A fast assistant decision-making system on the emergent maneuver of the tracking ship

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Abstract. This paper studies a fast assistant decision-making system on the emergent maneuver of the tracking ship, adopting the design method of the emergent working state of the tracking ship based on the meteorological prediction , the virtual display technology based on the multi-stage mapping, and the 2-dimension area algorithm based on the line-scanning. It solves problems that the tracking ship met during working, such as the long TT&C time, the dense crucial observation arc, the complicated working flow, and the changeful scheme. It established the hard basement for the fast design of the emergency working state when the tracking ship in the awful sea conditions.

1. Introduction

In all kinds of spacecraft launching, the tracking ship undertake the key measuring assignment of the flight segment of spacecraft at sea. In some important tasks , such as the manned space flight, the tracking ship must work long and continuously, the working waters is in the higher latitude, the weather is often changeful, and the awful sea weather occur frequently. Thus it is usual for the tracking ship to adjust the work scheme to meet an emergent TT&C in preparation of tasks. It is difficult to complete a fast, accurate and visualized design of the emergent working state of the tracking ship by the traditional techniques.

For this, based on analyzing the influence of sea conditions on the fast design of the emergent working state of the tracking ship, This paper brings forwards a fast assistant decision-making system on the emergent maneuver of the tracking ship.

2. Key technology

2.1. Design method of the emergent working state of the tracking ship based on the meteorological prediction

The meteorological prediction of the waters in which the tracking ship working is imported into the working state design software with diagram, which is taken as the foundation to analyze spacecraft track, signal coverage, and task segment, to meet an emergent work condition design etc., and the analysis result can be demonstrated visually.

The total system adopts the three-stage structure, carrying out the separation that the data, logic operation and chart display. The total structure is divided into three modules, task analysis, graphics drive, and user interface. Figure 1 show the total system structure.

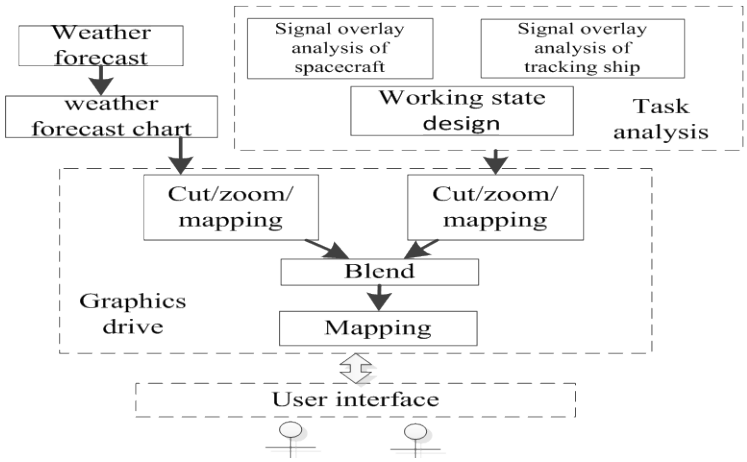

Figure 1. Total system structure.

2.2. Virtual display technology based on the multi-stage mapping

In order to make show district zoom and move freely, avoid the sketch flicker phenomenon when projecting directly that is easy to appear, and make the chart display more real-time, this system adopts a kind of virtual monitor technology, that is, before mapping the ground track of spacecrafts and the diagram of weather forecast to the show district, firstly complete all picture-related processing(such as overlying, cut, move, zoom etc.) in the memory, then project the picture to the show district, which can improve greatly the system processing efficiency and the final show effect.

Several graphic processing is needed in the human-computer interaction process, including a series of multi-level operation such as mapping, coordinate transition and area cutting. Therefore, the system adopts the multi-stage mapping technology which deal with the different level graphic operations respectively. The application of such technology can reduce the complexity and raise the flexibility of the system. Figure 2 shows the processing flow chart of the virtual display technology based on the multi-level mapping.

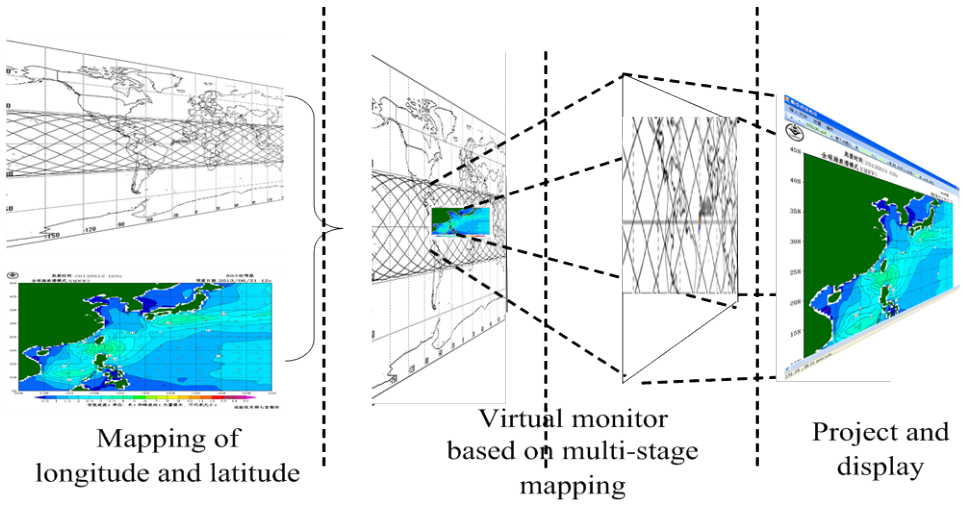

Figure 2. Processing flow of virtual display technology based on multi-stage mapping.

