

Research on Key Technology of INSAS Console System

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Abstract

INSAS Console System was designed to receive a large amount of data of interferometric synthetic aperture sonar. This paper mentions multithreading technology and data pool technology, which could solve a series of problem such as data transmission and memory consumption to guarantee 2D image and 3D graphic of INSAS display fluently in the system. The example of the INSAS Console System is shown in the end of the paper.

Keywords: *INSAS, data pool, data transmission, multithreading technology, 2D image display, 3D graphic display*

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1. Introduction

High resolution images play an important role in a number of different areas such as offshore exploration, pipelines survey and shipwrecks, and military applications [1]. In the past decades, side scan sonar (SSS) has become a well developed imaging technique to satisfy the needs above. Mapping of the seafloor using traditional SSS is limited to a 2D image, i.e. the height dimension of the mapping area is neglected [2].

Interferometric synthetic aperture sonar is a new type of high resolution underwater imaging sonar. Its principle is to use mobile small aperture array to get the moving direction (azimuth) synthetic aperture in order to get a high-resolution image of azimuth direction. Theoretically speaking, the resolution has nothing to do with the working frequency and the detection distance [3]. The high resolution imaging algorithm is complex and there are strict requirements on the sonar array platform motion. Interferometric synthetic aperture sonar can be used for detection and recognition of military target under water, high resolution detection and recognition can be applied to mine detective. In the aspect of the civil application, it can be used for underwater archeology and searching lost underwater objects and especially high-resolution seafloor mapping. It is of great significance to the research of Digital Ocean.

Currently only a few countries and regions developed interferometric synthetic aperture sonar prototype, such as HISAS-1030, PS-175 and Aquapix. China has begun research in high resolution of the terrain data acquisition from the shallow to deep sea, such as ChinSAS-150 supported by China's 863 Program [4].

Interferometric synthetic aperture sonar acquires and processes massive real-time high resolution sea-floor terrain data. The data's size is determined by its resolution. The displaying data includes three pieces – The inclined direction intensity data block, orthographic projection direction intensity data block and the elevation data block, every block data size is about 8000*8000*32bits, and the total size is at least 768MB per 15 seconds, the amount of data such a huge bring great difficulties to storage, transmission and processing.

The paper studied and developed a set of interferometric synthetic aperture sonar display and control platform, named "INSAS Console System". The platform can receive real-time, 2D or 3D sea-floor terrain data, then display the images dynamically.

2. INSAS System Structure

INSAS system consists of three parts: Towed Fish System, Signal Processor and INSAS Console System. The data flow of INSAS system is shown in Figure 1.

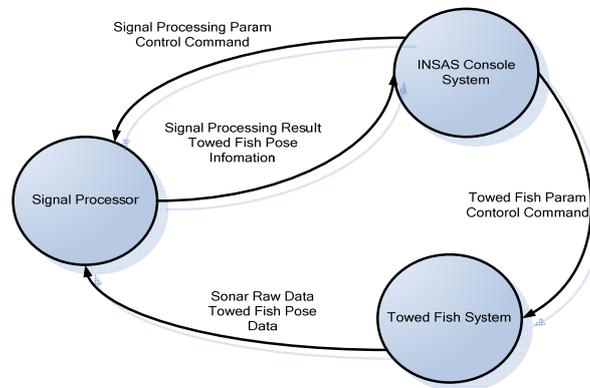


Figure 1. Data Flow Diagram of INSAS System

The towed fish system is used for raw sonar signal data acquisition and transmitting the data to signal processor.

The signal processor is responsible for the signal processing of sonar data and the processing result is transmitted to the INSAS console system. The signal processor receives the data from the towed fish system (including sonar data, OCTANS data, DVL data, depth gauge data), the data of GPS and console data (signal processing parameters and control command), and immediately sends sensor data to the console. Signal processor rapidly generates DEM according to the calculating of integrated navigation data and INSAS data.

The INSAS console system includes data input module, 2D image display module, 3D graphic display module, waveform display module, navigation data display module, the towed fish control module and the towed fish information display module. Each module is independent, loosely coupled.

The data input module gets the original data, as a variety of display data source, from the network or local hard disk. Five display modules are respectively using a variety of means to display variety of information. The towed fish control module controls towed fish on a variety of equipment's turning on or off through the network communication.

3. Key Technology and Solution

According to the system structure, data processing server transmits three two-dimensional arrays through the network; include slant range coordinate intensity array, orthographic projection coordinate intensity array and elevation array [5]. The inclined direction intensity array is for real-time display of 2D image, while orthographic projection direction intensity array and elevation array are for real-time display of 3D graphics. The transmission speed of data processing server depends on the size of the original data.

The INSAS console system has three kinds of data read mode: (1) Local file mode; (2) Offline mode; (3) Online mode. The local file mode is opening up data files through multithreading and reading three kinds of data by program [6]. In offline mode, the raw data which is stored on the server is processed by the signal processor, and the result data is send to the system. In online mode, the signal processor is waiting for receiving the raw data from the towed fish. After receiving the raw data, the signal processor calculates it, and then sends the result data to the INSAS console system. In the actual surveying work the data is continuous while the surveying time is not definitive. Therefore the dynamic 3D real-time display system needs to consider the following issues:

1. The problem of data transmission. Whether it is in offline or online mode, the system will communicate with the signal processor. The key problem is to ensure that data not to be lost, and to ensure the speed of the transmission.

