Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(5): 585-589

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Rapidly Processing Mechanism for Remote Sensing Image Based on EMD Model

Xiong Delan

International School of Education, Xuchang University, Xuchang 461000 (China)

ABSTRACT

This study focused on the theorial model and application foundation to solve some problems of global expanding spatial data. A global subdivision model of the Extended Model Based on Mapping Division(EMD) is introduced and used to establish a template-based rapid processing mechanism for Remote Sensing(RS) images. According to the parallel processing flow of RS images and their basic spatial relations, four kinds of computing modes are established to improve the processing speed of RS images. And a group of RS images are used in experiment to verify these operations in RS application. The results shows that this method is benefit for browsing, moving or transforming the RS images. This work provides the possibility and practicable foundation for rapidly applying RS images, and promotes practical application of EMD subdivision model.

Key words: Remote sensing image; EMD model; Subdivision template; Rapidly processing mechanism

---

INTRODUCTION

Remote sensing (RS) is considered as a high real-time, widely covering and rich information resource. It has become the important basic data for national spatial data infrastructure. And it plays an important role in many military and civilian fields such as aerospace, military reconnaissance, disaster forecasting, environmental monitoring, land planning and utilization, crop yield assessment and so on [1]. With the rapidly development of RS technology, computer and communications technology, the spatial data is expanding exponentially. At the same time, there are urgent requirements in many field of RS images for compatibility, timeliness, accuracy and reliability. The processing speed has already become the bottleneck of rapidly application of RS images. So it is necessary to develop more efficient theory and technology to organize and manage global spatial information. So that it can achieve high performance processing and application services of massive spatial data, and to meet the booming application demands.

The Global Subdivision Theory (GST) is proposed under this background. It has become one of focuses in this field [2-4]. The GST provides many new solutions to quickly processing global RS data [5]. Currently, many works were done about theoretical systems, encoding models and storing mechanisms. While specific application achievements are relatively rare, especially for rapidly processing strategies and methods. So it is necessary to research data model of subdivision cells, parallel processing mechanism of templates, rapidly processing methods of RS images, etc.

The Extended Model Based on Mapping Division (EMD) model has many common advantages of subdivision models at home and aboard. And it extends the applications for existing mapping divisions [6]. The subdivision and encoding method of the EMD model is introduced in this article, and the subdivision template of RS image and template-based parallel processing mechanism are discussed emphatically. Then, a rapidly processing flow for RS images is proposed. And depending on the basic spatial relation of subdivision cells, the rapidly computing modes for RS images are introduced. And the detail processing steps and special experiments are tried. This work will simplify processing operations of RS images and improve its operation speed, which will promote the application and development of EMD model.

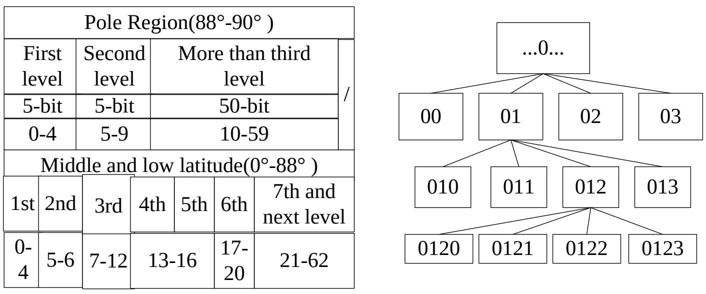
EXPERIMENTAL SECTION

MATERIALS RELATED TO STUDY

The subdivision model is the key of SGT, which researches on how to subdivide the Earth, what shape of subdivided cells and how to encode the cells. After researched on the advantages of various subdivision models, Cheng in Peking University proposed a new subdivision model of the Extended Model Based on Mapping Division [7]. The key points of EMD model can be described as following. It uses regular polyhedral and triangles subdivision method for high latitudes to realize spatial data organization for Polar Regions. And it uses a map-based and equal latitude and longitude grid subdivision method for middle and low latitudes to inherit and expand good subdivision properties of mapping division. Detail subdivision methods were introduced in related references [8-10].

