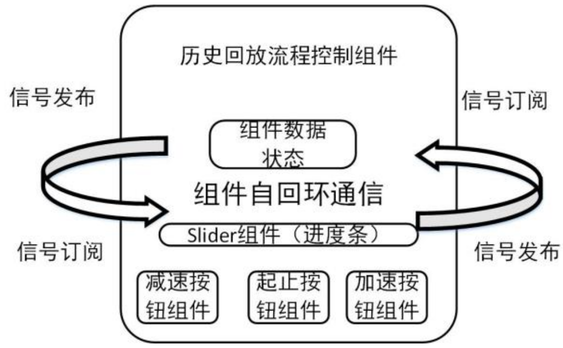


Figure 4-27 self loopback communication mode of process control component

Change the current playback rate status through the acceleration or deceleration button, and issue a signal to the batch data buffer timer inside the component through the self loopback communication of the component. The timer does not buffer the data immediately after receiving the changed speed status signal, The timer will judge whether the currently cached data can continue to be consumed according to the current rate and the current time frame index of playback. If it can continue to be consumed, it proves that the currently cached data can continue to support the use of playback, then continue to render the frame data, otherwise conduct batch data re buffering. Dragging the progress bar is the same. After dragging the progress bar, the self loopback communication is used to issue a signal to the batch data buffer timer inside the component. The timer does the same operation, so the acceleration and deceleration button component and slider component are used to realize progress control. The batch buffer control flow chart of historical data playback is shown in Figure 4-28.

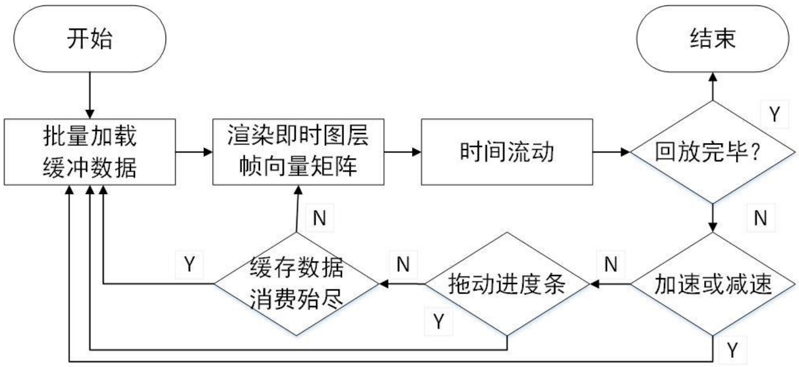


Figure 4-28 batch buffer control flow chart of historical data playback

When the data buffer is waiting, the progress bar will display the words in buffer. At this time, the front end constantly requests buffered data from the background, and the time stays at this moment. If you don't continue to walk, the data also stays at this moment. After the data buffering is completed, even if the server is closed, there is still buffered data locally, and the buffered data will continue to be played until the end of the local buffered data. If it is suspended at this time, the playback of buffered data will not be affected, and it can be accelerated to realize low coupling playback. Dragging the progress bar or sudden deceleration will trigger the buffer again, and accelerate during normal playback. The existing part of the buffer data will be played first according to the local buffer data until it is played to the part that is not, and then buffered. When accelerating and decelerating, dragging the progress bar will trigger the buffer again, and when buffering, dragging the progress bar to the buffered part will play normally again. The historical data playback rendering process and speed control algorithm are shown in Figure 4-29.

Algorithm 6 History Playback Process Render and Speed Control

Input:

The state of current playback S. The playback timer T.
The start time value of history data playback O.
The end time value of history data playback E.
Play speed factor r. The difference of adjacent frame time D.

Output:

The matrix Batch data M.

Create a buffer queue Q;
while $(S == True)$ **do**
  get current playbackFrameIndex $I := getCurrentFrameIndex()$;
  if $(getNextPlackbackFrame(I) == null || isSpeedFactorStateChanged(r) == True || isSlideProcess() == True)$ **then**
    $caculateCurrentSpeed(r)$;
    $Q \leftarrow bufferBatchData(O, E, D, I, r)$;
    $M \leftarrow Q$;
  else
    if $(I < getEndFrameIndex(E))$ **then**
      $getBatchSupermapMarkerVector(Q, M, I)$;
      $renderFrameData(Q, M, I)$;
      $changeCurrentFrameIndex(I)$;
    else
      $stopPlayback()$;
    end if
  end if
  Return M;
end while

Figure 4-29 historical data playback and rendering process and speed control algorithm

4.1.3.4 implementation of historical playback event alarm component

The historical playback event alarm component is a three-tier nested tree component. When fast forward playback to the time node containing key frame alarm events and important regional behavior information, the pop-up alarm notification will be suspended automatically. Select whether to stop fast forward playing keyframe events frame by frame or skip keyframe alarm events. The component contains notification component, which contains more complex key frame event notification content, and contains two button components. It performs interactive notification, gives the user's next action point, and the system actively pushes it.

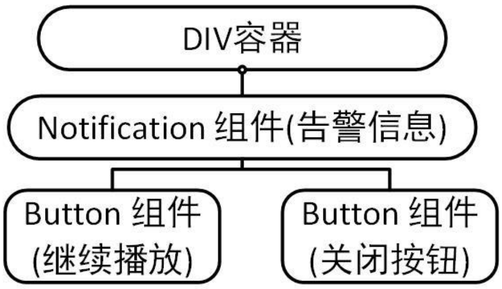


Figure 4-30 historical playback event alarm notification component

The historical playback event alarm notification component pops up a message notification in the upper right corner of the system interface using the open method of the notification component, displays the basic information of the event key frame preloaded by the data in the historical playback in the content part of the notification component, and changes the playback state of the current historical playback control process component by clicking the mouse event to control it to pause playback, And clear the buffer data timer. After clicking to stop fast forward frame by frame playback, the timer will be restarted. If it is in fast forward state at this time, the rate state will be transferred to normal rate for frame by frame playback of key events. If it is still fast forward, the event is skipped. If skip event is selected, the timer will be restarted automatically when the playback is restarted, and since it is now in fast forward state, it will automatically buffer and jump the data from the current playback progress state to the key event frame, and it is in the state of playback skip forward playback during fast forward, so it will automatically skip the key frame event. The fast forward playback event alarm process control is shown in Figure 4-31.

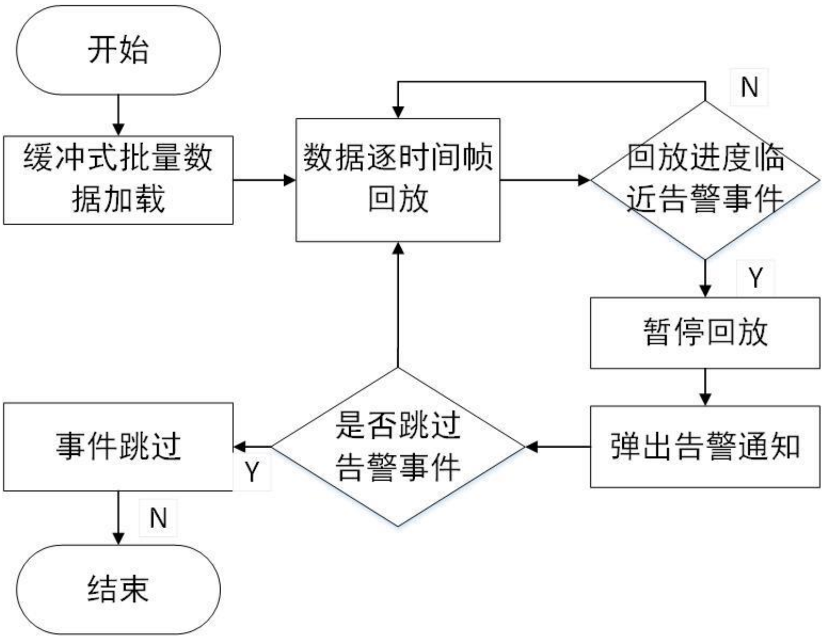


Figure 4-31 fast forward playback event alarm process control

Algorithm 7 History Playback Warning Behavior and Event Notify

Input:

The waring event time array T. The state of current playback timer$S$.
The difference of adjacent frame time D.

Output:

The matrix Warning event data M.

Create a buffer queue Q;
while $(S == True)$ **do**
  get current playbackFrameIndex $I := getCurrentFrameIndex()$;
  while $(isArrayEmpty(T) == False)$ **do**
    get current event time Index T_c=$getCurrentEventTimeIdex(T)$;
    if $(I < T_c \&\& I + D > T_c)$ **then**
      $caculateCurrentSpeed(r)$;
      $M \leftarrow getEventInfo(T_c)$;
      $publishSignaltoWarningNotification(M)$;
      $pauseHistoryPlaybackProcess()$;
      Return M;
    end if
    $changeCurrentEventTimeIdex(T_c)$;
  end while
  $continueHistoryPlaybackProcess(Q, M, I)$;
end while

Figure 4-32 alarm notification algorithm for historical batch buffered data playback events

For historical playback of alarm events, fast forward playback to the next playback time is the progress of the alarm event, that is, if there is no alarm at this moment, the alarm event at the next moment will be automatically suspended, and a notification box will pop up and suspended. Therefore, during fast forward playback, the timer will continuously match the current time frame index with the preloaded key event frame matrix. If the matching meets the condition of fast forward ignoring key event frames, an alarm notification will pop up. The alarm notification algorithm of historical batch buffer data playback event is shown in figure 4-32.

4.2 spatial paradigm design and component implementation of situation presentation system

4.2.1 target tracking interpretation design and component realization

4.2.1.1 target tracking vision and interpretation effectiveness model

In target visual tracking, the traditional methods based on correlation filter have the bottleneck of functional redundancy and lack of motion information. We can use a new tracking framework called multi-level independent correlation filter [25] 1 for target visual object tracking. Its framework architecture is shown in the figure below.

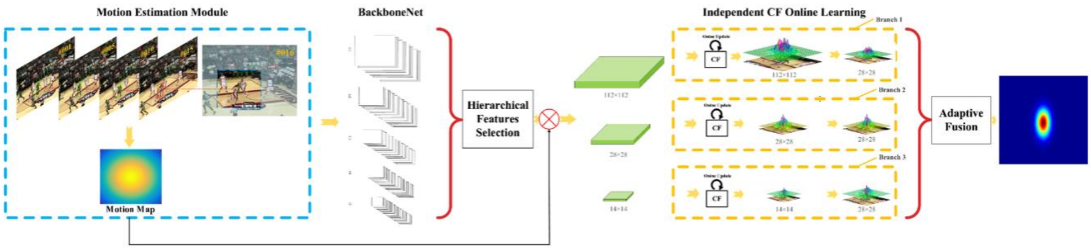


Figure 4-33 mhit framework system [25] 2

The multi-level independent correlation filtering model trains a set of independent filters for each feature [25] 4:

$$x_l = \sum_{i}^{D_l} x_{l,i} \tag{4-39}$$

Where XL and I are the characteristics of lth layer and ith channel. Each layer of convolutional neural network can be regarded as a set of nonlinear filters. With the increase of feature size, more complexity and redundancy will be introduced into the algorithm. Therefore, the input image is encoded by a filter of each layer. If there is a D filter in one layer and the size of the feature map is m times m, the number of channels corresponding to the feature map is also d. With the deepening of hierarchical features, D increases gradually, and the complexity of feature mapping increases gradually. If we directly combine multidimensional features, the dimension of features will be very high, which will greatly increase the computational burden [25] 3.

Therefore, it is effective to improve the accuracy of the results by increasing the specific area of the selected level or number of layers. On the contrary, too many layers will make it more difficult to select the correct results and encounter a lot of computational burden. Therefore, the best solution is to compromise specific areas and layers. The decomposed objective function can be expressed as l independent solution objective functions [25] 5:

$$\arg\min \sum_{k=1}^{K} ||\phi(x_{l,k}, f_l) - y_{l,k}||_{L^2}^2 + \lambda \sum_{d=1}^{D_l} ||w * f_{l,d}||_{L^2}^2$$

（4-40）[25]5

Where FL and D are the filter parameters of lth layer and DTH channel, and YK represents the predefined Gaussian window objective function [25] 4.

For the above optimization problem in equation 14, we first solve the filter parameter F. For each set of filters, the derivative is set to zero and the minimum value of the equation is solved by the following normal equation [25] 5, where

$$\Gamma = diag(f_{l,1}, f_{l,2}, ..., f_{l,D_l}) \in R^{D_l \times D_l}$$

(4-41) [25]5

$$Af = \Gamma^T X y$$

(4-42) [25]5

(4-43) [25]5

$$A = \Gamma^T X X^T \Gamma - \lambda W^T W$$

For multiple independent branches, the hierarchical filter is solved, and an adaptive weight scheme is used to effectively fuse and obtain more robust results. The final loss function is expressed as follows [25] 5:

$$E(f, m) = \sum_{l=1}^{L} m_l E_l(f) + \sum_{l=1}^{L} ||m_l||_{L^2}^2$$

$$s.t. \sum_{l=1}^{L} m_l = 1, m_l >= 0$$

(4-44)[25]5

The result of each layer is expressed as E. The optimization problem of M can be transformed into [25] 5:

$$\arg\min_{m} \mathbf{m}^{\mathbf{T}}\mathbf{E} + \mathbf{m}^{\mathbf{T}}\mathbf{m}, \quad s.t. \sum_{l=1}^{L} m_l=1, m_l>=0 \qquad (4\text{-}45)$$ [25]5

The following figure shows the expected average overlap, robustness and accuracy of the mhit model compared with the top ten best trackers. It can be seen that mhit is superior to other models in robustness, average overlap and expected average overlap [25] 6.

