Research on the Parallel Computing and Novel Methodology of Marine Data Visualization Linear Integral Convolution Algorithm based on GPU

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Abstract. In this paper, we conduct corresponding research on the parallel computing and novel methodology of marine data visualization linear integral convolution algorithm based on GPU. GIS visualization technology is widely applied in the area of the current information technology, geographic information science, computer science, cartography, cognitive science, information transmission and geographic information system as the foundation. Our proposed approach combines the linear integral convolution algorithm and GPU with the traditional visualization method. In the future, we plan to conduct more related research to polish the current method.

Keywords: Parallel Computing; Marine Data Visualization; Integral Convolution; GPU.

Introduction

While advances in supercomputer design are providing ever-increasing levels of performance and degrees of parallelism, there has not yet been a convergence towards a single type of architecture, nor does such a convergence appear to be on the horizon. Whether it is a real life or scientific research, complex network is everywhere. Many complicated relations in daily life can be abstracted as a complex network including network community structure in complex network topology is the most basic, the most important attribute. Community structure is characterized by compact connection nodes in the same community, and the node connection in the different communities is very sparse. To study the community structure of complex networks for research network transmission dynamics, based on the community structure of recommendation mechanism has important significance. With the expanding of network size, the calculation of complex network community structure in the mining quantity has been increased dramatically. GIS visualization technology is widely applied in the area of the current information technology, geographic information science, computer science, cartography, cognitive science, information transmission and geographic information system as the foundation, and through the computer technology, digital technology, multimedia technology, dynamic, intuitive, image transmission performance, interpretation, geospatial information and reveal its law. Vector field visualization in scientific computing visualization is one of the most challenging research topics. Traditional vector field visualization method is simple, but the dispersion and discontinuity, easy mixing and disorderly or missing key characteristics, is only suitable for local visualization. Vector field visualization method based on texture, the outline of the display field in the form of images, can express the change of details which is the good method of vector field visualization. Line integral convolution method based on texture, can express the direction of the vector field information, the thesis to improve the line integral convolution image, make the convolution image can not only express the direction information, also can show the size of the vector. Hope this method can be used in both

demands means the direction of the vector field is expressed in the size of a vector field.

In this paper, we conduct corresponding research on the parallel computing and novel methodology of marine data visualization linear integral convolution algorithm based on GPU. The GPU to join the GPU cluster rendering node internal resources isomerization, inside a single node can contain not only single core CPU, multi-core CPU, even the GPU computing resources, and contains a single GPU or GPU. GPU as computing resources for large-scale data parallel computing makes the GPU present more hierarchical cluster parallel computing ability. The GPU cluster is not only able to support the conventional particle size of single program multiple data and data more computing power, and can support more granular for mass data SPMD and single instruction multiple data computing power [1-4]. GPU cluster this heterogeneous computing resources and multi-level parallel computing capacity for parallel programming brought great difficulties. The detailed discussion will be introduced in the following sections.

The Principles of the Proposed Approach

The Parallel Computing. Social network in the community represents a collection of specific objects, such as community representatives which is formed by the human communication based on interest or background and formation of the real social groups; In the citation network community on behalf of the relevant papers on the same topic; The world wide web community is the discussion on the topic of a number of sites and biochemical network or electronic circuit can be one kind of functional unit in the network community. Community found for social network topology analysis, functional analysis and behavior prediction has important theoretical significance and practical value. In the following figure, we illustrate the topology of the mentioned structure.

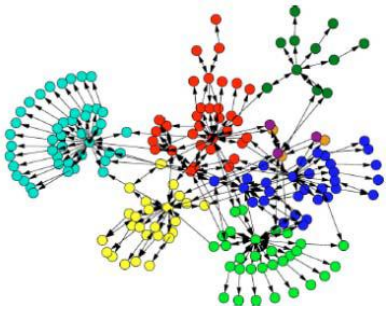

Fig. 1The Structure of the Original Parallel Computing Model

The accuracy rate for the proposed model is shown in the formula 1. Local type of terrain factors serial algorithm characteristics of the parallel computing environment oriented data partition granularity classification method and the result type fusion strategy to construct the local terrain factors of parallel algorithm model for parallel computation method to search plays an important role as well as parallel environment granularity model design provides a new way of thinking.

$$NMI = \left(-2\sum_{i,j} N_{ij} \log\left(N_{ij} / \left(N_i N_j\right)\right)\right) / \left(\sum_i N_i \log\left(N_i / N\right)\right) \quad (1)$$

Parallel computing is to point to use a variety of computing resources at the same time the process to solve the problem of computing parallel computing is generally divided into two methods of data parallel and task parallel) data parallel refers to the data is divided into several blocks on the image to different processing nodes respectively. Each of the same instruction on the assigned data processing nodes is to handle it normally with SPMD mode. For data parallel serial tasks to parallelize the serial algorithm is actually will need to deal with the original distributed to each node processing large data sets are divided into sub data sets) data is divided into divisions according to the specific according to the division of a certain size large datasets split into sub divisions of process data partition contains data sets and the partition granularity partition mode decision data split two aspects including partition granularity decided to split data size.