The subdivision cells are a series of discrete grid units in a particular model, which have evident structure and hierarchy. The cells in same level have similar shape and size, and they are continuous in geospatial. So they are the basis for indexing, storing, scheduling and expressing spatial data in GST. The subdivision code is a global and unique code for each cell. Generally, the cells are encoded sequentially according to certain encode curve or distribution rule. Usually, the common encode curves are included line sequence, H sequence, Z sequence and so on.

GeoID is the main encode method for subdivision cells in EMD model. It identifies a unique spatial entity from the three most essential characteristics of space, property and time. GeoID consists of 64-bit address codes, 84-bit attribute codes, 41-bit time codes and 35-bit extended codes. The address codes can be shown as Fig.1 (a). For the convenience of writing, the binary codes can be simplified as a decimal number. The cells' codes for four continuous levels can be expressed in Fig.1 (b).



(a) address code for subdivision cell (b) Four levels subdivision codes

Fig.1 Address codes of subdivision cells

METHODS FOR RS IMAGES PROCESSING

Subdivision template is the spatial features set of subdivision cell, which is extracted from high-resolution RS image. Actually, it is the data sample of RS image in special region corresponding to certain subdivision cell [11]. Usually, the orthophoto RS images with obvious characteristics are choosed to eshabish subdivision templates. The subdivision template inherits all advantages and features of subdivision cell. At the same time, it also has underlying information of reference images [12]. So it can establish association between abstract subdivision model and special RS images. According to different application requirements in data processing, there exist different kinds of subdivision templates. One type of template actually corresponds to a special data processing algorithm.

The key of template-based parallel processing for RS images can be described as follows [13].

1) Choose some proper RS images as reference images, according to different level and covered region in the EMD model.
2) Extract some important information in preprocessing process of RS images, and the subdivision templates are established for several continuous levels of geospatial data.
3) Use a template-based computing mode and generate rapidly parallel processing mechanism based on subdivision cells and their spatial relations.

So that the subdivision templates can substitute RS images to complete many computing processing tasks in an image's element level. This is the goal of rapidly parallel processing for RS images. Here, the subdivision code is seen as the key factor of cells identification and images processing. And it provides a convenient and simplified method to computing and processing massive spatial data [14]. Therefore, this method can realize management of whole lifecycle for spatial data, and greatly reduce the difficulties in its organization and updation, and evidently improve its service efficiency.

RESULTS AND DISCUSSION

BASIC SPATIAL RELATION

The spatial relation of subdivision cells is caused by its pure geometry location. It is the basis and premise for parallel processing of subdivision cell. There are three primary spatial relationships among subdivision cells. They are measure relation, location relation and topological relation [10]. The measure relation uses to decribe the distances and sizes among cells, which mainly contains space distance model and measurement accuracy. The location relation uses to express orientation relationship among cells, such as front or back, up or down, left or right, corner angle. The topological relation refers to some invariants under topological transformation, which is the key feature information for storing and computing of subdivision template [15]. In EMD model, the topological relation among cells is basis of quickly transforming and adjusting images in several levels.

RELATIONAL OPERATION MODES OF SUBDIVISION TEMPLATE

Template-based parallel computing of RS image is done depending on basic relation operations of contain, neighbor, distance and corner-angle. So the relational operation mode is useful to RS images operations, such as moving, changing, resizing, rotating, restructuring and so on. In these operations, relation operation mode is the key of subdivision template computing mode. It includes two kinds of operations, one is aggregation or split in longitude, the other is extension or conversion in transverse.