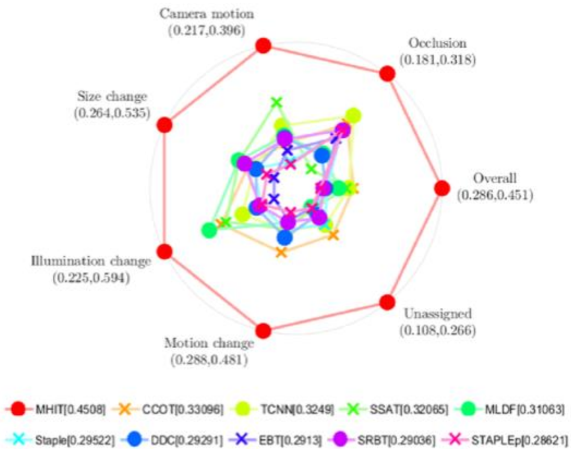


Figure 4-34 mhit comparison chart [25] 6

The situation system combining real-time and history is actually a typical multi-source sensor information fusion system. According to the complexity of the marine environment and the characteristics of the means, the efficiency model of the detection means is constructed by using the principle of analytic hierarchy process. Detection capability is the main index to evaluate the effectiveness of multi means cooperative detection. It reflects the measurement of the ability of multi means to complete the possible detection tasks. It can be comprehensively evaluated by target detection capability, target positioning capability, target tracking capability, recognition capability and target capacity.

The detection power area of the whole system of the target interpretation efficiency model is the synthesis of the power areas of all the means in the system. The size of the detection power area of the system is different under different target heights, different target cross-sectional areas and different detection probabilities. If disturbed, the detection power area of the system will change significantly. The detection capability evaluation indexes of target interpretation efficiency model include coverage coefficient, overlap coefficient and interference suppression ratio.

1) The coverage factor is defined as the ratio of the detection power area and the responsibility area of the system in the monitoring area:

$$C_{ov} = \frac{Y_{i=1}^{n}(A^{i}IA^{0})}{A^{0}} \tag{4-46}$$

$A^{i}A^{0}$ Where, it represents the detection power area of the ith monitoring and detection means, which is the area of responsibility area. Therefore, the minimum coverage coefficient of the power area is 0, which corresponds to that the monitoring and detection system does not want to intersect the detection power area and the responsibility area; If there is partial intersection, the coverage coefficient is greater than zero. The greater the coverage coefficient, the more the detection space reflected by monitoring and detection can meet the monitoring requirements.

2) Overlap coefficient refers to the ratio of the sum of the detection power area of monitoring and detection means to the detection power area of real system:

$$C_{cd} = \frac{\sum_{i=1}^{n} A^{i}}{Y_{i=1}^{n}(A^{i}IA^{0})} \tag{4-47}$$

3) Interference suppression ratio

The monitoring and detection system reduces the detection power area due to interference. The interference suppression ratio is defined as the ratio of the detection power area after the monitoring and detection system is disturbed to the detection power area without interference ratio:

$$J = \frac{Y_{i=1}^{n} A^{J,i}}{Y_{i=1}^{n}(A^{i}IA^{0})} \tag{4-48}$$

$A^{J,i}$Indicates the detection power area of the ith monitoring and detection means in the system after interference.

Considering the above evaluation indexes, the detection capability calculation model of multi means cooperative detection system is finally obtained:

$$C_{系统} = （1 + C_{ov}）^{k_1} \circ C_{cd}{}^{k_2} \circ (1 + J)^{k_3} \tag{4-49}$$

$k_1 k_2 k_3 \sum_{i=1}^{3} k_i = 1$,, and represent the weight factors of each coefficient in the detection capability of the monitoring and detection system, and.

Target interpretation efficiency model target positioning capability is to monitor the target positioning of the detection system, integrate the observation data of other means in the system on the premise of detection and discovery, and use a certain positioning algorithm to give the spatial position of the target. Generally, the evaluation of positioning ability includes expert evaluation method, qualitative analysis and fuzzy comprehensive evaluation method, or the technical parameters of sensors are calculated by detection means. These methods make the assessment results lack objectivity or can not reflect the interference brought by the marine environment. In order to quantitatively evaluate the target positioning performance of multi-means cooperative detection system in marine environment, positioning accuracy geometric dilution (GDOP) is used as the index to measure its positioning performance:

$$\mathrm{GDOP} = \overline{e_x^2 + e_y^2 + e_z^2} \tag{4-50}$$

$e_x^2 e_y^2 e_z^2$,, and represent the mean square deviation of positioning error of positioning three-dimensional coordinates.

The target tracking ability of target interpretation efficiency model can be expressed by target track and photoelectric target tracking accuracy.

$$E_{总} = E^i_{雷达航迹} + E^i_{光电} \tag{4-51}$$

I represents the number of sensor means. E represents the tracking accuracy of a sensor after normalization.

Target interpretation effectiveness model target recognition capability target recognition refers to the evaluation of correct recognition of target types and attributes, including target type recognition probability and target attribute recognition probability. Define step function:

$$W（X, Y）\begin{cases} 1 & X = Y \\ 0 & X \neq Y \end{cases} \tag{4-52}$$

X is the recognized target and Y is the real target. Single target recognition rate can be defined as:

$$P = \frac{1}{N}\sum_{i=1}^{N} W(X, Y) \tag{4-53}$$

N represents the number of different positions after target fusion, and then the multi-target recognition accuracy is obtained. If the number of targets is defined as K, the comprehensive correct judgment probability after the fusion of target attributes and types is:

$$P = \frac{\sum_{j=1}^{K}(N_j p_j)}{\sum_{j=1}^{K} N_j} \tag{4-54}$$

p_j Represents the probability of correct recognition of single target type and attribute fusion.

The target capacity of the target interpretation efficiency model refers to the maximum number of targets in the monitoring area. Generally speaking, when the target capacity is less than or equal to the maximum number of threat targets that may appear in the monitoring area, it is an indicator of the larger the more free; When it is greater than the maximum number of possible threat targets in the monitoring area, increasing the target capacity of the system has no obvious impact on the effectiveness of the system.

4.2.1.2 implementation of migration situation component

The migration situation component includes the model component, which contains two button components for operation interaction. Use the transfer component to select the target to view the migration situation, and use the Ranger component to select the time period to query the target spatial location data. The component realizes the spatial historical track of a specific single target in a specific period of time, displays the spatial migration and transfer situation of the target after data sampling, key track frame extraction and historical track query, and displays the historical static space-time information of the target migration track. The events, regional behaviors and alarm information in the process of target migration are rendered on the visual interface with high-density and scalable charts. The migration situation component structure is shown in Figure 4-35.

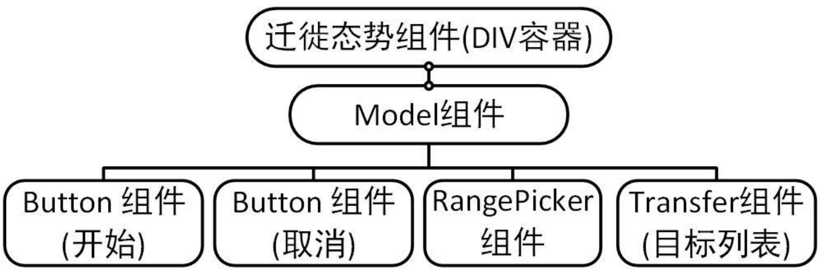


Figure 4-35 migration situation component structure

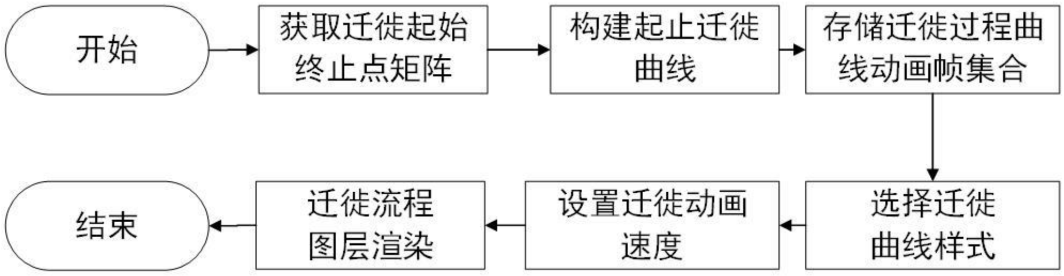


Figure 4-36 migration situation rendering process

The rendering process of migration situation is shown in Figure 4-36. Migration is a coarse-grained display based on space and global scope. After clicking the migration situation, the migration track of the target in a certain period will be displayed, and the end point of each track has a mark. Clicking the mark will pop up the historical information of this track. After clicking, you should select the target, select the start and end time of target tracking interpretation, return in the background, and the sampling start and end coordinates of target migration. When it can be single target or multi-target display, the migration tracks of different targets should have different colors, and the events on the chart should use different colors and indicate the legend. After clicking the migration situation, it will automatically send a request to the background to display the current target table data in the list. After clicking submit, it will send the target ID number to be tracked and interpreted to the background. The background will return to the historical migration start and end point during this period, fit the migration curve based on the data obtained in the Ajax success function, and write the migration information into the pop-up box, Finally, the migration curve and animation effect are displayed on the mapv layer. Note that drag the map layer here to redraw the mapv layer, otherwise animation errors will occur.

Events, behaviors (entering and leaving the protection zone) and alarm information during target migration are displayed in a scatter chart, and can display specific alarm events, location, time, characteristic information, as well as event alarm information entering and leaving the protection zone. The built-in data area scaling component can overview the data as a whole and pay attention to data details as needed. After the migration track is displayed, the event table should also be initialized, including initializing legends and initializing different data of different legends. Click the migration situation again, cancel all the current display contents, clear the layer, clear the chart data, and set the chart invisible.

Algorithm 8 Target Migrate Curve Render

Input:

The start point array of migration O.
The end point array of migration E.
The mapv curve render layder L.

Output:

The render migration curve set M.

for all i such that $0 \le i \le sizeof(O)$ **do**
  $lineData[i] := pushPointData(O[i], E[i]);$
  $curveData[i] := mapvUtilCurve(lineData[i]);$
  for $j = 0$ to $sizeof(curveData[i])$ **do**
    $timeMoveData[i][j] := pushTimeMovePoint(curveData[i][j]);$
  end for
end for
$M := pushData(curveData, timeMoveData);$
$setCurveFillStyleShadowColor(L);;$
$L \leftarrow addDataSettoLayer(M);$

Figure 4-37 migration situation rendering algorithm

The migration situation rendering algorithm is shown in figure 4-37. Firstly, query the historical track in a specific period of time, and obtain the key track start point matrix, and then traverse the key track start point matrix to build a start stop migration curve for each start stop point, and each start stop migration curve is established, It is necessary to traverse and sample the curve points of this migration curve to form a migration process curve animation frame point set, finally select the migration curve style, set the migration animation speed, and use the supermap.mapv layer in the mapv framework to render the above migration data set.

4.2.1.3 implementation of hot area components

The hot spot area component is a three-layer structure. For the area where a single target often occurs, the system renders the density of target spatial location data and area access frequency in the form of thermal map through the color band, uses the buffer to cross fill the gray superposition through the kernel density analysis method, and then maps the gray information in the color band space, Thus, the relative density and weighted density of the target thermal point are displayed from cold color to warm color. Two button components are accommodated internally for operation interaction. The transfer component is used to select the target that needs to view the hotspot area, and the Ranger component is used to select the time period for querying the target spatial location data. The structure of hot spot area components is shown in figure 4-38.

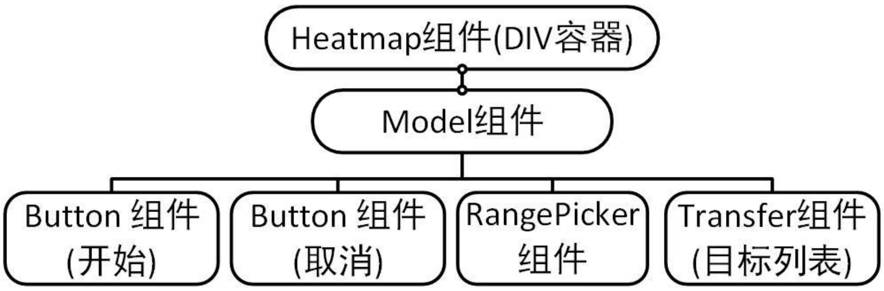


Figure 4-38 hot spot area component structure

The rendering process of hotspot area is shown in figure 4-39. The area where a single target often appears is displayed in the form of a hot spot map, and the area where the target often appears can also be displayed. Specifically, at what time point the target often appears.

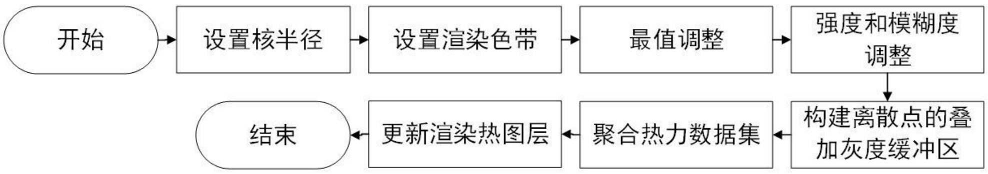


Figure 4-39 rendering process of hot area

The hotspot rendering algorithm is shown in Figure 4-40. Firstly, set the core radius, and then set a rendering ribbon representing the final thermal map effect, which is mapped by spatial gray value. Then we adjust the maximum and minimum values of the color band, and adjust the rendering effects such as its fuzziness and intensity, and then use the above parameters to establish a buffer for the target location data set queried in space, and then the gray value is obtained through the superposition of the buffer, and the gray value is mapped to the color band, Then rendering on the thermal layer completes the hot area rendering process.

Algorithm 9 Target Region Heatmap Render

Input:

The matrix of point P. The Heatmap render layder L.

Output:

The render Heatmap set M.