The Linear Integral Convolution Algorithm. Line integral convolution filter along the streamline convolution white noise image, it is very good visual the directionality of the streamline, reflect the whole structure of the vector field. Specifically, a line integral convolution with white noise as input texture, output texture of each pixel values are obtained by integral convolution: first of all, based on the pixels along the direction vector is, the symmetry of integral streamline, to streamline the value of all pixels corresponding to the input noise according to participate in convolution kernels, the results as output texture pixels which is shown in the expression 2.

$$I(x_0) = \frac{1}{\int_{-L}^{L} K(s)\,ds} \int_{s-L}^{s+L} K(s - s_0) T(\sigma(s))\,ds$$

(2)

Each sample point corresponding to the output image of a pixel, and calculates the strength value is assigned to the pixel, and then hit the pixels, each pixel of miss corresponding vector field again to the pixel center position to compute the flow of a certain length, and then along the same streamline sampling, hit multiple pixels, thus make it about one order of magnitude faster. Vector field visualization should be visible at the same time the size and direction of the vector. Paper USES multiple frequency noise and online integral convolution image attached other information method to achieve at the same time shows the result of two kinds of size and direction information. The following figure 2 shows the different linear integral convolution for the ocean data.

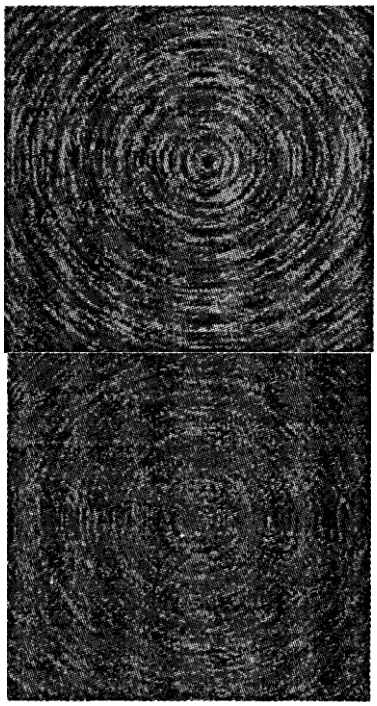

Fig. 2The Different Linear Integral Convolution for the Ocean Data

The spatial frequency, the smaller the particle size, the greater the image is fuzzy, the object movement speed. Therefore, can be based on the vector size synthesis of multiple frequency noise granularity, granularity big frequency is small, the corresponding vector. At the same time to ensure that the grey value is consistent, when the line integral convolution calculation, adopts variable-length filtering core. Line integral convolution image has already showed the direction of the vector field, the convolution using only when the direction of the vector information. Consider the size of the vector, and look at the size of the vector as a scalar field. Visualization of scalar field method are many, here only simple color mapping method, will be the size of the scalar linear interpolation, a grey value. Then the grey value of the scalar field and the original line integral convolution image gray value of each point on the stack, in order to meet the visual habit, vector of local gray scale is small, the vector small local gray level. Here for vector of scalar field size, can use different colors to show. Such as red, green, blue three kinds of color, they represent the size of the vector decreases in turn. Here, of course, you can

also use the method of gradient interpolation to represent the color value of vector, the size of the effect is better, because here the vector difference of size is bigger, here the color effect is not very significant. The most intuitive approach is online integral convolution image line to indicate the size of the vector. But the downside of this approach is that if line is too dense which would undermine the original convolution of the image effect. The sampling process is shown below.

$$I\left(x_{i\pm1}\right)=I\left(x_i\right)+\frac{1}{2n}\left[T\left(x_{i\pm(n+1)}\right)-T\left(x_{i\pm(n)}\right)\right] \quad (3)$$

The Marine Data Visualization and Transmission. Along with the advance of Marine surveying methods, the human's ability to obtain ocean data, accumulated amount of ocean data is becoming more and more amazing. As a collection, storage, management, analysis, processing and display of massive spatial data of effective tools, geographic information system technology has been successfully applied in many fields, such as traffic management, urban planning, etc. Will introduce GIS techniques and methods to study of Marine, help to integrated management and analysis of complex, dynamic ocean information, therefore, GIS technique has been the concern of the Marine science research field. Accurate ocean data visualization helps to improve the efficiency of Marine science research. Marine data visualization requires not only the data displayed in a graphic form, also requires a single spatial location query, select, spatial analysis and information in order to get deeper. Marine special geographic environment, make it hard to direct sea levels observed comprehensively and its internal characteristics. With the help of GIS data visualization technology, marine survey data can be comprehensively and visually express as far as possible, to assist in Marine scientific research personnel to the interpretation of the work. However, although the application of GIS in the Marine data visualization is more and more attention by people, but now more and more application is directly related to land based open design in the field of GIS application directly to the marine science. The user interface of the system is shown below.

