Chapter 77
Research and Implementation of Massive Data Atlas Visual Strategy

Peng Wang and Shunping Zhou

Abstract In order to solve the display problem with massive data atlas, researchers propose five kinds of visualization strategy to improve the display efficiency in this paper. By using the strategy of establishing the atlas map frame index, hierarchical visualization, real-time dynamic projection, double buffering + multi-threading data dynamic annotation, local cache based on spatial data mining visualization, researchers basically solve the problems existing in the process of multi-source heterogeneous mass data atlas display. The strategy has achieved on the MapGIS K9-based platform and successfully applied to the basis of the outcome of mapping system of the national fundamental geographic information center. Researchers found that the display strategy is significantly more efficient than traditional visualization strategy. Thus, the effectiveness and accuracy of the algorithm are verified.

Keywords Massive data · Atlas · Visualization strategy

77.1 Introduction

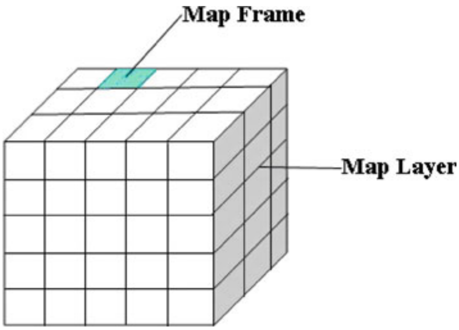
With the widespread application of GIS, an increasing number of industries are involved in GIS. A variety of GIS data systems do not have a unified standard, but it's likely to intercross and need for integration of multi-source heterogeneous data [1]. In order to manage the multi-source heterogeneous mass data, we choose atlas model of MapGIS platform, and firstly the display efficiency of massive data atlas is an urgent problem to be solved.

P. Wang (✉) · S. Zhou (✉)
Faculty of Information Engineering,
China University of Geoscience(Wuhan), Wuhan, China
e-mail: wp19850104@163.com

S. Zhou
e-mail: zhouspin@yahoo.com

W. E. Wong and T. Ma (eds.), *Emerging Technologies for Information Systems, Computing, and Management*, Lecture Notes in Electrical Engineering 236, DOI: 10.1007/978-1-4614-7010-6_77,

Fig. 77.1 Atlas cube management model



77.2 Atlas Model of MapGIS Platform

Atlas model management of MapGIS platform adopted a cube model (Fig. 77.1) based on map frames and map layers [2]. Map frame units manage spatial data in the atlas management model, which constitute horizontal grid. Individual frames are composed by several layers in vertical overlap [3], layers division correspond to the division of the input editing layer class, such as administrative boundaries layers, water system layers. Layer horizontal division makes gallery management more rational, more layered.

77.3 Atlas of Huge Amounts of Data Visualization Strategy

In order to reasonable and efficient display multi-source heterogeneous atlas of huge amounts of data; we propose the following visualization strategy.

77.3.1 Establish the Atlas Map Frame Index

The map frame management index is established by the characteristics of the spatial data's horizontal framing and vertical stratification [4], which is beneficial to query and select the atlas frame data. The atlas visualization process is divided into two processes (1) Using the particular range to query extract spatial data, (2) Drawing this particular data on the screen. Creating map index can improve the speed of querying extract data, is the first step to improve the efficiency of display process. Testing proved that when the space numbers of features are about 300 million or so, if you create a frame index and use the index filters the space data, the shortest response time was only 2 s, so we can create map frame index to improve the query efficiency of massive data atlas.

77.3.2 Hierarchical Visualization Strategy

When atlas of graphic information is displayed to the subscriber, the region of display information received by the user was only the region of the computer screen [5], due to the limited display area of the atlas; user is difficult to obtain their useful information unless we choose the display ratio control and content hierarchical display. To make atlas more naturally display the data layers and give user a better interactive experience, we can set the displayed radio to achieve the purpose of the outline. After setting a suitable displayed radio, the atlas can dynamically adjust displayed loading capacity. Due to adjust the display ratio, in small scale, the map information displayed relatively rough, in large scale, relatively detailed map information displayed. The hierarchical visualization strategy can be a good solution to the problem of multi-scale feature class displaying in the same view. Therefore, the use of hierarchical visualization strategy can quickly improve efficiency of massive data atlas display.

