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Representation and Organization for Spatial Data in LBS

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ABSTRACT: Aiming at the special demand on SVG_based representation and organization for spatial data in location based services (LBS), the research is made in this article on the conversion method from multiple formats to SVG format, and a harris_corner detector method is proposed and verified to evaluate the conversion result. Based on the above, an optimized compression arithmetic is proposed, which integrated the characteristic of code simplification and GZIP compression. The test shows that the techniques on conversion and compression are feasible, which means that SVG_based representation is suited for spatial data in LBS and the improved compression arithmetic is prior to the former.
KEY WORDS: location based services (LBS), scalable vector graphic (SVG), conversion method, harris_corner detector, optimized compression arithmetic.

1 INTRODUCTION

The fields of geoinformation technology and cartography have seen dramatic changes in the last decade. With the mobile internet, which is flourishing at a very fast rate in the world, and with the popularity of mobile devices such as PDA's, mobile phones etc., the industry is eying at the marriage of geoinformation services and mobile devices in the form of location based services (LBS) (Gao et al., 2009; Meng, 2005; Li et al., 2002). However, geo-visualization for small displays of mobile devices is restricted by several technical limitations such as the small display size and resolution, lack of processing power and memory, and most critical the battery life. Furthermore, the mobile network bandwidth is considerably lesser than that in fixed networks. Though these are improving day by day due to technological advancements, at the moment every graphical application still has to deal with these restrictions. With the developing need of multi-scale spatial data organization and management in LBS, the representation, organization, transformation and adaptive visualization for multi-scale spatial data in LBS exist as a crucial problem to be solved (Gao et al., 2009; Shi and Lü, 2009; Sun et al., 2008; Dunfey et al., 2006). So in this context, SVG (scalable vector graphics) becomes a popular and efficient vector representation format in wireless internet environment (Jiang and Yang, 2011; Lee and Baek, 2009; Shi and Lü, 2009; Sun et al., 2008; Zucker and Bulterman, 2007; Li et al., 2005). Because SVG has some characteristics such as neutrality, easy use, strong interaction and independent platform, many large companies involve in SVG technology, such as Microsoft and ESRI, and so on. The companies use SVG technology to improve transport speed of spatial data in network. Mobile SVG as a part of SVG fits to visualize 2D graphs under mobile network.

Before using SVG data, acquiring SVG from existent special data forms in some way is necessary. At the same time, the feasible solution is also need to be provided to represent and compress SVG data. Focusing on the advantages of expressing geographic information by use of SVG in the network the mobile environment, many studies are made in the field of SVG file conversion (Joubert et al., 2011; Shi and Lü, 2009; Sun et al., 2008; Antoniou and Tsoulos, 2006; Li et al., 2005), SVG file organization (Jiang and Yang, 2011; Wang and Zhu, 2011; Li and Huang, 2010; Wessel, 2003) and SVG file compression (Claude and Navarro, 2010; Ferragina et al., 2005; Chen and Song, 2004; Beszedes et al., 2003). However, there are few researches on the data quality comparison before and after conversion. In addition to literatures (Jiang and Yang, 2011; Duignan et al., 2003), which only made a simple qualitative visual evaluation on the transition effects from the point of visual view, almost all the research in this filed have not considered the problem of quantitative evaluation on the data format conversion effect, and only shows poor convince on conversion effect. So a suit of appropriate SVG conversion method and conversion effect evaluation methods is necessary to be proposed.

On the other hand, in the field of SVG data organization, the current study focused on the SVG lossless compression algorithm on the server-side component, such as Huffman coding, run-length coding, LZ coding and so on (Li and Wang, 2011; Wang and Zhu, 2011; Tomokazu, 2007; Chen and Song, 2004). There is little research on how to optimize the expression format of the SVG entity's own coding. In fact the data amount of SVG's own coding directly affects the size of the compressed packet, so only lossless compression algorithm without taking into account of the SVG code compression is difficult to achieve satisfactory results.

In summary, the present study on SVG image quality inspection before and after conversion is still blank, and there is

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also little deep study on SVG_based compression and organization model in LBS. Therefore, aiming at the unique demand on SVG_based representation and organization for spatial data in location based services (LBS); this article intends to make a study on conversion method and conversion effects evaluation, and also on an appropriate data compression method, in order to achieve a reliable SVG_based compression and organization model in LBS.

