Comparison between Block-Encoding and Quadtree Compression Methods for Raster Maps

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Abstract. The compression methods are essential for big data, such as maps, images and large data, because the storage spaces are more required as long as data are being overloading. In this paper, quadtree compression method and block-encoding compression method are compared by their lossless compression results based on the raster maps. Quadtree is a method which is very mature and popular in segmentation and compression area. Block-encoding method is a 2D version of run-length encoding method.

Keywords: Quadtree, Block-Encoding, Lossless Compression.

1 Introduction

The maps are useful to locate the area where the place is. The original maps sizes are usually extremely large. The storage spaces of an android device are very small if it is comparing with computer storage spaces. With the android devices are very popular, maps that uses in android devices are also needed to compress for storage space. Raster maps are grid cells based structure of the pixel. One pixel can be representing a place where is the importance area. Therefore, lossless compression is very important for maps. When some pixels are lost at the compress time, the information on the map will also be missed information. Therefore, lossless compressions of raster maps are essential and very effective. When compressing the maps, many lossless compression techniques can be used. Quadtree compression technique is very popular, and quadtree has very effective segmentation result. Block-encoding technique is very similar to quadtree data structure in working. But block-encoding can work on the sizes of the images such as width and height of the image are not equal to length while the quadtree can only work on the square images.

2 Related Works

Doaa Mohammed and Fatma Abou-Chadi [4] investigated image compression using block truncation coding. In their paper, two algorithms were selected namely, the original block truncation coding (BTC) and Absolute Moment block truncation coding (AMBTC). The two algorithms are based on dividing the image into non overlapping blocks and uses a two-level quantize. The two techniques were applied to different grey level test image each contains 512×512 pixels with 8 bits per pixel (256 grey levels). Xin Li and Shawmin Lei [5] presented a novel block-based segmentation and adaptive coding (BSAC) algorithm for visually lossless compression of scanned documents that contain not only photographic images but also text and graphic images. Gregor Klajnšek, Bojan Rupnik and Denis Špelic [6] presented a novel algorithm for lossless compression of volumetric data. Their algorithm is based on their previously presented algorithm for lossless compression of volumetric data, which uses quadtree encoding of slices of data for discovering the coherence and similarities between consecutive slices. Guobin Li and Lin Li [7] described Multi-level spatial index techniques are always used in the management of large spatial databases. In that paper, according to the characteristics of spatial index of grids and QR-tree, a hybrid structure of spatial index is presented based on multi-grid and QR-tree. Clair Cho, Eike Grimpe and Yin-Chun Blue Lan [8] discussed that the quadtree compression technique is the most common compression method applied to raster data. Quadtree coding stores the information by subdividing a square region into quadrants, each of which may be further subdivided in squares until the contents of the cells have the same values. Xin Zhao, Hanyu Lu, Huajun Wang, and Panpan Yao [9] described that Mobile GIS has developed into a popular and important research direction of GIS. They are implemented the browse query of mobile GIS on the mobile terminal applications, using Mobile Widget and Mobile Maps Widget as Technology platform. Ming Yu, Jinting Zhang, Qingquan Li, and Jingnan Huang [10] were witnessing the exploding development of Mobile Geoinformation Services (MGS). However, MGS is a complex system engineering involving many different technological fields or disciplines. There are many problems still existing and deserving to be further clarified and studied.

3 True Color and Color Maps

Color schemes, display or output devices with a radiometric resolution exceeding the color-resolving power of the human eyes are commonly called 'true-color'. In computer graphics, this apply to radiometric resolutions of at least 24 bits equivalent to 224 (16.8 Million) colors. A radiometric resolution of up to 16 bits (65'536 colors) is sometimes referred to as 'hi-color' [1, 2].

Color maps are also denoted to as color palettes or color look-up tables. They use an 'indirect' or 'pseudo-color' representation which assigns an index value, instead of actual color values, to each pixel. These index values represent addresses used for 'looking-up' the actual color values in the previously established color table. Color tables allow a significant reduction in the amount of data when applied to images with relatively few colors. This is because the index values can be kept much smaller than actual color values, such as complete RGB triplets. Typically, index values are stored as 4-bit or 8-bit integer values in contrast to the color map elements, which are usually stored as 24 bits (3x8 bits per color). Color tables are, however, not suited for storing images, such as photographs, which contain more than 256 colors. Color maps are well suited and frequently used for cartographic raster data with their limited number of colors often corresponding to individual color 'layers'[3]. In this paper, 24-bits true colors are used for lossless compression of maps.