$setNuclearRadius(L);$
$setGrayBuffer(L);$
$setPointsWeight(P);$
$adjustRenderRibbon(L);$
$ajustIntensity(L);$
$adjustMaximunAmbiguity(L);$
$L \leftarrow addDataSettoLayer(P);$
$M \leftarrow renderHeatmapLayer(L);$

Figure 4-40 hotspot rendering algorithm

4.2.1.4 implementation of data cellular components

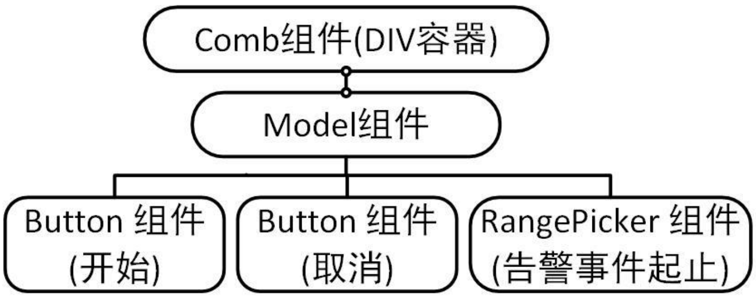


Figure 4-41 data cellular component structure

The structure of the data cell component is shown in figure 4-41. The component is divided into three layers. The rangepicker component is used to select the start and end time of the alarm time, and the grid aggregation diagram is used to show the distribution and statistical characteristics of the spatial data of the target alarm events and behaviors. Based on the grid aggregation algorithm, the spatial area is divided into a nested and hierarchical set of grid cells, and each grid cell has the statistical information of target alarm events.

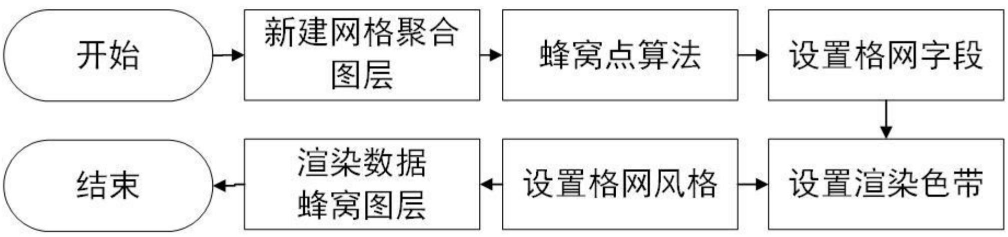


Figure 4-42 data cellular rendering process

The area with frequent events and hot spots in the protection area should have its own unique characteristics. This area can be displayed by the method of data cell. The data cell rendering process is shown in figure 4-42.

Grid aggregation graph is simply a spatial aggregation method to represent the distribution and statistical characteristics of spatial data. Its basic principle is based on the grid aggregation algorithm. The spatial region is divided into a nested and hierarchical set of grid cells based on the grid aggregation algorithm. Each grid cell has statistical information.

Mapv framework supports the construction of grid aggregation graph for spatial point data, and provides aggregation display of two shapes of grids, one is rectangular grid and the other is hexagonal grid. The map point elements are meshed through the grid, and then the number of point elements in each grid cell is calculated as the statistical value of the grid. The weight information of points can also be introduced, and the weighted value of points in the grid cell can be considered as the statistical value of the grid; Finally, based on the statistical value of the grid cells, the grid cells are filled with color through the color band.

For data cellular rendering, first create a new mesh aggregation layer, use hexagonal mesh cells as a grid of uniform size, and the size of mesh cells is fixed with the change of map scale; The grid is used to count the number of point objects falling into each grid cell. Each grid center has a label, which is the statistical value of grid cells. The statistical value can be the number of point objects falling into each grid cell or the weighted value of points falling into each grid cell. The filling color of grid cells indicates the distribution trend of grid statistical values, and its color ranges from dark to light, indicating that the value of grid cells ranges from large to small. In addition, you can set the style of grid rectangular border.

Algorithm 10 Honeycomb point and region render

Input:
The matrix of point P. The Honeycomb render layder L.

Output:
The render comb set M.

$dx := 3 * sideLength(P)$; $dy = sideLength(P)/2 * 1.73$; $indent := dx/2$;
$xmin := XMin(P) - dx; ymin := YMin(P) - dy * 3.0$;
$xmax := XMax(P) + dx$; $ymax := YMax(P) + dy * 3.0$;
$numrows := int((ymax - ymin)/dy) + 1$;
$numcols := int((xmax - xmin)/dx) + 2$;
$y := ymin$;
for $r = 0$ to $range(numrows)$ **do**
  $x := xmin - indent/2$;
  if $(r\%2! = 0)$ **then**
    $x+ = indent$;
  end if
end for
for $c = 0$ to $range(numcols)$ **do**
  $p := Point(P)$;
  $p.X := x$; $p.Y := y$;
  $x+ = dx$; $y+ = dy$;
end for
$setGridAggregationRenderRibbon(L, P)$;
$L \leftarrow setGridFeildFrameStyle(L, P)$;
$M \leftarrow renderCombLayer(P)$;

Figure 4-43 data cellular rendering algorithm

According to the cellular rendering algorithm, see figure 4-43. Firstly, the cellular hexagon is generated by using the cellular point algorithm, and then the grid field is set. If a grid field is specified, the field value will be used as the weight information of the points. At this time, the statistical value of each grid cell in the grid aggregation graph is the weighted value of the points falling in the cell. In addition, the specified grid field is numeric. Set the rendering color band, render the grid cells with the largest and smallest statistical values in the grid aggregation diagram through the maximum value color and minimum value color, and other grid cells are rendered with other colors in the gradient color band. The larger the statistical value, the closer the rendering color is to the end of the maximum value color in the color band. Set the style of grid, including grid size, grid border and grid label. The size is determined by specifying the side length. There are three cases for the linetype of the rectangular border line of the cell: no border, solid line border and dotted line border. You also need to set the border line width, border line color and translucent effect. Sets the style of statistics labels within grid cells.

4.2.2 target design and Realization

Target portrait service is to distinguish the differences of target behavior, characteristics and events into different types, extract typical features from each type, give descriptions such as identification and statistical elements, form a target prototype, that is, target information labeling, analyze and statistically mine potential value information for these features, and establish a target data cube, Abstract the feature panorama of a target. Target portrait can help security monitors find the target that really needs attention, analyze statistics and mine potential value information, so as to predict the next action of this target to a certain extent.

Firstly, the target information is labeled. The system obtains the target feature information through a series of algorithms or rule mining or directly obtains the target feature information according to the behavior data, and labels it. The feature has a certain timeliness or half-life. The tags obtained at different times need to be weighted. For example, the closer the time, the higher the weight. The perceptual characteristic tag of the target includes nationality, length and width, ship type, destination, rotation rate, radial speed, electromagnetic frequency, actual heading, etc. the target behavior attribute tag includes access to the protection area, alarm, haunting area (in the form of longitude and latitude), ship status and event type (regional problems, personnel falling into the water, abnormal speed, excessive steering, continuous approach to the island, abnormal size, abnormal state, abnormal ship name), residence time in the protection area, nearest distance to the island, etc.

Then build the target prototype data cube. The target portrait not only extracts the behavior characteristics of the target and gives the target a type or prototype, but also displays the information of the prototype itself, that is, some historical behavior and threat alarm data about this kind of target in the intelligence base we have established, which realizes the establishment of data cube for these characteristics, analysis and statistical mining Dig out the potential value information of the target prototype, so as to predict the next action of the target to a certain extent. Suppose that we have achieved electromagnetic control, a target is labeled as UHF Communication, but it does not trigger any alarm events and does not produce dangerous behavior temporarily, but most of the historical targets of this kind of high-frequency communication are of high threat level The current goal can be predicted to a certain extent.

To accurately identify the target, according to the existing data association scheme, we can basically analyze the target dynamic behavior and track the target from three aspects: equipment, area and path. We need to evaluate the target in combination with four dimensions: time, place, target static data, threat or behavior.

The system makes a preliminary attempt on the target portrait and realizes the preliminary portrait of the target prototype. The portrait methods are as follows:

1） The percentage of targets with similar characteristics (aspect ratio average speed) in the total target and its percentage according to the alarm level.

2） The target aspect ratio feature is selected for aggregation analysis with the threat degree index

After using echart and componentization technology for state management, the prototype view is rendered in componentdidupdate. The problem of rendering the prototype view is solved by rendering the prototype view after the activekey state is changed to the prototype view. The specific portrait effects are shown in figure 4-44 and 4-45 below.

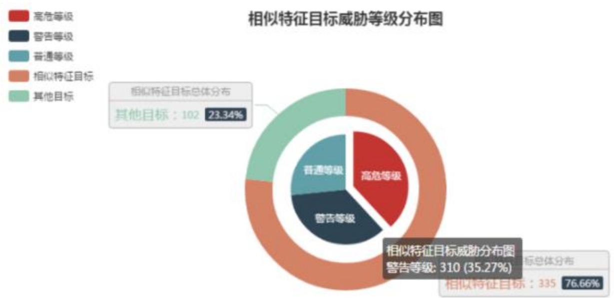


Figure 4-44 threat level distribution of targets with similar characteristics

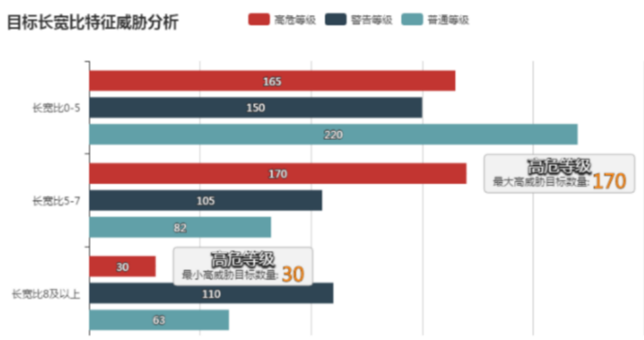


Figure 4-45 characteristic data cube of target aspect ratio

4.3 summary of this chapter

This chapter details the component implementation of the design and implementation of the temporal and spatial paradigm of the situation presentation system. The system uses the temporal paradigm to design the real-time situation monitoring mode and historical data playback mode, and uses the spatial paradigm to design the target tracking interpretation and target portrait service. This chapter introduces in detail the component implementation of the dual display mode of the combination of real-time and history in the temporal paradigm in the system This paper introduces in detail the use of spatial paradigm for coarse-grained spatial history playback from the global, and introduces the specific implementation method of spatial big data visualization.

Chapter V system test and verification

This chapter tests the function and performance of the system.

5.1 system test objectives and hardware test environment

5.1.1 system test objectives

This paper designs and implements a multi view target situation presentation system combining real-time and history. The system realizes real-time situation monitoring and historical data playback based on target information map, tracking interpretation and target portrait based on GIS service, and designs and implements a situation presentation system supporting real-time history dual display mode by using space-time paradigm In this chapter, the function and performance of the system are tested and verified in detail. By building the system test simulation platform environment and describing the test methods, function test processes and test results of each function, it is proved that the system is A situation presentation system with relevance of display information, in-depth understanding of objectives, following the paradigm of time and space, and dual display mode of real-time history

The purpose of the system test is to verify the effectiveness and reliability of the function of the situation system. The test functions include: the display of target information map and multi-dimensional data views of original perception, characteristics, behavior events and threat criteria in the real-time monitoring mode, equipment display and control linkage, video monitoring, real-time alarm and scenario playback functions in the real-time monitoring mode, and historical data playback mode Historical playback display mode, buffered batch data loading algorithm, historical playback process control, historical playback event alarm, tracking and interpretation of service migration situation, hot area, data cell, and target portrait function. The system verifies the effectiveness and reliability of situation system function through function test.

We test the response time, concurrent buffer performance and stability performance of the system respectively, and conduct quantitative analysis. The final quantitative analysis results verify the reliability and effectiveness of the system.

5.1.2 hardware test environment

(1) Platform structure

The structure of the test platform is shown in Figure 5-1.

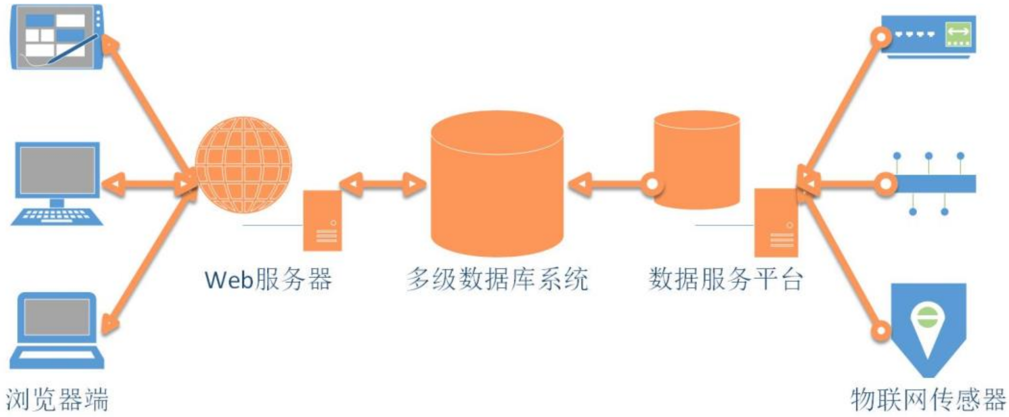


Figure 5-1 system environment topology

The topology of system simulation test platform includes:

Client: the browser side of the system, which is responsible for visualization.

Server: the server uses Tomcat 6.0.45 lightweight web container to provide background data interface service and control command publishing and subscription service.

Multi level database system: neo4j graph database, HBase column database and MySQL relational database deployed on the server to store multi-dimensional data view and target information map.

Data service platform: provide IOT access services, real-time computing and history mining services, streaming media services, GIS services and other computing intensive services.

IOT sensor: various underlying sensor devices, which realize the functions of multi-source heterogeneous original sensing data collection, datagram upload and so on.

(2) Simulation test platform hardware

The system test hardware environment built in this chapter is

Table 5-1 hardware parameters of testing machine

operating system	Windows 7
Processor type	Intel i7 processor 2.5GHz

Memory	32.00GB
System bits	64 bit operating system

5.2 system function test

This section tests all functions of the system, including the display of target information map and multi-dimensional data view of original perception, characteristics, behavior events and threat criteria in real-time monitoring mode, equipment display and control linkage, video monitoring, real-time alarm and situation playback functions in real-time monitoring mode, historical playback display mode in historical data playback mode and buffered batch data Loading algorithm, historical playback process control, historical playback event alarm, tracking and interpretation service migration situation, hot area, data cell, and target portrait function.