2 SVG_BASED REPRESENTATION OF GEOGRAPHIC INFORMATION

As the natural advantage of the graphics expression based on SVG is concerned, it is a viable solution to express the geographic information in LBS system by use of SVG. There are existing two general kinds of accesses to acquire SVG-based geographic data (Jiang and Yang, 2011; Li and Wang, 2011; Li and Huang, 2010; Goto et al., 2010; Molina et al., 2007; Holmberg et al., 2006): One is to generate SVG by sue of some graphics software like Illustrator and CorelDRAW; the other is to acquire SVG from existent special data forms by use of format conversion. The former has the shortcomings of limited data source and low accuracy, and the latter seems more feasible to share geographic information.

Taking shp (the format of shapefile vector file in ARCGIS) data for an example, there exists three patterns to convert itself to SVG format. Firstly, the third-party software-shp2svg is easy to use, but it is expensive to buy. Secondly, core component of ArcGIS is used to render, but it is difficult to integrate the attribute information. Last, the research is done by use of code programming by analyzing the corresponce between shp format and geographical expression of SVG. The last way is most effective with most scholars' experiences as well. So the third method is adopted in this article.

In this article, the experimental verification is respectively done by use of raster images loading method and by use of vector data conversion programming method, in which raster data is loaded by <image> label in SVG format, and vector data is firstly converted to GML format through a Java program, and then to SVG file by use of an XSL convert ion tool. The test result shows that the Change is small in the size of data file before and after the conversion for raster data, however, as the shp vector format is concerned, the data size becomes smaller. The test result s showed in Table 1, which means converted SVG file accounts for the ratio of the original shp file, and it seemed highly effective in SVG_based representing spatial data.

It can be seen from Table 1 that the SVG _based Conversion advantage of is more obvious when the greater the shp file size. Even after several experiments, this conclusion is still valid. On the other hand, the little change in accuracy can be observed visually compared to the original JPG raster and converted SVG image, but converted SVG image clarity is not as good as the clarity of the original JPG raster. But the convince is poor only from the view of human eye to distinguish transition effects, so it is necessary to propose appropriate and quantified test method on the transition effects.

Table 1 The illustration of file size before and after the conversion

ID	SVG file size (MB)	Shp file size (MB)	Ratio (%)
1	13.7	95.4	14.36
2	66.3	437	15.17
3	111	713	15.57
4	219	1 310.72	16.71

3 CONVERSION EFFECT EVALUATION BASED ON THE HARRIS CORNER DETECTION ALGORITHM

In previous studies, how to test the image quality of SVG_based spatial data in LBS is still blank. Since the corner detection method in the field of image edge detection has a wide range of applications (Li et al., 2012; Wu et al., 2011; Edward and Jose, 2009), this article draw on the image target detection technology to evaluate the accuracy of detection of SVG images based on Harris corner detection algorithm.

3.1 Basic Principles and Processes

The corners are those where the two-dimensional image brightness has a violent change or those with maximum curvature at the image edge curve (Ryu et al., 2011; Krystian and Cordelia, 2004). compared to the image edge, The corners are more unique to determines the characteristics of the target outline, so corner detection is widely used in camera calibration, the virtual scene reconstruction, motion estimation, image registration and other computer vision processing tasks (Gueguen, 2011; Zhao and Zhang, 2006; Krystian and Cordelia, 2004; Zhao and Li, 2003). There are generally several corner detection methods, such as corner detection based on template matching, corner detection based on edge features, corner detection based on brightness change detection, and so on (Khan et al., 2012; Bellavia et al., 2011; Zhao et al., 2008; Zhao and Zhang, 2006).

In this article, the Harris corner detection algorithm based on the brightness change detection is adopted to evaluate the transition effects. The basic idea is explored as follows. Define a Gauss window and then move it in any direction to extract the interest pixel points with great value in the local range, which corresponds to the corner. In the case of image quality differences, the corner number affects the clarity of the image: the number of corner points is more, the better the image clarity.

The corner detection algorithm based on the Harris operator has the advantage that can extract directly corner without depending on other local feature of the detection targets. Considering the whole image as a target, this algorithm detects every feature point in order by use of the Gaussian window, and has an important reference to verify the conversion of image quality.

In the process of searching the corner, it takes out every pixel in order from its eight neighborhood pixels, and get the maximum pixel among the center pixel and its eight neighborhood pixels. If the center pixel has a maximum value, it is a corner point.

During this process, it can be done to choose different search radius threshold, and the number of obtained corner points will become less with the larger radius threshold. As two piece of images to be compared is concerned, we can select the same search radius and compare the ratio of the number of corner before and after conversion, so in order to judge the loss extent of the image accuracy.

3.2 Case Test

Based on the above algorithm idea, taken the raster and Shapefile formats data from the same study as an example, an experiment are made in the Matlab environment to vivificate the conversion effects. The results are shown respectively in Figs. 1 and 2.