2. The problem of data integrity. The new data will cover the old data which is stored in the memory, which will lead to data loss.

3. The problem of memory consumption. (1) The data display must be finished before the INSAS console system receives the next block of data; (2) The data which is displayed must be promptly removed. Otherwise the system memory will be more and more, and image will play more and more slowly. Even the system will collapse.

4. The problem of 2D image display. The original data is the intensity data, and we must convert it to color data in order to construct the image, and the display screen width is far less than the transmission data width, so the data must be sampled and be displayed by rolling. The system also provides zoom mode in which interesting area should be selected and recalculated.

5. The problem of 3D graphic display. The 3D dynamic real-time display is difficult. Refresh rate is too low if sampling rate is too high, and the details will be lost if sampling rate is too low.

In order to solve the above problem, several methods have been used.

1. Variety of data communication way and multithreading technology.

Multithreading technology is used in the system. There are four working threads: Thread 1 is used for local data reading. Thread 2 is for reception and transmission of the massive data, and the network transmission mode is TCP/IP connection. Blocking mode is used to ensure the integrity of the data. Thread 3 and thread 4 connect with the towed fish system and the data acquisition card by TCP/IP, and the connection mode is 'select mode', which is convenient for immediate communication with two devices [7].

2. 2D real-time display technology.

System uses the queue as a data pool of memory. In order to reduce the memory consumption, the 2D image is calculated dynamically. When the block's bottom passes the bottom of the display window, the memory is released. The flow-process diagram of queue data processing is shown in Figure 2.

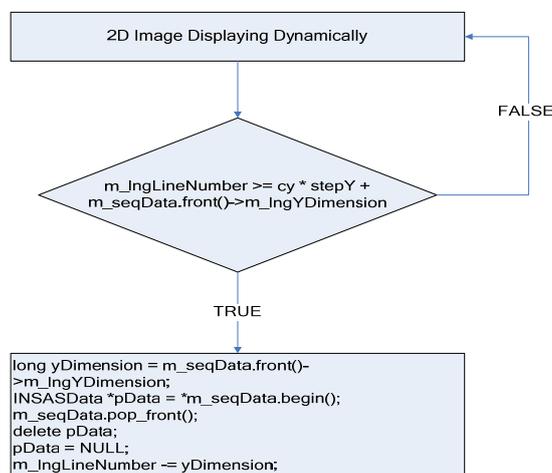


Figure 2. Flow-Process Diagram of Queue Data Processing

In Figure 2, The processing of “2D Image Displaying Dynamically” is simplified. The variables “m_IngLineNumber”, “cy”, “stepY”, “m_seqData” and “INSASData” are current bottom line of 2D image, 2D image window’s height, sampling height, the queue which is used as data pool of memory and a class which describes a block of INSAS data [8].

3. 3D dynamic display technology.

The entire data can be displayed in 3D graphics, but we keep the 3D graphics the same data width with the 2D image in order that the memory does not exceed the limits and the display speed is same as 2D image.

When 3D graphics display window is opened, the memory should be cleared by 3D graphic display module to prevent wild pointer which causes the program crashing because the speed of 3D graphic display may be slower than 2D image display [9].

According to the traditional geographic theory, the terrain representation can be expressed by the method of layering, namely the shading model terrain. Different elevation region is rendering by different color. Compared with single color model, shading model is more 3D sense, authenticity.

The interferometric synthetic aperture sonar data may be invalid if the slope is too large. It means that the calculated elevation height value is not the true height of the objects [10]. And the calculated value is far away from the actual value, which leads to unsatisfactory 3D graphics. So transparent value is used for the invalid data to hide it.

The morphology algorithm is a good way for this purpose. We calculate the invalid data's boundary and expand a pixel, identified as the mask region. In order to mark the mask area, the invalid data is defined as a negative number. For the particularity of the sonar data, all data must be a negative number, elevation mask regional agreement is negative, which is obtained through its absolute value. Judge whether it is plus when drawing [11]. If it is negative the elevation value is calculated as opposite number to its absolute value, and the color value is assigned to a transparent value, which can not only ensure the correctness of the transparent display, but also decrease server computation burden without increasing the memory.