2.3. 2-dimensiona area algorithm based on the line-scanning

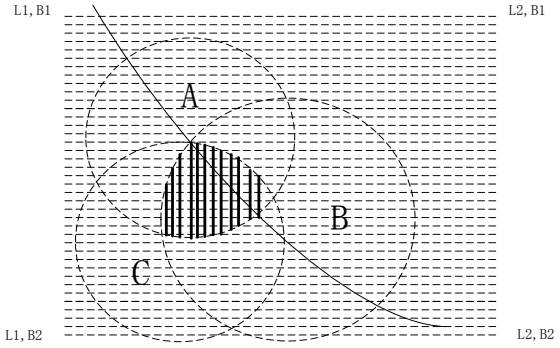

Figure 3. Intersection algorithm in 2-dimension area.

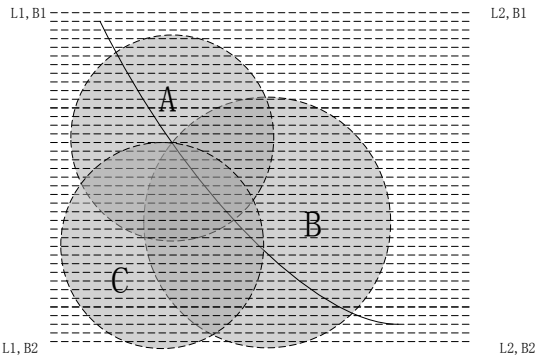

Figure 4. Combination algorithm in 2-dimension area.

Since the computer only can be used to deal with the discrete data, appropriate mechanism is needed for the continuous data processing of the 2-dimensiona area, like the intersection, combination and complement calculation. In this mechanism, the 2-dimensiona area should be dispersed firstly. Then a dispersed method is applied to actualize the logic calculation. The logic calculation sketch of the 2-dimensiona area is shown in figure 3 and figure 4.

3. Main functionality

The system has the following main functionality:

3.1. The weather forecast diagram can be imported as the base map of the work condition design.
According to the bound of longitude and latitude of sea area, the system can import and show the corresponding weather forecast diagram with the different resolution, size, and format that the weather system provides. It's convenient to design the emergent working state of the tracking ship based on the specific meteorological condition.

3.2. The tracking ship coverage analysis.
According to the location of the tracking ship and the track parameters of aerospaces, it can draw the coverage contour of the tracking ship when the tracking elevation angle is 0 degree, 3 degree, 5 degree, 7 degree and 75 degree etc, freely increase, modify, delete any coverage contour, and set their show style(type, weight, color of line etc.).

3.3. Signal coverage analysis.
Calculates and analyzes the signal coverage of aircrafts on all kinds of orbits by means of the flight track, the attitude parameters, and the antenna location.

3.4. The emergent work state design of the tracking ship.
Shows the sail route when the tracking ship carries out an emergency TT&C task. According to user's demands, calculates real-time the emergency maneuver distance and direction. To any measuring point users choose on the map, the system can provide services of calculating real-time the working parameters of the tracking ship, and displaying the statistics.

3.5. Show the trail of spacecrafts.
According to a variety of spacecrafts orbit elements, such as circular orbit, elliptical orbit etc., and flight arc, the system can show their ground-track and path number, and set the show style(type, weight, color of line etc.).It can also display the key TT&C segment and the common .TT&C segment differently.

3.6. Overlay area operation.
According to the cover district of spacecrafts on the sea, the projection on the sea of the cover district of the tracking ship to spacecrafts, and the districts users custom, this system can make the assemblage operations, such as combine, overlap, cut, move etc.

3.7. The user interface.
According to users' operations, the analysis results can be displayed visually, zoomed in and out in any multiple, and moved parallel. To any measuring point users choose on the map, the system can realize the real-time interactive functions, including of calculating the working parameters of the tracking ship, giving the tracking feature points, drawing the coverage diagrammatic sketch of the tracking ship to spacecrafts.

4. Conclusion
This system has been applied successfully in the fast and visualized adjustment of the emergent maneuver scheme of the tracking ship in the Shenzhou-10 mission, ensuring the design of the maritime TT&C implement scheme efficiently. The automated combination of the weather forecast result and the maneuver area of the tracking ship makes the design of the emergent maneuver scheme efficiently, the virtual display technology based on the multi-stage mapping improves the visualization of the system greatly, and the application of 2-dimensiona area algorithm based on the line-scanning raises the degree of automation of the design.

The system is of applied value in many fields like follow-up rendezvous and docking(RVD) task, as well as the technique support for the emergent maneuver in the subsequent maritime TT&C task. The future work is focused on the system flexibility optimization.

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