5.2.1 real time situation monitoring mode test

5.2.1.1 original perceived data view test

For the display logic and visualization effect of the original perceived data view in the real-time monitoring mode, the function test process is shown in table 5-2:

Table 5-2 real time monitoring mode raw perceived data view test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion label in the interface control area, the drop-down component list will pop up automatically, and click the real-time monitoring component. （3） After activating the real-time monitoring component, the component turns red, and the real-time monitoring target mark points appear on the map. Click the target mark to open the multi-dimensional data view card container component. （4） Click the multi-dimensional data tab of the multi-dimensional view card container to open the original perception data view.

The test results show that the system can correctly obtain the information of the original perceptual data view in real time and perform reliable real-time rendering. The real-time rendering effect is smooth without jamming. The original perceptual data view completely shows the target multi-dimensional perceptual data, and the interface operation logic is correct, smooth and without jamming. The test results are shown in figures 5-2 and 5-3.

Figure 5-2 overall visualization effect of original perception data view

Figure 5-3 visualization effect of card container in the view of original perceived data

5.2.1.2 feature data view and target information atlas test

For the display logic and visualization effect of real-time monitoring mode feature view and target information map, the function test process is shown in table 5-3:

Table 5-3 characteristic view and target information atlas test of real-time monitoring mode

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion label in the interface control area, the drop-down component list will pop up automatically, and click the real-time monitoring component. （3） After activating the real-time monitoring component, the component turns red, and the real-time monitoring target mark points appear on the map. Click the target mark to open the multi-dimensional data view card container component. （4） Click the feature View tab of the multi-dimensional view card container to open the visualization of feature view and target information atlas

The test results show that the system can correctly obtain the information of feature view and target information atlas in real time, and conduct reliable real-time rendering. The real-time rendering effect is smooth without jamming. The feature view and target information atlas completely display the target feature data and target information atlas, and the interface operation logic is correct, smooth and without jamming. The test results are shown in Fig. 5-4 and 5-5 As shown in.

Figure 5-4 overall visualization effect of feature data view and target information Atlas

Figure 5-5 visualization effect of card container in the view of original perceived data

5.2.1.3 behavior event data view test

For the display logic and visualization effect of real-time monitoring mode feature view and target information map, the function test process is shown in table 5-4:

Table 5-4 real time monitoring mode behavior event data view test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion label in the interface control area, the drop-down component list will pop up automatically, and click the real-time monitoring component. （3） After activating the real-time monitoring component, the component turns red, and the real-time monitoring target mark points appear on the map. Click the target mark to open the multi-dimensional data view card container component. （4） Click the behavior View tab of the multi-dimensional view card container to open the behavior event data view

The test results show that the system can correctly obtain the information of the behavior event data view in real time, and conduct reliable real-time rendering. The real-time rendering effect is smooth without jamming. The behavior event data view uses structured tables to display the behavior event data completely, and the interface operation logic is correct, smooth and without jamming. The test results are shown in figures 5-6 and 5-7 As shown in.

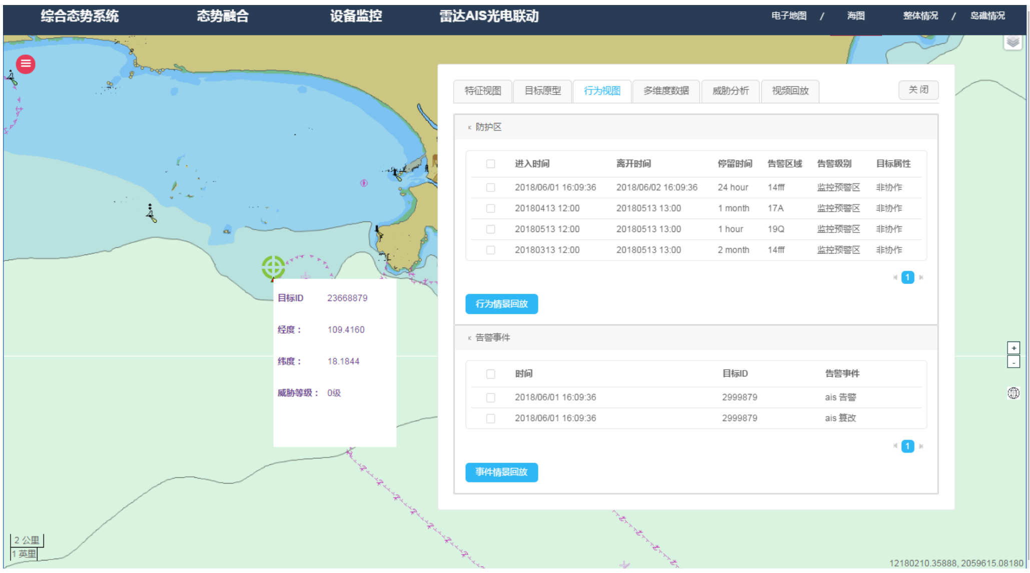


Figure 5-6 overall visualization effect of behavior event data view

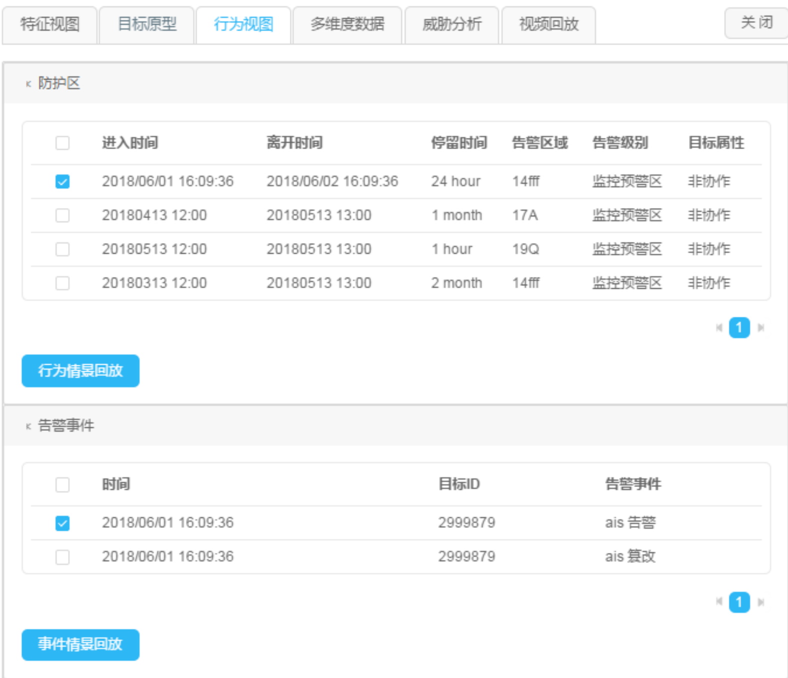


Figure 5-7 behavior event data view card container visualization

5.2.1.4 threat criterion data view test

For the display logic and visualization effect of threat criterion data view in real-time monitoring mode, the function test process is shown in table 5-5:

Table 5-5 real time monitoring mode threat criterion data view test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion label in the interface control area, the drop-down component list will pop up automatically, and click the real-time monitoring component. （3） After activating the real-time monitoring component, the component turns red, and the real-time monitoring target mark points appear on the map. Click the target mark to open the multi-dimensional data view card container component. （4） Click the threat analysis tab of the multi-dimensional view card container to open the threat criteria data view

The test results show that the system can correctly obtain the information of the threat criterion data view in real time, and conduct reliable real-time rendering. The real-time rendering effect is smooth without jamming. The threat criterion data view completely shows the target threat level, threat criterion and alarm transition process, and the interface operation logic is correct, smooth and without jamming. The test results are shown in Figure 5 -8,5-9.

Figure 5-8 overall visualization effect of threat criterion data view

Figure 5-9 threat criteria data view card container

5.2.1.5 equipment display control linkage and video monitoring tracking test

For the real-time monitoring mode, the equipment display and control linkage, video monitoring tracking display logic and visualization effect are tested. The function test process is shown in table 5-6:

Table 5-6 real time monitoring mode equipment display control linkage and video monitoring tracking test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the equipment display and control label in the interface control area, and the drop-down component list will pop up automatically. Click each equipment component in the drop-down list in turn to turn on the equipment display and control function, and start the real-time monitoring mode. （3） After activating the device display and control function, the component turns red, and the real-time monitored target mark point and device perception information appear on the map. Right click the target mark point or device mark point to pop up the menu. Click the menu item photoelectric follow-up start, pop up the photoelectric video box, and complete the device linkage function. （4） Click the target tag to open the multi-dimensional data view card container component. Click the multi-dimensional label of the multi-dimensional view card container to open the original perception data view, click the open map small video button of the photoelectric dimension in the view, and click the tracking button. Complete the video monitoring and tracking function

The test results show that the system can correctly perform equipment display and control, linkage, video monitoring and tracking functions, and the interface operation logic is correct, smooth and free of jamming. The test results are shown in figures 5-10 and 5-11.

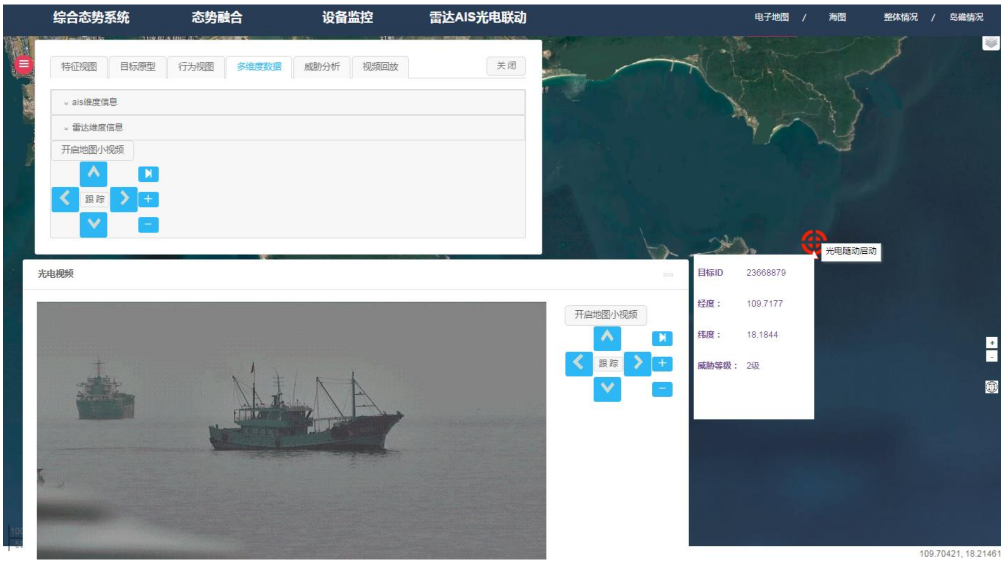


Figure 5-10 effect of equipment display control linkage function test

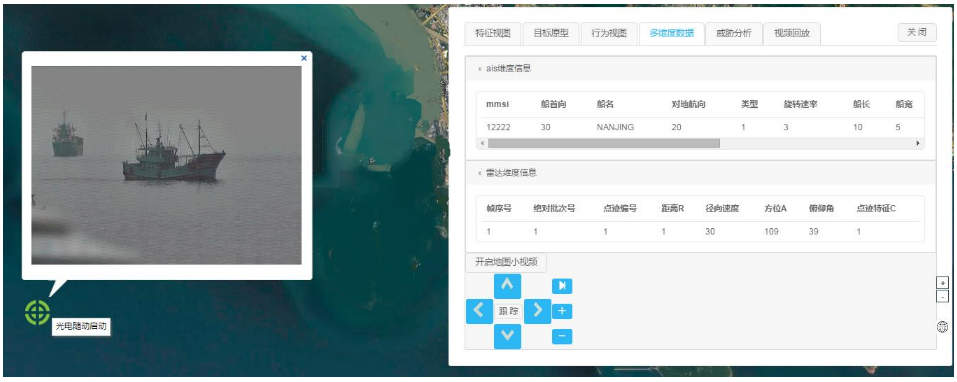


Figure 5-11 video monitoring and tracking function test effect

5.2.1.6 real time alarm test

For the display logic and visualization effect of real-time alarm function in real-time monitoring mode, the function test process is shown in table 5-6:

Table 5-7 real time alarm function test of real-time monitoring mode

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically. Click the real-time monitoring component to start the real-time display and control mode. （3） After the real-time monitoring mode is activated, the real-time monitoring target marker points appear on the map. When

	the target generates an alarm event, it will flash in varying degrees according to the alarm level, and the marker will turn red or yellow according to the alarm level.

The test results show that the system can correctly display the alarm information in real time, and reliably render the flicker effect in real time. The real-time alarm flicker effect is smooth without jamming, and the interface operation logic is correct, smooth and without jamming. The test results are shown in Figure 5-12.

Figure 5-12 test effect of real-time alarm function in real-time monitoring mode

5.2.1.7 behavior event scenario playback test

For the real-time monitoring mode behavior event scenario playback function display logic and visualization effect, the function test process is shown in table 5-8:

Table 5-8 real time monitoring mode behavior event scenario function test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically. Click the real-time monitoring component to start the real-time monitoring mode. （5） After activating the real-time monitoring mode, the real-time monitoring target mark points appear on the map. Click the target mark to open the multi-dimensional data view card container component. （3） Click the behavior View tab of the multi-dimensional view

card container to open the behavior event data view.

（4） Select a behavior or event record in the behavior event data view, and click the behavior event scenario playback button.

The test results show that the system can correctly play back the behavior event scenario in real time, the behavior event scenario playback effect is smooth without jamming, the information of scenario playback is complete, and the operation logic of control playback is correct, smooth and without jamming. The test results are shown in figures 5-13, 5-14 and 5-15.