Longitudinal computing mode: The aggregation and split are the main computing mode in longitudinal direction. Aggregation refers that several cells in same level gather into a high-level cell. It mainly involves cells' position recombination and data structure adjustment. Split refers that a high-level cell split into several cells in low level. It mainly involves cell's segmentation, sub cells' rearrangement, and high-precision images selection. Suppose the cell is expressed as A, L_A is expressed as the code of A, $L_A(i)$ is the number in bit i of L_A. If several cells of $A1, A2, ..., Ai$ $(i<=N)$ aggregate into one higher level cell B, which can be described as:

$$\begin{aligned} L_B &= Min\left(L_A(\mathrm{i})\right) - \log(\mathrm{N}) \\ M_{Bi} &= \& M_B, M_A(i) \oplus (j) \end{aligned} \qquad (1)$$

Where, $logN$ is the length of cell's code, the mark $\oplus$ represents *EXOR* operation in binary, the mark *&* represents *and* operation in binary. This formula can be repeated recursively bit by bit. The operation that one cell B split into several cells of $A1$, $A2$, ..., Ai can be looked as reverse operation of it.

Transverse computing mode: This mode is mainly among cells in same level, which provides facility for browsing and retrieving operations of RS images. It includes extension and conversion in transverse direction. Extension represents that some cells directly connect and compose a large temporary view. Conversion is corresponding to the specific operation of RS images for moving, rotating, cropping.

RAPIDLY PROCESSING EXPERIMENTS

There are many cases of aggregation and split operation, as shown in Fig.2. The detail operation steps and computing process can be defined by RS data set and GeoID codes. So that it can complete radiply parallel processing tasks of RS image. The aggregation degree is the levels difference of cells before and after aggregation. If N number of cells, A_1, A_2, …, A_N aggregate into one cell B, the aggregation degree is the levels difference of A_N and B.

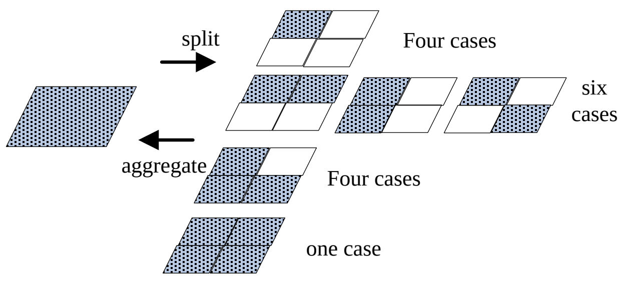


Fig.2 The cases of aggregation and split operations

Experiment environment: In experiment, we select four group of high-resolution RS images. The images have three to seven bands, and are about 10-30Mb in size. The original images are preprocessed by ERDAS 9.2, including image enhancement, geometric correction, division cutting. They are related to subdivision cells in the tenth level of EMD model. The parallel processing cluster consists of six parallel processing nodes. Each node is configured as CPU of Core (TM) 2 E7300 2.66 GHz, RAM of 4GB. The operating system is Ubuntu 10.04, and the program is developed by C++ and MPI technology.

RESULTS AND DISCUSSION

One of RS images coved several cells can be encoded and divided into 24 parts. Four small parts aggregrate into one image, the results can be shown in Fig. 3. To ensure the correctness of results, the program is executed for ten times under different conditions with parallel processing nodes.

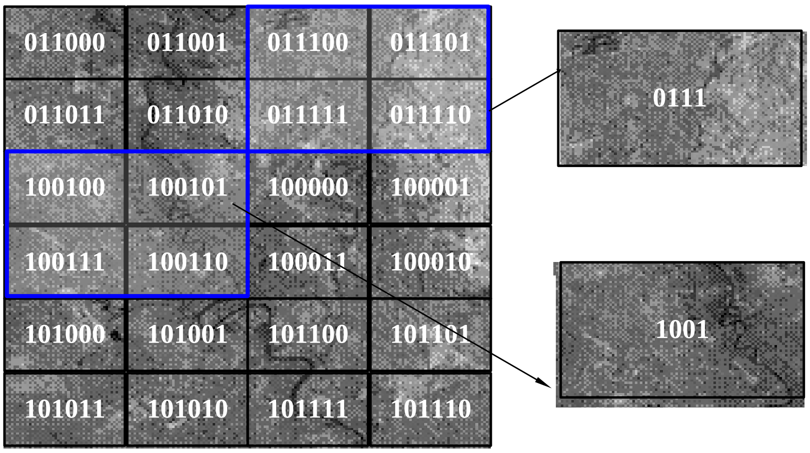


Fig.3 Four cells aggregation results

The results show that the processing time would gradually decrease when the number of nodes increase, but the rate of decrease was not linear. When the number of nodes was even, the parallel efficiency improved obviously. When it was same with aggregation degree, i.e. 4 , the parallel efficiency reached to maximum. The possible reason is when the aggregation degree is same with parallel processing tasks, it will save tasks dividing and nodes' waiting time.

