Fast Near-Lossless or Lossless Compression of Large 3D Neuro-Anatomical Images

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1. SUMMARY

3D neuro-anatomical images and other volumetric data sets are important in many scientific and biomedical fields. Since such sets may be extremely large, a scalable compression method is critical to store, process and transmit them. To achieve a high compression rate, most of the existing volume compression methods are lossy, which is usually unacceptable in biomedical applications. Our near-lossless or lossless compression algorithm uses a Hilbert traversal to produce a data stream from the original image. This data stream enjoys relatively slow image context change, which helps the subsequent DPCM prediction to reduce the source entropy. An extremely fast linear DPCM is used. The linear DPCM takes the average of the previous two voxels' intensity to predict the current voxel's intensity. If near-lossless compression is desired, the prediction error can be uniformly quantized. For lossless mode, no action is taken on the prediction error. The prediction error is further encoded using Huffman code. In order to provide efficient data access, the source image is divided into blocks and indexed by an octree data structure. Each sub-volume block has its unique prediction error distribution. To form a Huffman code book of the prediction error for the entire volume is inefficient. On the other hand, to produce a Huffman code book for every sub-volume block also introduces heavy coding overhead. We characterize each block's error distribution as a point in a high-dimensional space and then bin the points using a novel binning method.[1] All the error distributions that fall into the same bin are summed together to form a summed error distribution. We build a Huffman code book for this distribution. The total number of Huffman code books is the number of bins. The coding overhead is therefore effectively reduced. All the sub-volume blocks' prediction error is coded according to its own Huffman code book. Although our compression method is designed for performance-critical digital brain atlas applications, it would be suitable for other applications that require very fast data access without prior decompression and for which a modest compression rate is acceptable. For detail, please see the full length technical report.[2]

REFERENCES

1. R. Zhao, T. Tao, M. Gabriel, and G. Belford, "Lossless compression of very large volume data with fast dynamic access," in *Electronic Imaging and Multimedia Technology III*, **4925**, pp. 179–190, SPIE, Oct 2002.
2. R. Zhao, M. Gabriel, and G. Belford, "Fast near-lossless or lossless compression of large 3D neuro-anatomical images," Tech. Rep. UIUCDCS-R-2004-2399, CS Dept., Univ. of IL at Urbana-Champaign, Jan 2004. Engr. No. UILU-ENG-2004-1701.

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