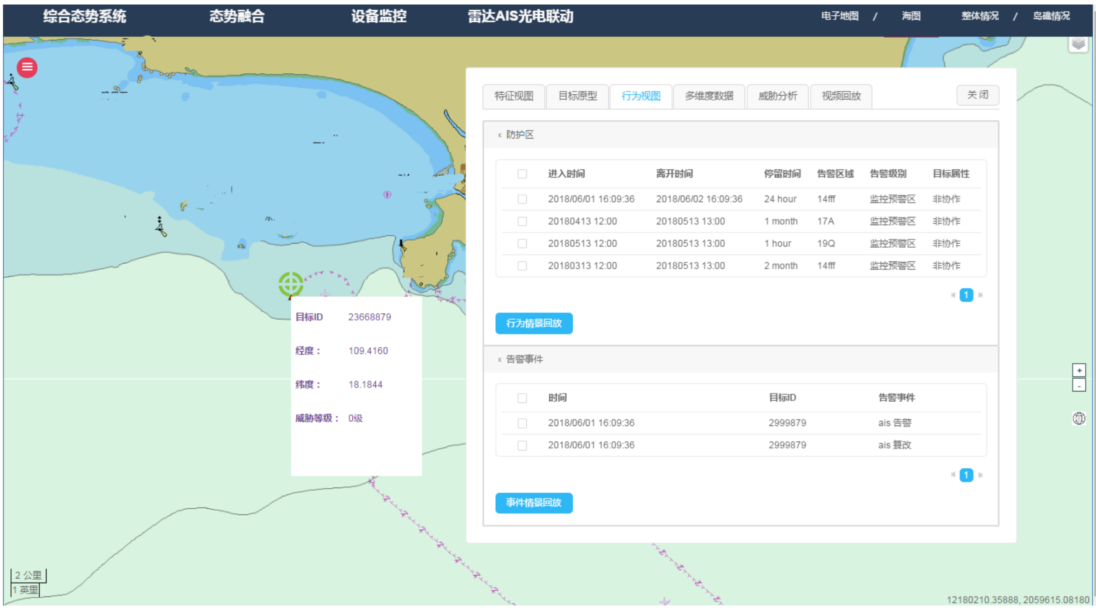


Figure 5-13 test effect of real-time monitoring mode behavior event scenario selection function

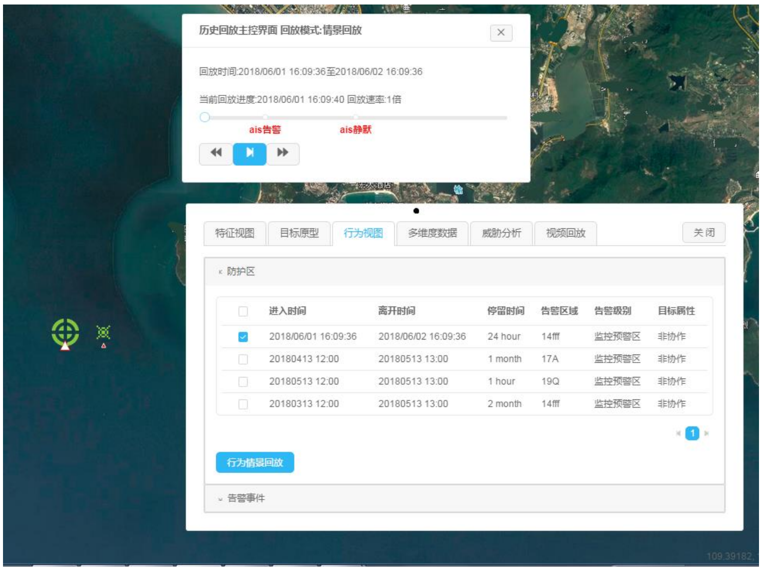


Figure 5-14 detailed playback function test effect of behavior event scenario in real-time monitoring mode

Figure 5-15 real time monitoring mode behavior event scenario playback progress control component

5.2.1.8 video scenario playback test

For the display logic and visualization effect of video scenario playback function in real-time monitoring mode, the function test process is shown in table 5-9:

Table 5-9 real time monitoring mode video scene function test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically. Click the real-time monitoring component to start the real-time monitoring mode. （6） After activating the real-time monitoring mode, the real-time monitoring target mark points appear on the map. Click the target mark to open the multi-dimensional data view card container component. （3） Click the video playback View tab of the multi-dimensional view card container to open the video playback view. （4） Select the video in the video playback list and click the start playback button to play the video.

The test results show that the system can correctly perform video scenario playback, the video scenario playback effect is smooth without jamming, the information of scenario playback is complete, and the operation logic of control playback is correct, smooth and without jamming. The test results are shown in Figure 5-16.

Figure 5-16 video scenario playback test effect in real-time monitoring mode

5.2.2 buffered batch data loading algorithm test

5.2.2.1 batch data buffer test

Test the buffered batch data loading algorithm in historical playback mode, and the steps are shown in table 5-10:

Table 5-10 real time monitoring mode video scene function test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically. Click the target playback component in the historical playback, select the playback target and playback interval of the test, and start the historical playback. （3） After the historical playback starts, the target marker point of historical playback appears on the map, and then view the allowable time and buffer time of historical playback.

Figures 5-17 and 5-18 show the operation effect of buffered batch data loading algorithm in the process of historical playback. 30 frames of perceptual data are buffered at a time, and each frame contains the comprehensive sensor information of 20 targets.

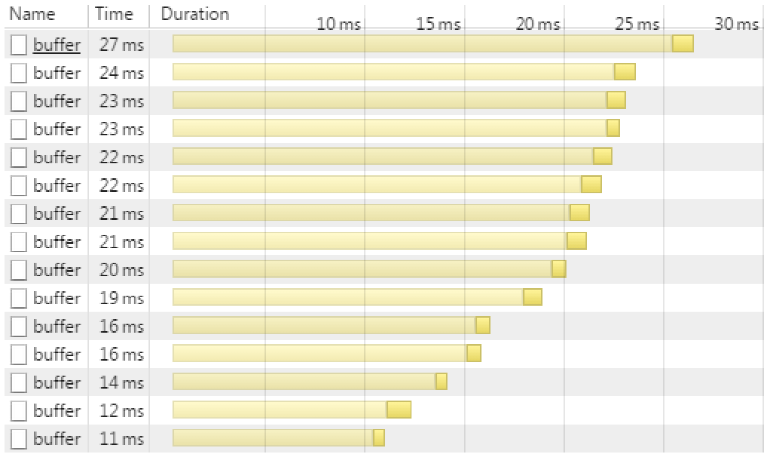


Figure 5-17 test effect of buffer batch data loading algorithm batch data buffer time

Figure 5-17 shows the buffer waiting time for 15 buffers, buffering 30 frames of data each time, with an average buffer time of 19 milliseconds.

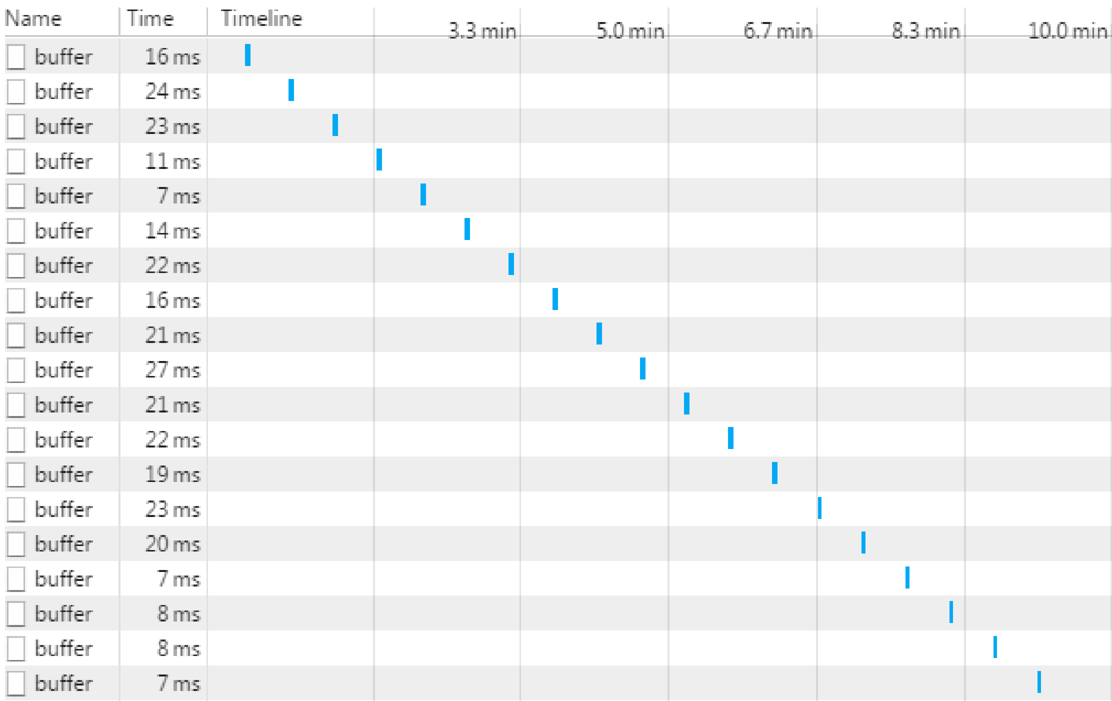


Figure 5-18 buffer timing test effect of buffered batch data loading algorithm

Figure 5-18 shows the sequence diagram of buffering batch data within 10 minutes, in which the time difference between adjacent frame data is 1s, and 30 frames of data are buffered each time, that is, according to the buffering batch data algorithm, it is buffered every 30 seconds. The actual effect is that 19 times are buffered within 10 minutes, which meets the expectation of the algorithm.

The test results show that for the historical playback mode with the update frequency at the second level, the buffered batch data loading algorithm is used to return the buffered data in time without obvious jamming, and the buffered data will not affect the user experience, meeting the requirements of low delay.

5.2.2.2 historical data playback mode test

For the test of historical playback mode and historical data playback mode, the function test process is shown in table 5-11:

Table 5-11 function test of historical playback mode and historical data playback mode

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically. Click the internal component of the corresponding mode in the history playback component in the drop-down component list. （3） After the historical playback starts, the target marker point of the historical playback appears on the map to view the effect of the historical playback method.

The test results show that the system can correctly play back the historical data in the corresponding way. The interaction effect of components in the historical data playback mode is smooth without jamming, the playback information is complete, and the operation logic of controlling the historical data playback mode is correct, smooth and without jamming. The test results are as follows.

Figure 5-19 test results of four historical data playback methods

Figure 5-20 test effect of panoramic historical data playback mode

Figure 5-21 test effect of target historical data playback mode

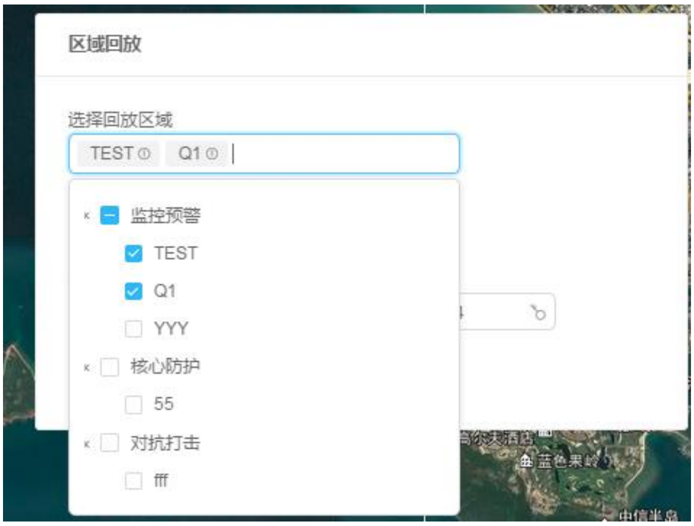


Figure 5-22 regional historical data playback mode and regional selection test effect

Figure 5-23 regional historical data playback mode and regional drawing test effect

Figure 5-24 regional historical data playback mode and regional playback test effect

Figure 5-25 test effect of event history data playback mode

5.2.2.3 history playback process control test

For the historical playback mode, the historical playback process control is tested, and the function test process is shown in table 5-12:

Table 5-12 historical playback mode historical playback process control function test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically. Click the internal component of the corresponding mode in the history playback component in the drop-down component list. （3） After the historical playback starts, the target marker point of the historical playback appears on the map to view the effect of the historical playback. And drag the progress bar, pause playback, accelerate and decelerate.

The test results show that the system can correctly control the historical playback process in the corresponding way, the interactive effect of the historical playback process control is smooth without jamming, the playback information is complete, and the operation logic of the historical playback process control is correct, smooth and without jamming. The test results are as follows.

Figure 5-26 test effect of acceleration and deceleration function of historical playback

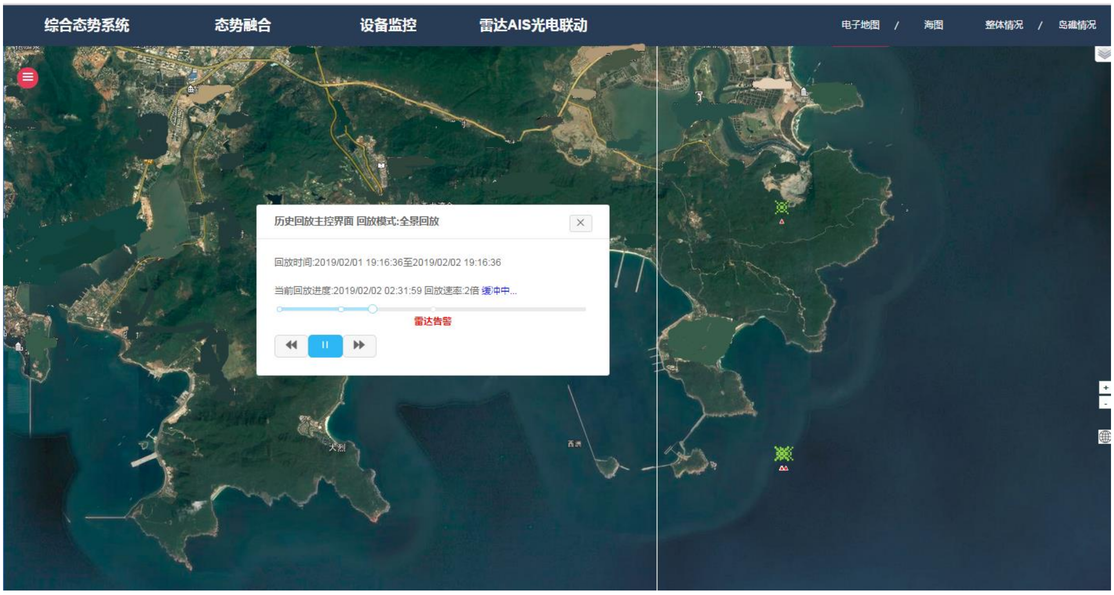


Figure 5-27 test effect of history playback drag progress bar control function

5.2.2.4 event alarm test

For the historical playback mode, the historical playback event alarm is tested, and the function test process is shown in table 5-13:

Table 5-13 historical playback mode historical playback event alarm function test

Fun	（1） Start the multi view situation system service combining real-

ction test process	time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically. Click the internal component of the corresponding mode in the history playback component in the drop-down component list. （3） After the historical playback starts, the target marker point of the historical playback appears on the map to view the effect of the historical playback. And accelerate the operation. （4） An event alarm notification will pop up when the history playback is near the key frame event.