77.3.3 Real-time Dynamic Projection Strategy

In view of atlas manages massive heterogeneous data with different reference coordinate system; we must solve the problem of unified reference coordinate system before the integration of heterogeneous data show. We can set the reference coordinate system of the atlas when atlas integrated display [6], atlas will real-timely dynamic project the heterogeneous data to the setting coordinate system, and then unify display projected data, so end-users can preview of the multi-source heterogeneous data in the same view, such as raster and vector data overlay display in the same view is shown in Fig. 77.2, the use of dynamic projection can solve different reference coordinate system of heterogeneous data integration display.

77.3.4 Using of Double Buffering + Multi-threading to Achieve Efficient Mass Data Dynamic Annotation

Double buffering technique means to not modify visible graphics cache conditions, and request a equal size storage of screen area in memory, the image which will be displayed is simultaneously drawn in the virtual memory, then directly copy virtual memory to the visible pattern cache (because of memory copying, the entire copy process is very quickly). Drawing process need not to directly operate on the screen, but operate the background of virtual memory, so it is a good solution to

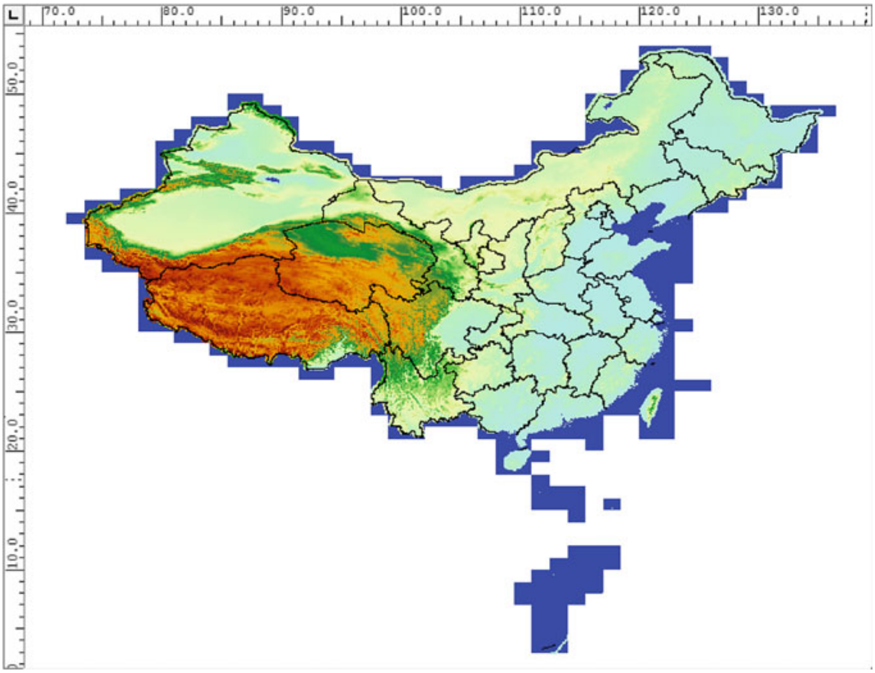


Fig. 77.2 Atlas of vector and raster data unified display

the jitter, flicker problem of screen draw. Therefore, using this method can significantly improve the drawing speed, enhanced graphics effects. Its principle is shown in Fig. 77.3.