4. Examples of INSAS Console System

1. The system UI is shown in Figure 3.

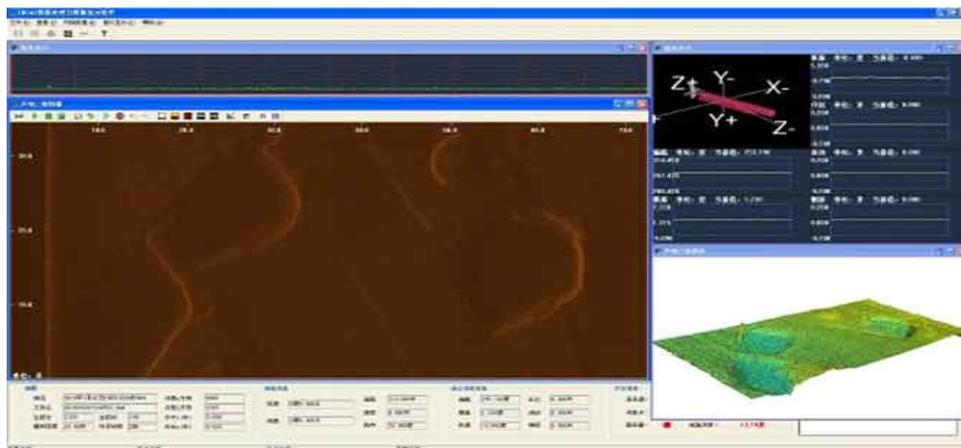


Figure 3. UI of INSAS Console System

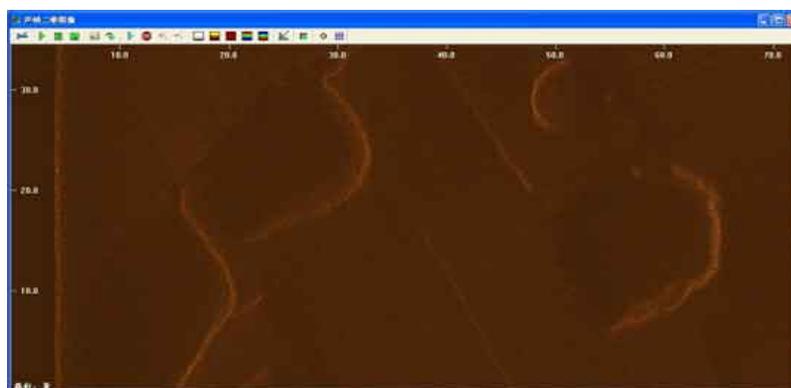


Figure 4. 2D Image Display

2. 2D image display.

Bitmap rendering method is used for real-time display of 2D image data, and data through the memory copy display technology section, fast copy to the image memory, and use the bitmap in the form of drawing. This is shown in Figure 4.

3. 3D graphic display.

OpenGL is used for real-time dynamic display of 3D graphics. 3D display speed and 2D display speed are consistent. This is shown in Figure 5.

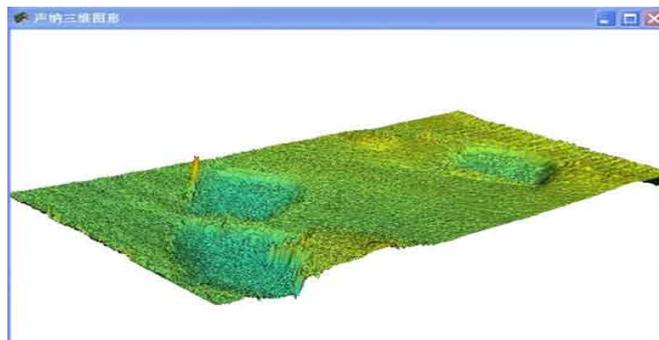


Figure 5. 3D Graphic Display

4. The target detail information

Correct, clearly show the fine image of a partial position of the sonar detection. This is shown in Figure 6 and Figure 7.

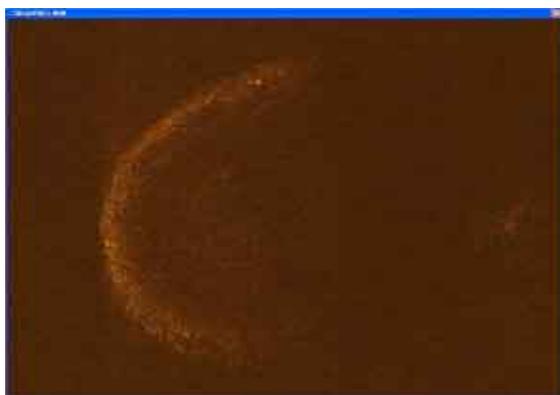


Figure 6. Details of 2D Image

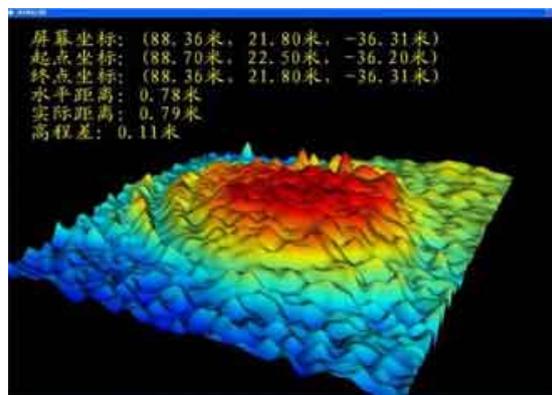


Figure 7. Details of 3D Graphics

5. Conclusion

All techniques above are used in the INSAS console system. Real-Time and dynamic 2D image and 3D graphics are displaying fluently. Three characteristics of the system are good performance in data transmission, lower memory consumption and high displaying rate.

Acknowledgement

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