It can be observed from Figs. 1 and 2: as the raster data detection is concerned, before the conversion, the number of corners for original raster data is 4 957; after SVG conversion, the number of detected corner points is 4 478, and the ratio of the corner number before and after conversion is 90.3%. Similarly, as the Shapefile vector data detection is concerned, before the conversion, the number of corners for original raster data is 1950; after SVG conversion, the number of detected corner points is 1 765, and the ratio of the corner number before and after conversion is 90.5%.

It can be confirmed by the large number of detection experiments that the ratio of the corner number before and after conversion is almost 90% for both raster and vector data files, which means that the accuracy loss of SVG data after image conversion is smaller, and the image quality is better and more suitable to represent geographic information in LBS. On the other hand, due to differences in conversion method, compared with vector data, the proportion of corner points for raster data is slightly lower than that of the vector data. Which shows that the accuracy loss of the conversion from raster data to SVG image is a little larger, and the conversion effects of the raster data is slightly worse than the effect of the vector data.

4 OPTIMIZED COMPRESSION BASED ON SVG CODING SIMPLIFYING

4.1 Basic Principles and Processes

Though XML_based SVG is smaller than other traditional vector data, its size is also large before compression when it is

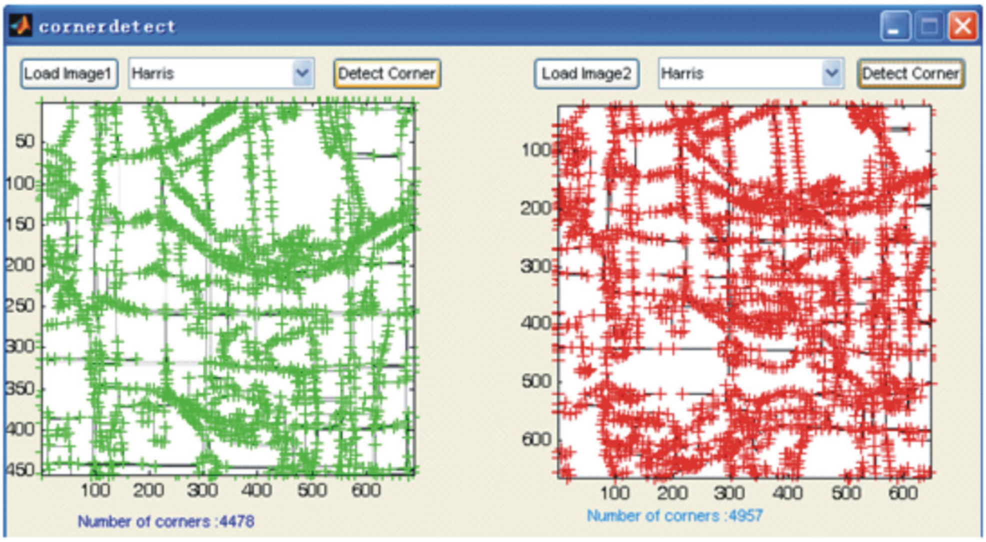

Figure 1. The corner detection illustration of SVG conversion effects for raster data.

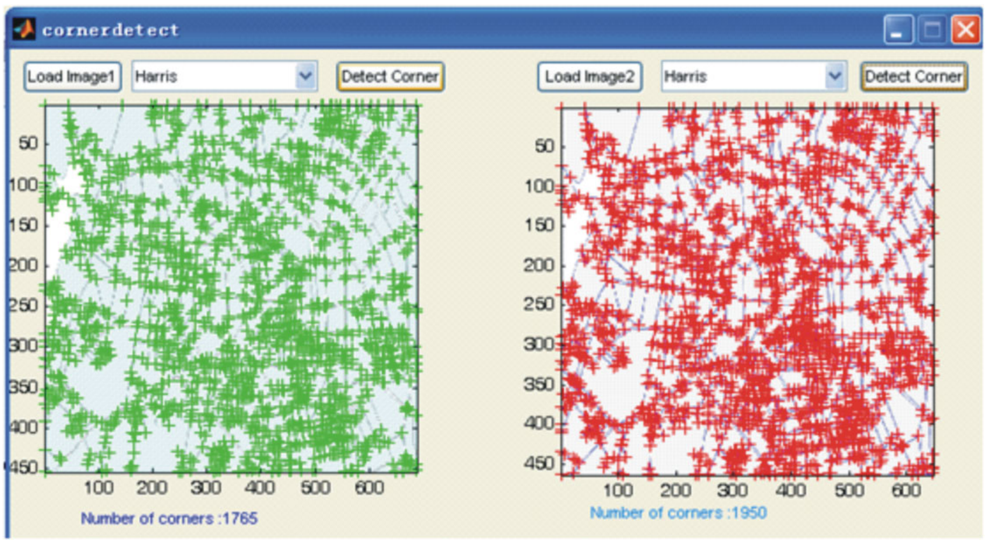

Figure 2. The corner detection illustration of SVG conversion effects for vector data.