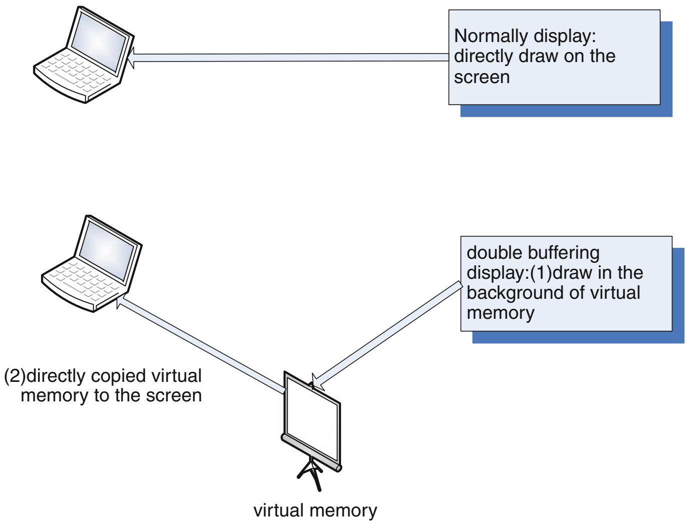


Fig. 77.3 Double buffering schematic diagram

Fig. 77.4 Traditional dynamic annotation mode

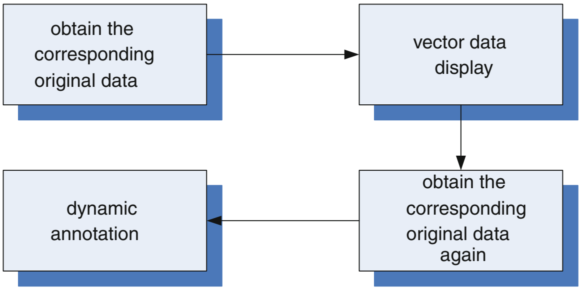
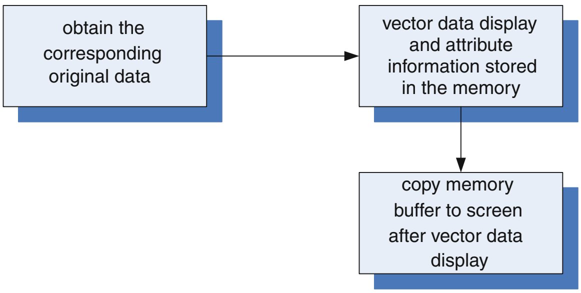


Figure 77.4 depicts a conventional dynamic annotation process, which is the most intuitive and simple manner, after the completion of the vector data display, then obtain the corresponding original data from the database in accordance with the display range. After the dynamic projection of the original data, calculate the annotation point position and its related information, and then dynamic annotation according to the annotation information. The advantage of this way in the practical application of the process is intuitive and simple, its correlation function is easy to implement, but its obvious shortcomings is that the method process is extremely inefficient in the practical application.

Figure 77.5 describes improved double buffering dynamic annotation mode, In the process of the vector data atlas show, when the data's display range is acquired from the database, the projection data's spatial information associated with the attribute information stored in the corresponding memory buffer, using of general flow to display vector data with range, after completing the display of the vector data, then calculating the note according to the space within the data buffer (completed dynamic projection calculation) and attribute information. This way greatly improved the efficiency of the whole show, but affects the speed of the graphics display, due to adding a dynamic annotation process in the graphical display of the process.

Figure 77.6 depicts a multi-threaded + double buffering to achieve dynamic annotation, the double buffering dynamic annotation based on a multi-threading support, new threads to achieve double buffering of dynamic annotation, so as to avoid affecting the image display speed and solve the problem which exists in the double buffering dynamic annotation, multi-threaded + double buffering

Fig. 77.5 Double buffering dynamic annotation mode



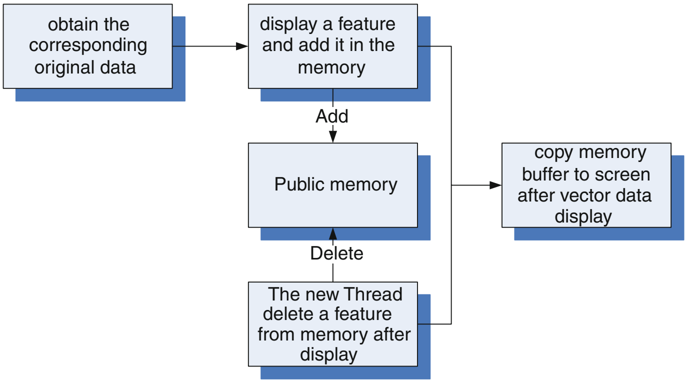


Fig. 77.6 Multithreaded dynamic annotations

combined dynamic annotation has a very high efficiency display, but the specific logic implementation is relatively complex, need to accurate handle the critical region, mutex semaphore.

77.3.5 The Local Cache Based on Spatial Data Mining Visualization Strategy

Spatial data mining refers to using space or attributes condition to extract user's interested spatial patterns, characteristics, spatial and non spatial data universal relation from the spatial database [7].

In order to efficiently display data atlas, we consider using a local cache. As the amount of data is too large, directly cached massive amounts of data from the database to the local which is time-consuming, wasting of disk space. Therefore we need to analyze the characteristics of the data, as well as the regular habits of users to preview data, then organize and manage the cached data, thus efficiently show users' most interested content. We carefully analysis of the spatial and attribute data according to the idea of spatial data mining, and ultimately achieve a unique visualization strategy based on local cache of spatial data mining.