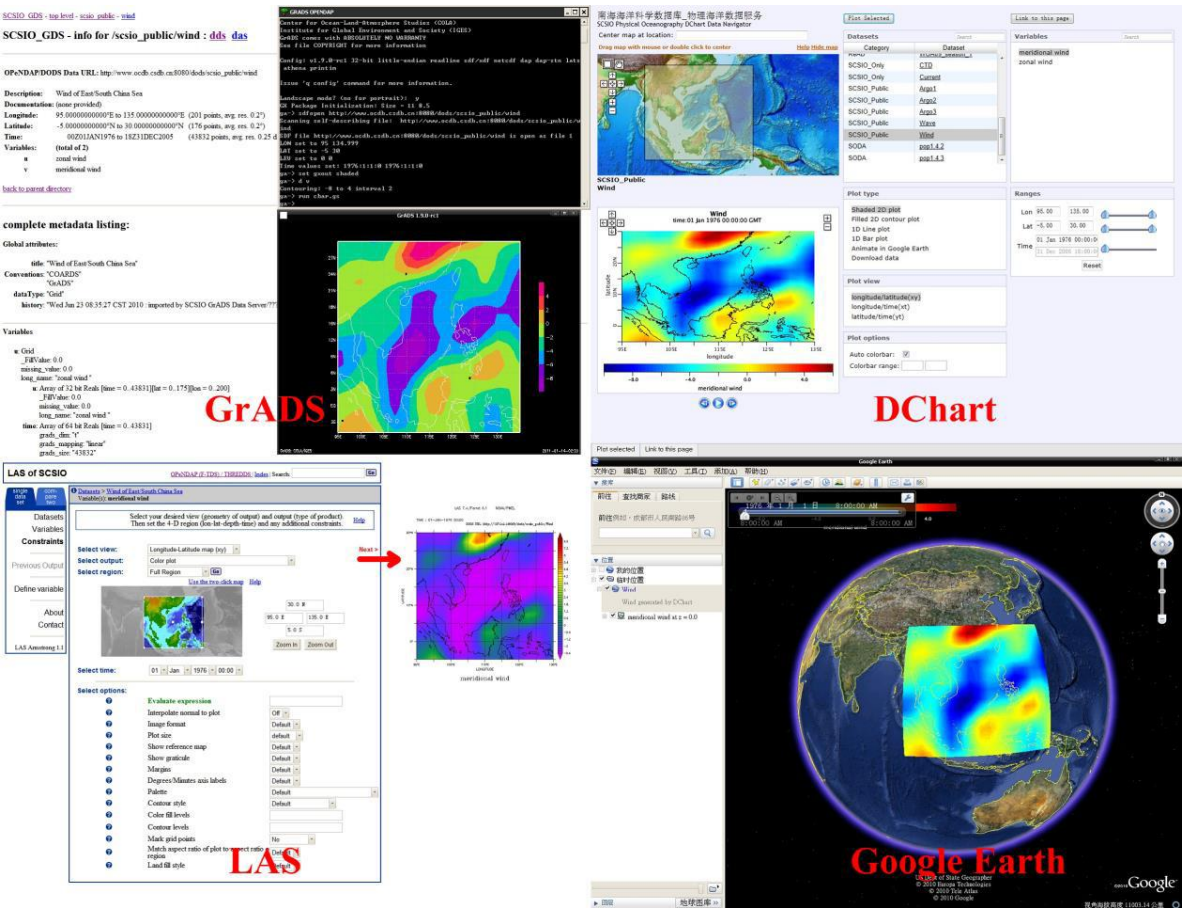

Fig. 3The User Interface of the Designed System

CONCLUSIONS

In this paper, we conduct corresponding research on the parallel computing and novel methodology of marine data visualization linear integral convolution algorithm based on GPU. The geodatabase geographic data model is benefit to organize, manage and generally visualize multi-dimension oceanographic data，therefore it is the best way to use geodatabase to construct oceanographic database. Visualization of scalar field method are many, here only simple color mapping method, will be the size of the scalar linear interpolation, a grey value. Data visualization for ocean data is currently urgently needed. In the future, we plan to conduct more theoretical analysis on the modelling process to optimize the traditional methodology.

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