organized with more different scale layers. Studies have shown that SVG can be compressed to 30%–10% by GZIP compression algorithm. SVGZ is the compression file after GZIP, and it can be shown automatically in the browser without any further treating and the display speed is approximate the same as the original. Although the size of the data file has yet to be reduced, there is little research on how to optimize the expression format of the SVG entity's own coding. In fact the data amount of SVG's own coding directly affects the size of the compressed packet, and how to simplify the SVG coding is still one of the key compression issues.

Taking into account that the SVG format supports GZIP compression which integrate Huffman and LZ coding, therefore, further integrating with GZIP compression algorithm, the article proposes an algorithm named as "coding simplifying" to further reduce the SVG data size.

The so-called "coding simplifying" algorithm follows the idea: Similar geographical entities with the common features are packaged together, and then by use of reasonable algorithms and flexible description to reduce the graphic description coding of the package, so as to greatly reduce the description of the SVG code. Simplified representation of SVG is reduction of descriptive code by reasonable and excellent algorithm. The article packages the similar spatial data with the idea of modularization. </symbol> is representation of code. It is easy to visualize SVG by bringing the symbolic ID. Judgment is necessary before compression. The principle of simplifying is similar spatial data which only changed in displacement but not in shape relatively large. In addition, The SVGZ format cannot be opened in text and is difficult to read even after it is opened, and this enhances the security of system to some extent.

Therefore, this article intends to propose an optimization algorithm which integrates GZIP compression and coding simplifying algorithm to deal with SVG data compression. The basic process of the optimization algorithm is to judge if the layer has similar spatial data. If the answer is yes, it needs to make a representation simplification before GZIP compression algorithm. If the answer is no, then it need not to make a simplification, but turn directly to the server-side component of compression (GZIP compression).

4.2 Case Test

In the experimentation of comparison of file size, six groups of shp files from ArcGIS are used as data source through digitization in ArcGIS. Conversation form shp to SVG is processed by running 'Shp2svgSource' source code in the environment of compiled C#. Table 2 shows the Comparison of three kinds of algorithms for SVG compression.

From Table 2, it can be seen that the compression ratio of optimization algorithm is obviously better than those of coding simplifying and GZIP compression algorithm, and also that the greater the amount of data, the better the compression effect. In practical applications, when the system stores large amounts of data at different spatial scales and different time, using the optimized compression method can significantly improve compression efficiency of the SVG data, and the compression rate of Compressed SVGZ file can reach 70% to 90%. Furthermore, while browsing through the browser, the SVGZ data can be automatically extracted and displayed, and almost does not affect the display speed, which means a great significance to visualize GIS data on mobile side and transmission in wireless network.

Table 2 Comparison of algorithms for SVG compression

		Coding simplifying algorithm		GZIP algorithm		Optimization algorithm	
ID	Original SVG file size (MB)	File size after coding simplifying (MB)	compression ratio (%)	File size after GZIP compression (MB)	Compression ratio (%)	File size after optimization compression (MB)	Compression ratio (%)
1	3.16	1.41	55.4	1.01	68.0	0.741	76.6
2	11.4	3.45	69.7	2.68	76.5	0.763	93.3
3	25.3	3.8	85.0	4.2	83.4	0.797	96.8
4	54.5	4.5	91.7	4.76	91.3	0.811	98.5
5	165.8	6.8	95.9	5.2	96.8	0.832	99.5
6	274.3	8.7	96.8	7.1	97.4	0.841	99.7

5 CONCLUSION

The research is made in this article on the conversion method from multiple formats to SVG format, and then a harris_corner detector method is proposed and verified to evaluate the conversion result, which shows that the accuracy loss of SVG data after conversion is smaller, and the image quality is better and more suitable to represent geographic information in LBS. On the other hand, due to differences in conversion method, compared with vector data, the proportion of corner points for raster data is slightly lower than that of the vector data. Which shows that the accuracy loss of the conversion from raster data to SVG image is a little larger, and the conversion effects of the raster data is slightly worse than the effect of the vector data. Based on the above, an optimized compression arithmetic is proposed, which integrated the characteristic of code simplification and GZIP compression. The test shows that the techniques on conversion and compression are feasible, which means that SVG_based representation is suited for spatial data in LBS and the improved optimization compression arithmetic is prior to the former.

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