CONCLUSION

The EMD model can be seen as a uniform spatial data record standard and high efficient data organization method. It reflects the spatial characteristics of RS images data in the maximum extent. So it realizes integrated organization and management of multi-scales and multi-sources spatial data. This article introduced the EMD model and encoding method of subdivision cell, and proposed a template-based parallel processing mechanism. The experiment in three continuous levels shows that this method had obvious effect to simplify RS image data and improved its parallel processing efficiency. This work provides the necessary foundation for application of GST and EMD model. And it creates a new attempt for high-performance processing method of RS images. In the future, our studies will focus on the template-based parallel processing strategies and algorithms, aiming to improve the classification speed and expand new application demonstration.

Acknowledgments

The author wish to thank the National Natural Science Foundation of China for contract U1304403, the Henan Science and Technology Program under Grant 132102210398, the Science and Research Project of Xuchang University under Grant 201402 and Xuchang University Young Teachers Program, under which the present work was possible.

REFERENCES

[1] Li D.R., Gong J.Y., Shao Z.F. *Geomatics and Information Science of Wuhan University*, v 35, n 2, p 127-132, February **2010**.

[2] Shen Z.F, Luo J.C., Chen Q.X., etc. *Journal of Harbin Institute of Technology*, v 38, n 11, p 1968-1971,1976, March **2006**.

[3] Wang H.P., Zhang J., Liu X.G., Huang X.D.. Parallel algorithm design for remote sensing image processing in the PC cluster environment. *18th International Conference on Geoinformatics*, Beijing,China, pp.1-5, May 17-21, **2010**.
[4] Li C.R., Cai X.W.,etc. *Science Technology and Engineering*, v 35, n 12, p 9540-9543, December **2012**.
[5] Zeng Z.L.,Liu R.Y., Li X.T., etc. *Journal of Zhejiang University (Science Edition)*,v 39 n 2, p 225-230, February **2012**.
[6] Tong X.CH.. *Acta Geodaetica et Cartographica Sinic*a, v 40, n 4, p 536, April **2011**.
[7] Cheng Ch.Q., Ren F.H., Pu G.L.. Introduction to Spatial Information Subdivision Organization. *Science Press, Beijing*, pp:21-298, **2012**.
[8] Cheng Ch.Q., Guan L.. *Acta Geodaetica et Cartographica Sinica*,v 48, n1, p 123-132, January 2012.
[9] Tan Y.P., Cheng Ch.Q., Geng X.. *Geographical Research*, v 31, n6, p 1132-1142, June **2012**.
[10] Guan L., Lu X.F.. *Acta Scientiarum Naturalium Universitatis Pekinensis*, v 27, n 3, p 1-5, March **2011**.
[11] Li D.R., Yi H.R., Jiang Zh.J.. Introduction and Analysis of Grid Technology. *Editorial Board of Geomatics and Information Science of Wuhan University*, v 30, n9, p 757-761, September **2005**.
[12] Du G.Y., Miao F., Xiong D.L. *Computer Science*, v 39, n8, p 263-267, August **2012**.
[13] Xiong D.L.,Du G.Y. *Modern Computer*,v10,n 1, p 62-64, October **2012**.
[14] Xiong D.L., Du G.Y.. *International Journal of Computer Science Issues*, v 10, n 1, p 388-392, January **2013**.
[15] McNaim H., Ellis J., Van Der S.. Int.J. *Remote sensing*, v 23, n 5, p851-870. May **2002.**