The test results show that the system can correctly carry out historical event alarm notification, the interaction effect of historical event alarm notification is smooth without jamming, the playback information is complete, and the operation logic of historical event alarm notification is correct. The test results are as follows.

Figure 5-28 test effect of historical playback event alarm function

5.2.3 tracking interpretation service and target portrait test

5.2.3.1 migration situation test

Test the migration and transfer situation of tracking and interpretation services. The function test process is shown in table 5-14:

Table 5-14 function test of tracking and interpreting service migration and transfer situation

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, the drop-down component list will pop up automatically, and click the migration situation button in the tracking interpretation drop-down component. （3） In the pop-up dialog box, select the target and time interval for spatial data query.

The test results show that the system can correctly render the tracking and interpretation service migration and transfer situation, the interaction effect of tracking and interpretation service migration and transfer situation is smooth without jamming, the information is complete, and the operation logic of tracking and interpretation service migration and transfer situation is correct, smooth and without jamming. The test results are as follows.

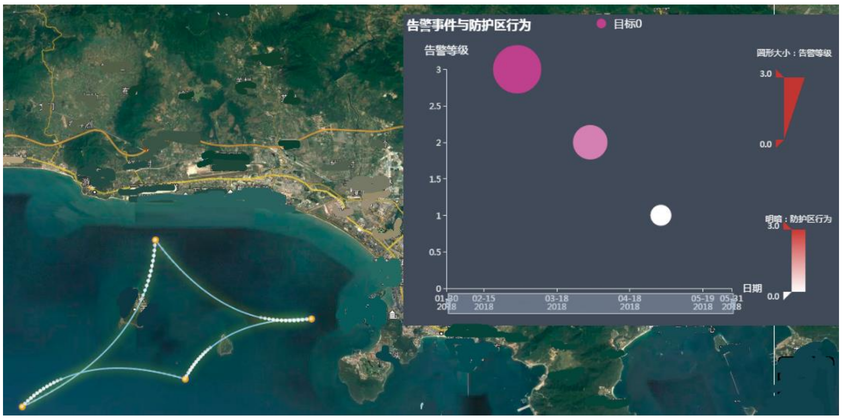


Figure 5-29 migration and transfer situation function test effect

5.2.3.2 hot spot flow area test

For the test of tracking and interpretation service hot areas, the function test process is shown in table 5-15:

Table 5-15 function test of tracking and interpretation service hotspot area

Function test process	(1) Start the multi view situation system service combining real-time and history. (2) Slide the mouse pointer to the situation fusion tab in the interface control area, the drop-down component list will pop up automatically, and click the hot area button in the tracking interpretation drop-down component. (3) Select the target and time interval for hot spot area analysis.

The test results show that the system can correctly render the tracking and interpretation service hotspot area, the interaction effect of the tracking and interpretation service hotspot area is smooth without jamming, the information is complete, and the operation logic of the tracking and interpretation service hotspot area is correct, smooth and without jamming. The test results are shown below.

Figure 5-30 function test effect of hot area

5.2.3.3 alarm data cellular test

For the tracking and interpretation service data cell, the function test process is shown in table 5-16:

Table 5-16 tracking interpretation service data cellular function test

Function test process	(1) Start the multi view situation system service combining real-time and history. (2) Slide the mouse pointer to the situation fusion label in the

	interface control area, the drop-down component list will pop up automatically, and click the data cell button in the tracking interpretation drop-down component. （3） Select the time interval for data cellular analysis.

The test results show that the system can correctly render the tracking and interpretation service data cell, the interaction effect of the tracking and interpretation service data cell is smooth without jamming, the information is complete, and the operation logic of the tracking and interpretation service data cell is correct, smooth and without jamming. The test results are shown in the figure below.

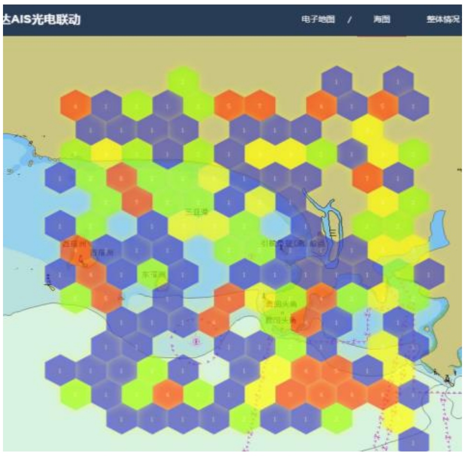


Figure 5-31 effect of data cellular function test

5.2.3.4 target portrait function test

Test the function of the target image. The function test process is shown in table 5-17:

Table 5-17 target portrait function test

Function test process	（1） Start the multi view situation system service combining real-time and history. （2） Slide the mouse pointer to the situation fusion tab in the interface control area, and the drop-down component list will pop up automatically to enter the real-time monitoring mode and open the multi-dimensional data view. （3） Select the target prototype label for the multi-dimensional data view

The test results show that the system can correctly carry out the target portrait, the interaction effect of the target portrait is smooth without jamming, the information is complete, and the logic of the target portrait is correct, smooth and without jamming. The test results are shown in Figure 5-29.

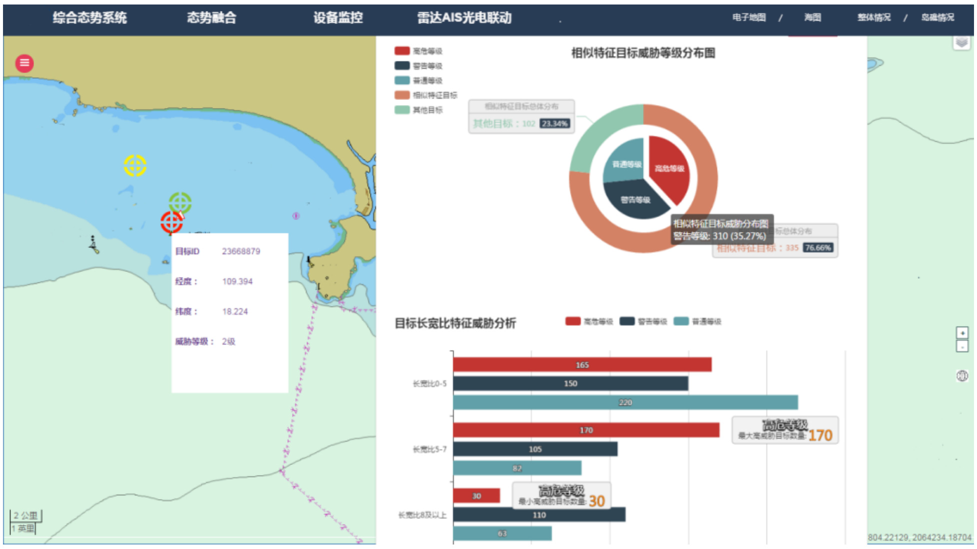


Figure 5-32 effect of target portrait function test

5.3 system performance test

5.3.1 system response performance test

When the browser side requests the HTML file, CSS style resources and JavaScript script of the home page from the background, the timing starts from the time when the request is sent to the time when the resource file of the home page is fully loaded. Calculate the difference between these two times, that is, the first response time of the system.

We refresh the home page in the browser until the home page is fully loaded, and then refresh the home page again. This continues for ten times. Find the average system first response time for ten home page refreshes

Table 5-18 average first response time of the system refreshed ten times

Average system response time	2.85s
Average system loading	19.1ms

time	
Average system script run time	711ms
Average system rendering time	73.16ms
Average system drawing time	85.32ms

A screenshot of the results of one of the tests is shown below.

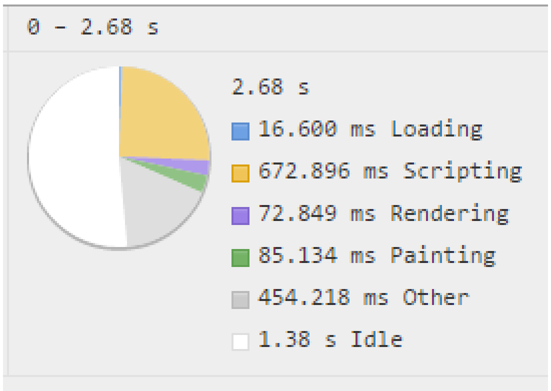


Fig. 5-33 pie chart of system response time

For the average first response time of the system, there is a time judgment principle. If the average first response time of the system is within the range of 0-2 seconds, the system is evaluated as a system with excellent response performance, the average first response time of the system is within 2-5 seconds, the system is evaluated as a system with good response performance, and the average first response of the system is within 5-10 seconds, It is evaluated as a pass performance system. According to this time judgment principle, the system is evaluated as a good response system

5.3.2 system stability test

The situation presentation system needs long-term operation stability to facilitate long-term monitoring of regional situation.

First, turn on the real-time and historical services of the system to maintain the status of system service execution. After waiting for one month, cycle and repeat the recording of the first response time of the system for ten times, and calculate the average value to the following table:

Table 5-19 average time of first response of ten systems after one month of operation

Average system response time	4.0s
Average system loading time	30ms
Average system script run time	1.5s
Average system rendering time	80ms
Average system drawing time	100ms

The screenshot of one test result is shown in Figure 5-34.

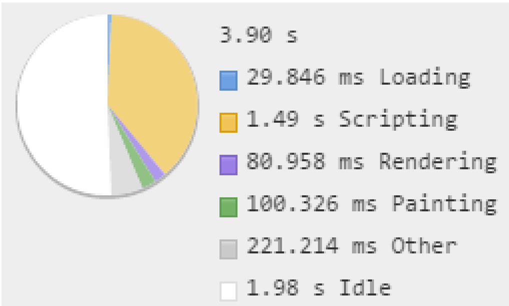


Figure 5-34 first response after one month of operation

The experimental results show that the average response time of the system after running for one month can be seen that the rendering efficiency and performance of the browser are slightly reduced, which directly leads to the extension of the loading time, but the overall performance is still good. The test results show that the system response time is stable.

After the system runs for one month, record the CPU, disk and memory occupation of the server.

Table 5-20 server CPU, disk and memory after one month of system operation

Memory	CPU	disk
577MB（1.76%）	20%	767KB/s

CPU utilization is shown in the figure below

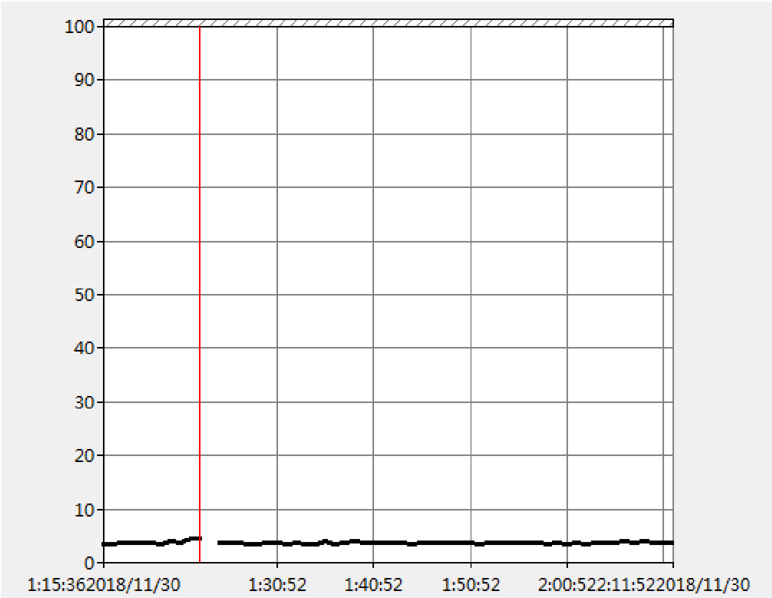


Figure 5-35 CPU utilization after one month of system operation

It can be seen from the results in table 5-35 that the disk I / O rate, memory occupation and CPU occupation of the system are within the normal range, the system operates normally, and there is no damage to the disk, heap depletion and memory leakage. The system operates stably.

As shown in figure 5-36. Use the rendering performance test tool on the browser side to test the occupation of heap space. The test diagram is a periodic right triangle, which shows that in the rendering process, the system tag node set will periodically clean up the layer. By cleaning up the over time data of the last layer rendering, we can ensure the maximum utilization of heap space and prevent stack depletion Memory leak.

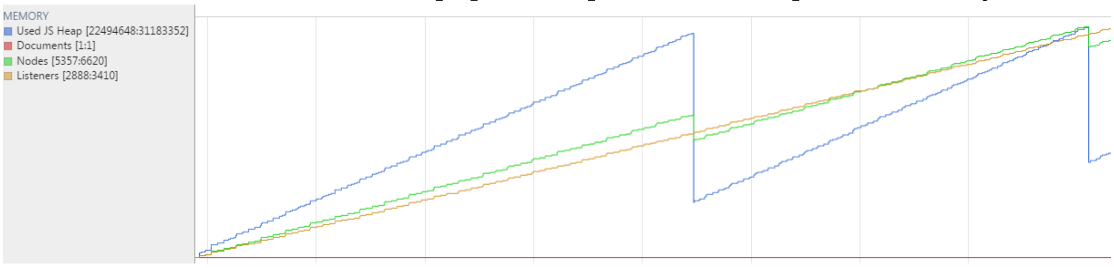


Figure 5-36 JavaScript heap occupation

5.3.3 system concurrent buffer performance test

We use Apache JMeter stress test tool to simulate huge load, constantly make concurrent requests for the interface of system buffered batch data, and test the relationship between time window, concurrency and system throughput of buffered batch data in turn.