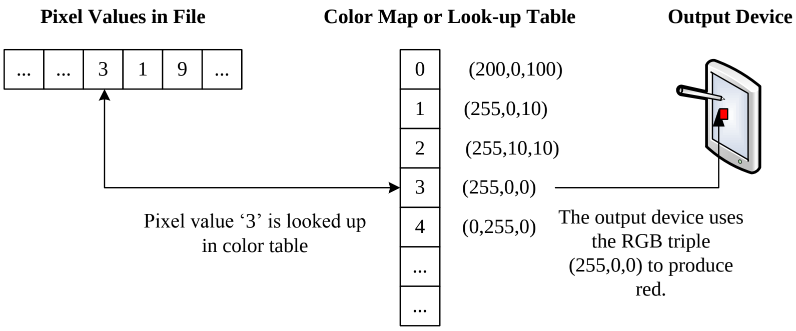


Fig. 1. Example of Using a Color Map to Specify a Color

4 Quadtree Compression Method

In our quadtree method, it has two major steps: segmentation step and a color pixel region merging step. In the segmentation step, a quadtree initial segmentation is performed first, providing the color pixel merging process with basic color elements. In this step, we also conduct a spatial indexing creation and color pixel calculation, in order to provide color values and neighborhood information. In the second step, we use color table to express the relationship between color pixels. In color table, regions are represented by nodes. Region merging is merged the same color pixels. Region merging process will stop when it reaches the last layer that is equal to the pre-defined minimum block size. After the merging process, the final segmentation result is obtained.

5 Block-Encoding Method

In block encoding method, it consists of two parts, namely flag encoding and block data encoding. Flag encoding records the location and color information of the block targets, and block data encoding records get block data and their boundary information.

6 Overall Performance

To evaluate the performance of this system, it computes the compression ratios for the images in the dataset by using following equation.

$$Compression\ Ratio = \frac{\text{size of the output stream}}{\text{size of the input stream}} \quad (1)$$

In the following, it calculates the compression ratio of the one image from Map Set #1 by choosing randomly. Image name is T1_1 image, and its original size is 1024 x 1024 pixel size bitmap file. Original file size is 3MB. The output file size, after compressing, is 1.3MB. When calculating the compression ratio, the compression ratio output is 0.4. And, it is calculating by using this equation 100 x (1- compression ratio) for a reasonable measure of compression performance. When inserting the compression ratio into the equation, 100 x (1 – 0.4) = 60 it get the output result is 60. The result value of 60 means that the output stream occupies 40% of its original size or that the compression has resulted in savings of 60%. In this system, time is not effective as much as run on the computer. Because this system is run on the android device that has the OS version is v4.4.2 (KitKat), Chipset is Qualcomm MSM8226 Snapdragon 400, CPU is Quad-core 1.2 GHz Cortex-A7, GPU is Adreno 305, internal memory storage is 8 GB and RAM is 1.5 GB.

7 Experimental Results

In this system, for maps, 1024x1024 map sizes, 49 maps for MapSet#1, 5 maps for MapSet#2 and 4 Maps for MapSet#4 are experimented. Their some detail results and maps are shown in below.

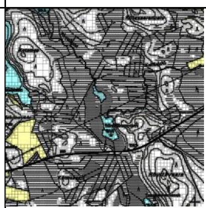
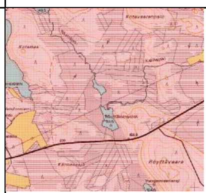
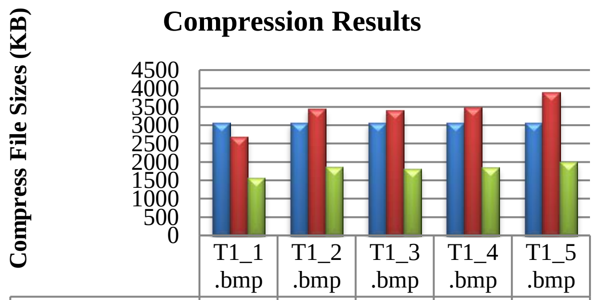
Name and Size Of Original Map	**Compression Approaches**	**Analysis Results**	
 T1_02.bmp Original File Size = 3073 KB Image Size = 1024x1024	Quadtree		CompressionTime= 21.456100096 Image Size = 1024,1024 Minimum Block Size = 1 QuadTree Node = 294919 QuadTree Level = 10 DecompressionTime= 4.001779425 Compress File Size = 3457 KB
	Block-Encoding		CompressionTime= 11.17007432 Image Size = 1024,1024 Block Count = 16384 DecompressionTime= 2.380869582 Compress File Size = 1863 KB

Fig. 2. Compression Results



	T1_1.bmp	T1_2.bmp	T1_3.bmp	T1_4.bmp	T1_5.bmp
Original	3073	3073	3073	3073	3073
Quadtree	2691	3457	3409	3488	3896
Block-Encoding	1577	1863	1813	1852	2014

Fig. 3. Compression Results Chart

Table 1. Compression Ratio Results

File Name And Size	Quadtree	Block-Encoding
T1_1.bmp, 3073 KB	0.875691507	0.513179304
T1_2.bmp, 3073 KB	1.124959323	0.606247966
T1_3.bmp, 3073 KB	1.109339408	0.589977221
T1_4.bmp, 3073 KB	1.135047185	0.602668402
T1_5.bmp, 3073 KB	1.267816466	0.655385617
Total	56.13016596	30.20240807
Average	1.145513591	0.616375675

8 Conclusion

By conclusion, although quadtree is mature for the segmentation of the images and effective for black and white images, it is not effective for true color maps lossless compression. Sometimes, it can be large compression file size more than original file size of the map. Block-encoding method can compress the file nearly 2:1. Compression time is also effective. So, block-encoding method is more effective than quadtree method for this paper.

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