Based on spatial data mining visualization of local cache strategy process is: firstly, we choose a layer of the original spatial data in the massive data atlas for data mining by attribute extraction classification, and then create a local cache atlas to manage the multiple local extraction results class. By the atlas hierarchical visualization strategy such as configuration transition display ratio or layer display sequence, we can make local cache atlas meet our users' preview habits, natural transition, and rapid response effect. The layer data in the atlas, no longer display the original spatial data, but display the configured local cache atlas. We can greatly improve the spatial data visualization efficiency by setting the local cache atlas.

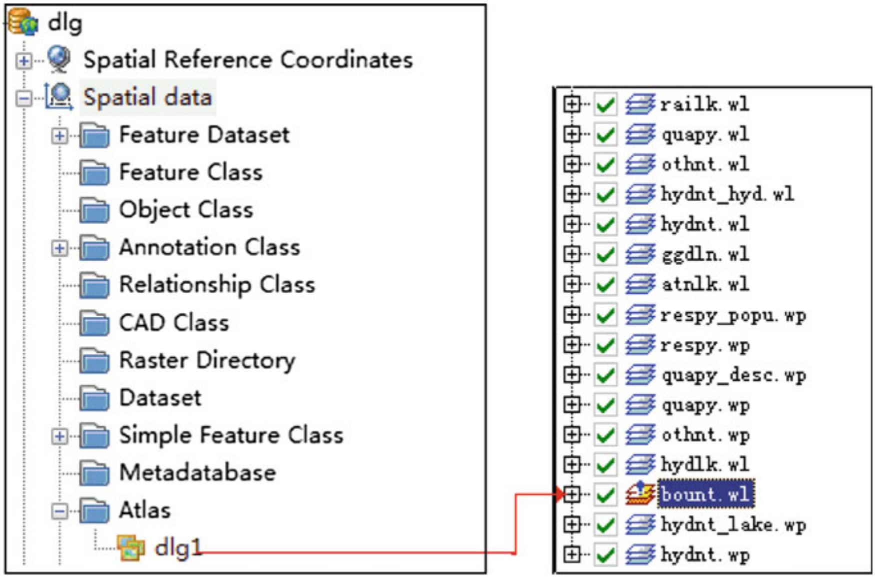


Fig. 77.7 Bount.wl layer example

In Fig. 77.7, we use the National Geographic Information Center's 1:25 million achievement database map set's boundary line layer (bount.wl) as an example.

77.4 Conclusion

Massive data atlas visualization strategy presented in this paper basically solves the problems that exist in the process of multi-source heterogeneous mass data display, and significantly improve the efficiency of displaying huge amounts of data. It also solves the multi-scale, multi-source heterogeneous data integration display problems, and massive data dynamic annotation inefficiencies. This paper innovatively has proposed visualization of spatial data mining strategy based on local cache, making the local cache with flexible configuration features. Caching strategy greatly optimizes the massive data's visual effects. Due to the complexity of the vast amounts of data, there are still some visual problems to solve in pending further study, such as how to ensure the consistency of the cache data with the original data, the establishment of dynamic tile cache.

Acknowledgments This research was supported by the National Science and Technology Support Program, China (No.2012BAB11B05) and by the Research Center for GIS Software and Application Engineering, Ministry of Education Program, China University of Geosciences, Wuhan (No.20111113; No.20111114). Peng Wang and Shunping Zhou thank the great efforts they have paid.

References

1. Zhou, S.P., Wang, P.: The Integration of Multi-source Heterogeneous Data Based on Middleware, ICISE (2009)
2. Fang, F., Wang, P.: The Algorithm and Realization of Vector-Data Attenuation-Junction of Arbitrary Scope, ESIAT (2009)
3. Zhou, S.P., Wei, L.P., et al.: A study of integration of multi-source heterogenous spatial data. Mapp. Sci. **25**, 25–27 (2008)
4. Song, G.F., Zhong, E.S., et al.: A study on seamless integration of multi-sources spatial-data (sims). Prog. Geogr. **19**, 110–115 (2000)
5. Huang, Z.Q., Feng, X.Z.: The research of spatial heterogenous data source integration of GIS. J. Image Grap. **9**, 904–907(2004)
6. Wu, X.C.: Design and Implementation of Geographic Information System. Publishing House of Electronics Industry, Wuhan (2002)
7. Wu, X.C.: Application Software development of Geographic Information System. Publishing House of China University of Geoscience, Wuhan (2001)