Firstly, the system uses 50 threads to access the background at the same time, with a polling interval of 20 times, 100 threads to poll the background access at the same time for 10 times, 1000 threads to access the background and poll once, and draws the variation law of the average response time, variance and throughput of the system with time. The buffer data time window is 150, and the concurrent performance test is carried out. The test results are shown in the figure below.

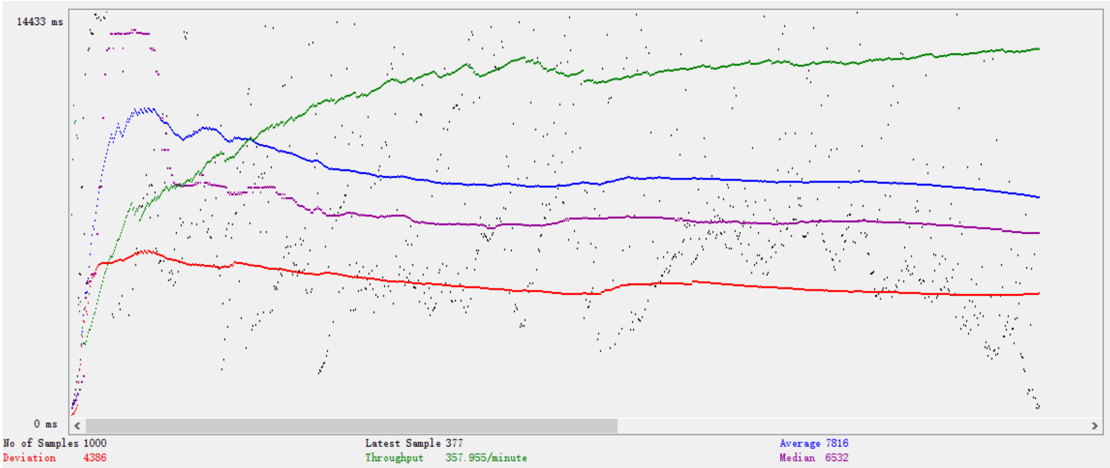


Figure 5-37 50 concurrent background performance diagram

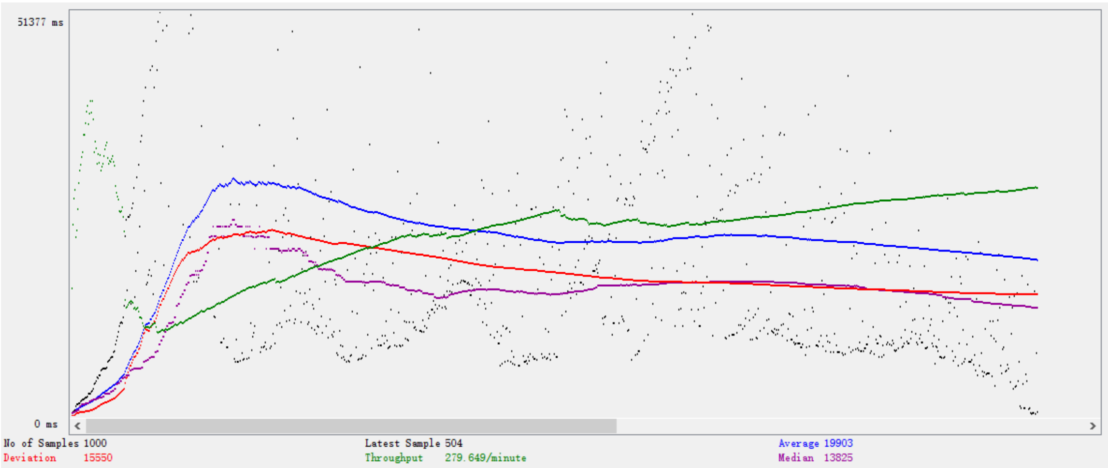


Figure 5-38 100 concurrent background performance

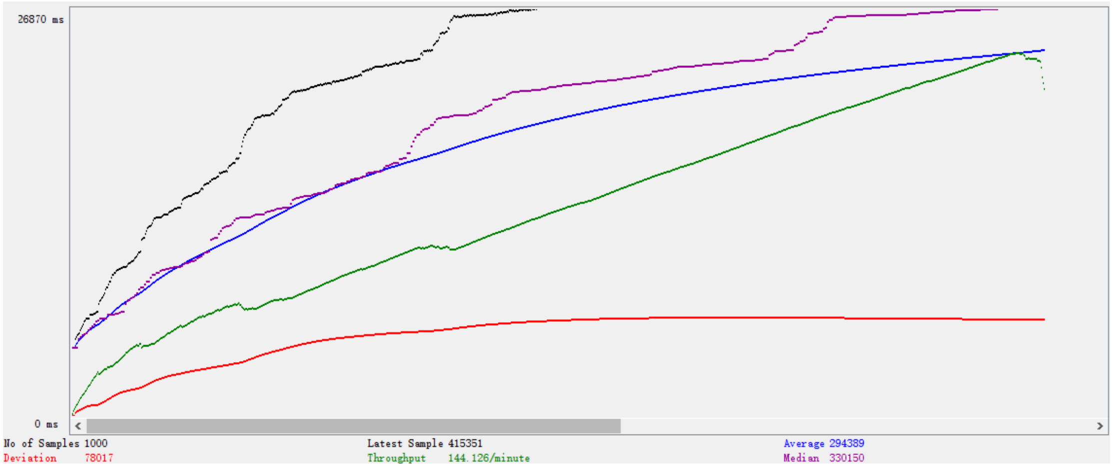


Figure 5-39 1000 concurrent background performance

Label	# Samples	Average	Median	90% Line	95% Line	99% Line	Min	Maximum	Error %	Throughput	Received K...	Sent KB/sec
HTTP Request	2000	14655	12948	25268	25390	33467	288	42156	26.20%	1.2/sec	151.33	0.22
TOTAL	2000	14655	12948	25268	25390	33467	288	42156	26.20%	1.2/sec	151.33	0.22

Label	# Samples	Average	Median	90% Line	95% Line	99% Line	Min	Maximum	Error %	Throughput	Received K...	Sent KB/sec
HTTP Request	1000	19903	13825	44015	57175	66105	248	84377	0.00%	4.7/sec	1127.36	1.33
TOTAL	1000	19903	13825	44015	57175	66105	248	84377	0.00%	4.7/sec	1127.36	1.33

Label	# Samples	Average	Median	90% Line	95% Line	99% Line	Min	Maximum	Error %	Throughput	Received K...	Sent KB/sec
HTTP Request	2000	157146	67084	351496	358976	368961	248	415351	0.00%	2.1/sec	501.31	0.59
TOTAL	2000	157146	67084	351496	358976	368961	248	415351	0.00%	2.1/sec	501.31	0.59

Figure 5-40 polymerization analysis

As shown in the figure above, the variance of the system tends to be stable with the flow of time, indicating that the system gradually reaches a steady state. In the experiments of 50 concurrency and 100 concurrency, the throughput first increases and then decreases, indicating that the system conforms to the background resource allocation model. The average response time first increased and then stabilized.

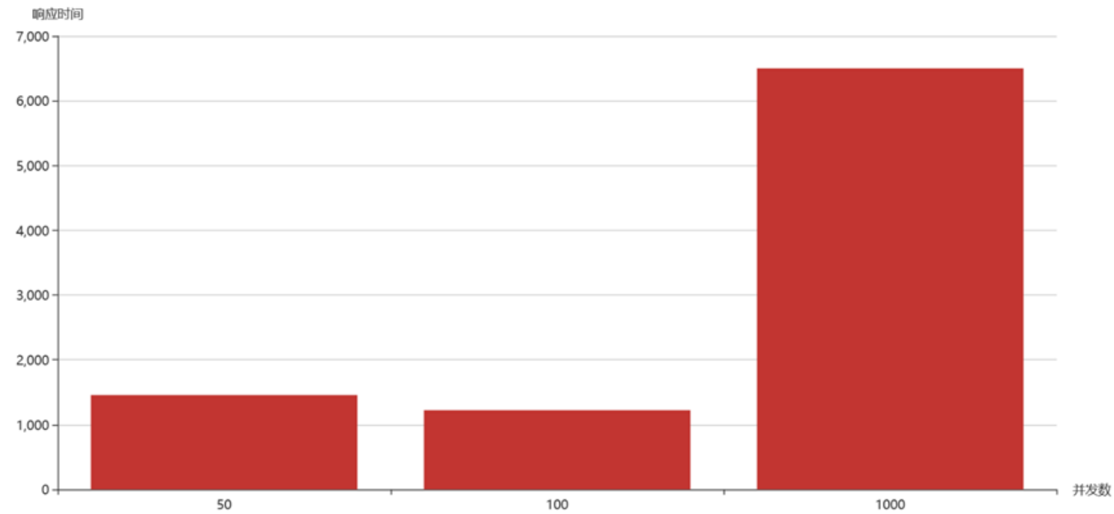


Figure 5-41 comparison of background response times with different concurrent numbers

It can be seen that when the number of concurrency increases, the response time of the background decreases, indicating that the background uses a reasonable load balancing allocation scheme to improve efficiency. When the number of concurrency exceeds the threshold supported by the background, the response time becomes very large.

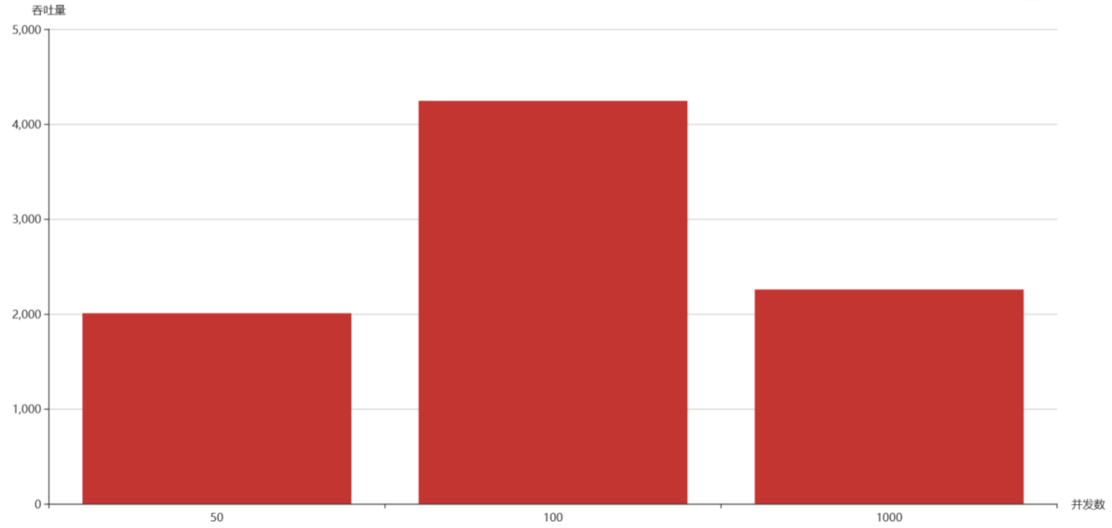


Figure 5-42 comparison of background throughput with different concurrent numbers

It can be seen that when the number of concurrencies increases, the system throughput first increases and then decreases, indicating that the system uses the resource adaptation model to reasonably schedule and allocate resources, but it will decrease when it exceeds the system threshold.

Set the buffer time window to 10 and 150 respectively, repeat the above different and send the value change experiment of throughput and response time. The experimental results are as follows.

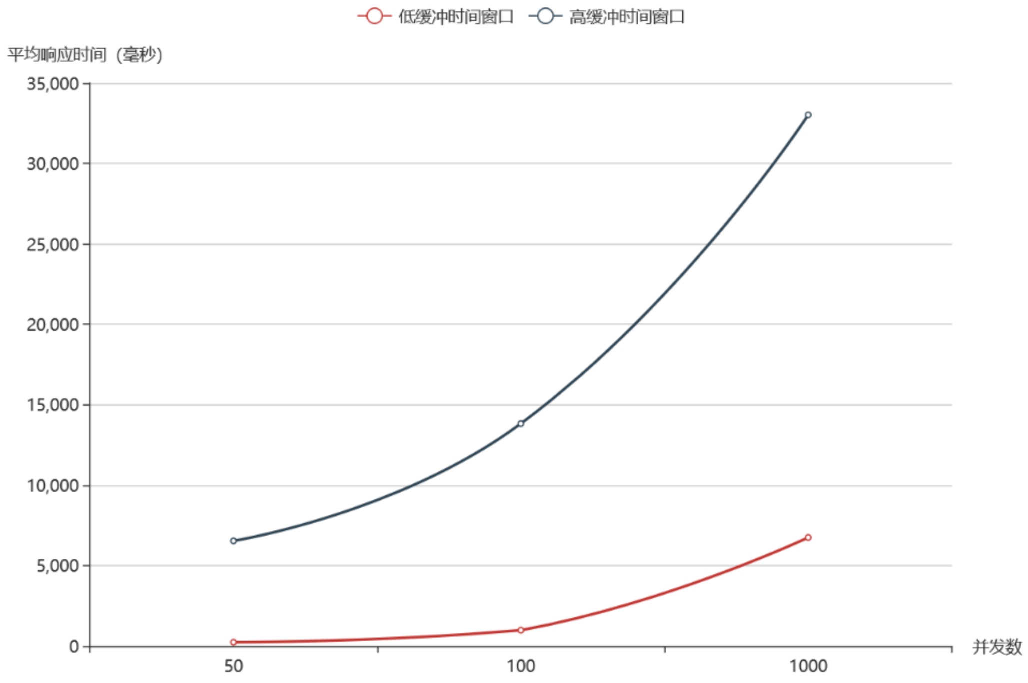


Figure 5-43 comparison of response times of different buffer windows and different concurrency

The figure shows the comparison of the average response time curve with the hyperparametric buffer time window in the process of increasing concurrency in 50100150. At this time, the size of the low buffer time window is 10 and the size of the high buffer time window is 150, indicating that when the buffer time window decreases, the system concurrent response time will be improved, and when the buffer time window increases, It will reduce the performance of system concurrency.

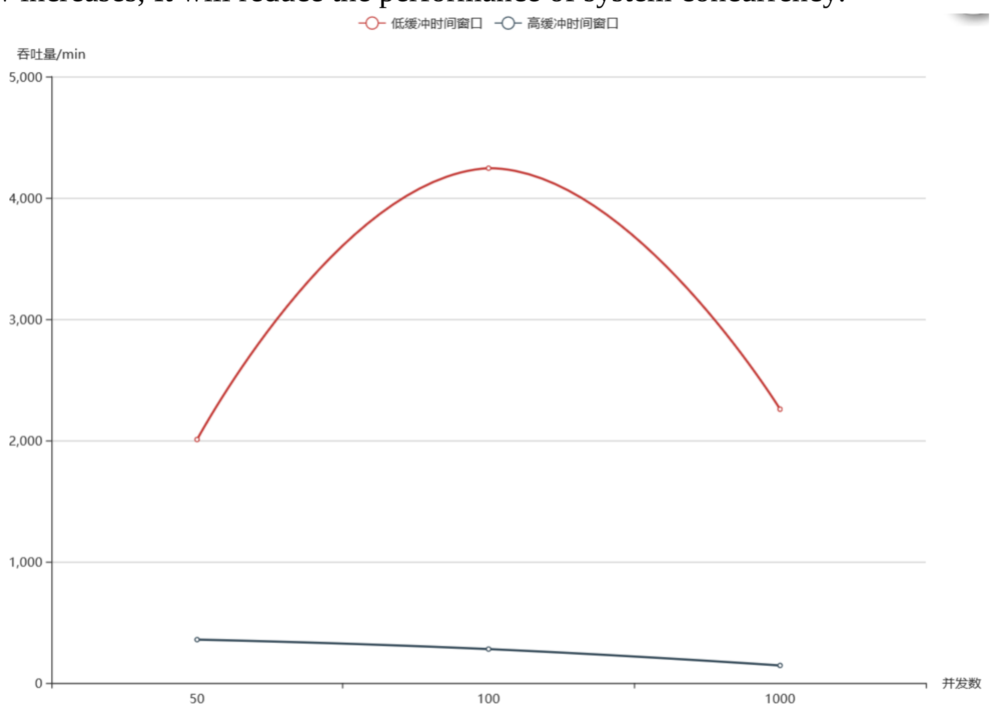


Fig. 5-44 comparison of throughput time of different concurrent in different buffer time windows

The figure shows the change trend of system throughput in different buffer time windows with the increase of concurrency. At this time, the size of low buffer time window is 10 and the size of high buffer time window is 150. It shows that when the buffer time window is low, the number of concurrency has a great impact on the steady-state throughput of the system. With the increase of the number of concurrency, the throughput first increases and then decreases. Moreover, the buffer time window will also affect the throughput. The smaller the buffer time window, the larger the relative throughput.

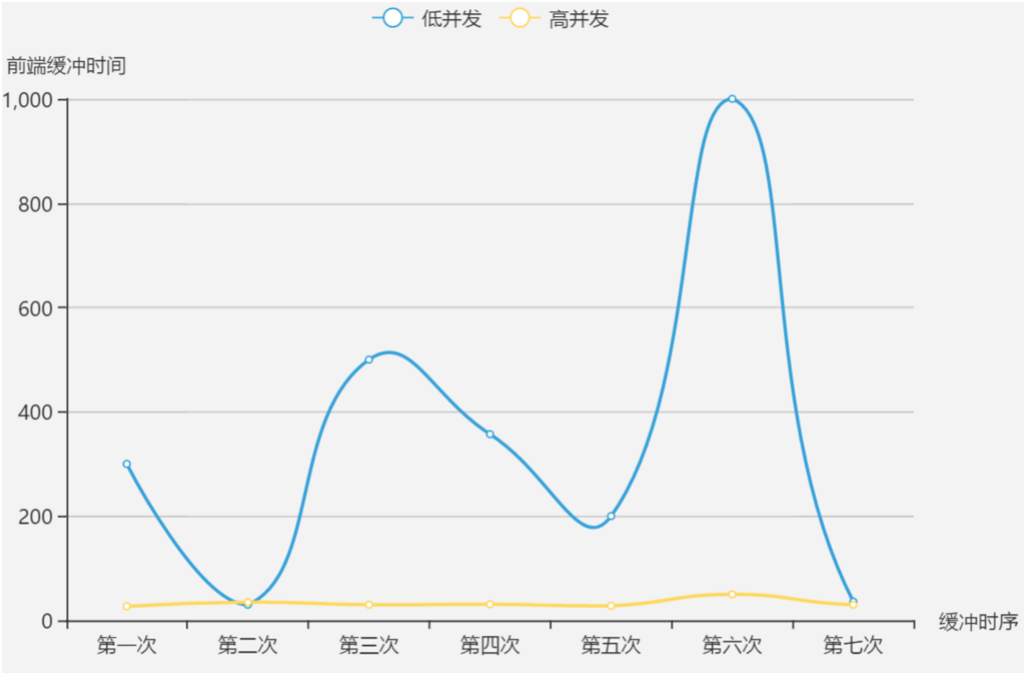


Figure 5-45 comparison of buffer times for different concurrency

The figure shows the impact of concurrency and front-end buffer time with the increase of buffer time. The figure shows that the higher the number of concurrency, the more unstable the front-end buffer time, the longer the time, the lower the number of concurrency, the lower the number of concurrency, and the smoother the playback of the front-end.

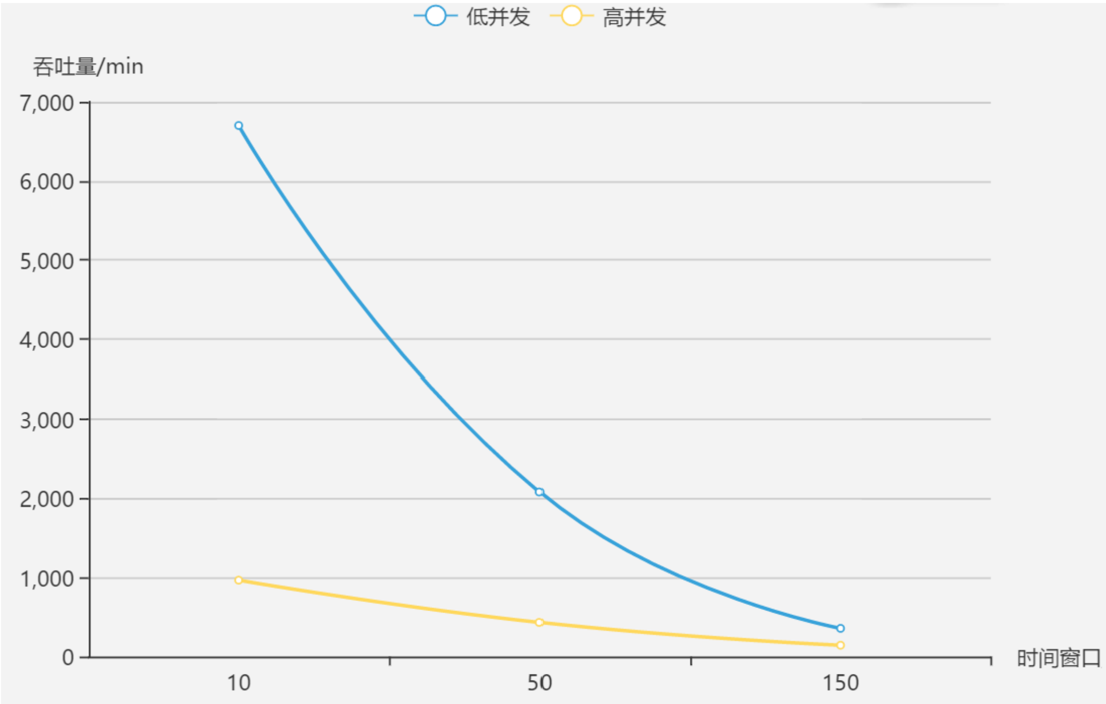


Figure 5-46 comparison of throughput in different time windows

The figure shows the impact of concurrency on throughput with the increase of buffer time window. At this time, the size of low buffer time window is 10 and the size of high buffer time window is 150. It can be seen that the larger the buffer time window, the smaller the throughput, and the higher the number of concurrency. In the same buffer time window, the smaller the throughput difference and the lower the concurrent data, The greater the throughput difference within the same buffer time.

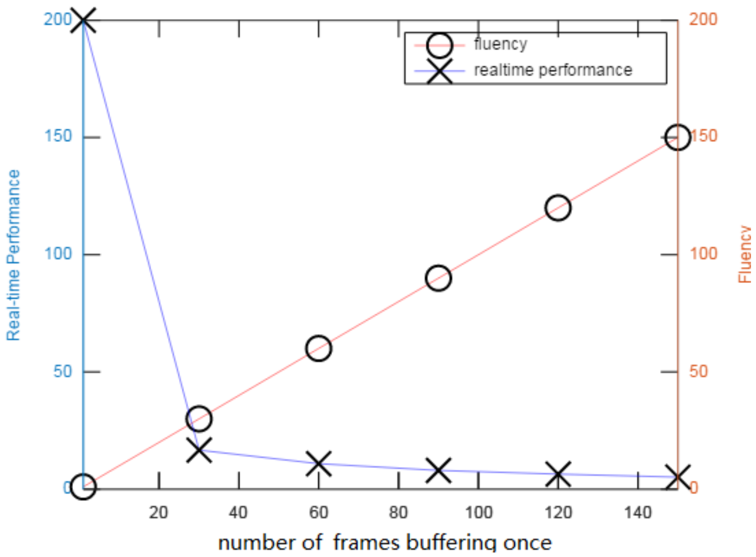


Figure 5-47 parameter tuning diagram of buffer time window

In this experiment, different buffer time window parameters will affect the real-time and fluency of historical playback. Figure 5-47 shows the relative real-time and fluency of buffering batch data with different buffer time window parameters.

Obviously, when the buffer time window parameter increases, the fluency will increase, but the real-time performance will decrease, because the increase in the number of buffer data will increase the buffer delay, thus reducing the real-time performance of playback.

The test results show that an appropriate buffer time window is needed, which can not only maintain a certain real-time playback, but also ensure the fluency. The cache time window is set to 30 in this system. That is, the intersection of the two curves. Figure 5-47 shows that when the current cache time window is set to 30, the average buffer time is 20ms, which has good real-time performance and ensures fluency.

5.4 summary of this chapter

This chapter tests the system function and performance to verify the effectiveness and availability of the system. Firstly, all functions of the system are tested, and then the performance stability of the system is analyzed from the perspective of system response performance, stability performance and concurrent buffer performance. Finally, it is verified that the system has complete functions and stable performance, and meets the situation presentation requirements of real-time history dual display mode.

Chapter VI summary and Prospect

6.1 work summary

This subject studies and implements a multi view IOT situation display and control system based on the target information map and the combination of real-time and history. The system will combine the IOT and cloud GIS technology, associate, fuse, mine and analyze a variety of monitoring data with the target as the core, so as to form the target information map and multi angle data view, Finally, the big data visualization technology based on spatio-temporal paradigm and the combination of real-time and history realizes a visual interface with excellent performance, beautiful appearance and friendly human-computer interaction.

Firstly, the overall design of the system is carried out, and the overall architecture design of the situation presentation system is determined. The goal of the system is to realize real-time target monitoring and historical playback based on target information atlas and multi data view, and target tracking interpretation and target portrait based on GIS service. Through the space-time paradigm, a situation presentation system with real-time history double display mode is formed. The design part summarizes the overall service structure of the system, explains the idea of the combination of real-time and historical services from the perspective of service interaction, and summarizes the complementary relationship between real-time services and historical services. The overall service structure and overall functional structure are designed from the perspective of the combination of real-time service and historical service. In order to realize system service decoupling, MVVM component architecture based on react framework is adopted in this paper, and the overall component design of the system is carried out. Finally, it combs the upstream and downstream data flow and overall process of system services, components and functions, and completes the overall design of the system.

After the overall design idea is determined as the combination of real-time and history, this paper mainly realizes the component of the situation presentation system in detail through the space-time paradigm. The implementation method of fine-grained and local data visualization based on time dimension forms a component scheme and specific implementation algorithm of real-time history double display mode. The coarse-grained and global spatial location big data visualization method based on spatial paradigm realizes the detailed implementation scheme of rendering algorithm and component architecture in tracking interpretation and target portrait rendering service.

Finally, after function by function, step by step system function test and comprehensive performance analysis test of the system, it is proved that the situation presentation system can solve the pain points of current situation monitoring, realize the relevance of situation information display, have a certain depth of cognition of the target, and can recognize the historical spatial attributes of the target from the perspective of global coarse granularity, Finally, it becomes a situation presentation system with real-time history dual display mode.

6.2 work prospect

The situation system already has stability and performance reliability, but it still has the potential to continue to evolve into a higher dimensional and more intelligent situation cognition system. The work to be done to realize the evolution of the system is as follows:

1) The target portrait in the situation presentation system is only preliminarily labeled with target information, and only two labels are aggregated to form a data cube. The future intelligent situation cognition system should aggregate the data cube of any label according to needs, and use the intelligent self-planning portrait algorithm, The targets in the target information base are divided into multiple target aggregation subgroups with the same commonness to form the target group portrait and group perception.

2) The historical trajectory data in the time dimension of the system can provide intelligence support for real-time situation monitoring combined with historical mining information, but it does not provide intelligence support for real-time situation monitoring based on historical coarse-grained location data in the spatial dimension. In the future, a real-time monitoring scheme based on historical mining data combined with space-time model can be carried out.

3) The system only supports the historical playback based on the target information base. After realizing the group perception of the target in the future, it needs

to support the playback of group historical behavior, group historical events and group regional events of the common target aggregation sub group, that is, to realize the historical playback of group consciousness based on the situation cognition of the target group.

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