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of

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**“A New Progressive Lossy-to-Lossless Coding Method for 2.5-D
Triangle Meshes with Arbitrary Connectivity”**

Department of Electrical and Computer Engineering

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1:30 P.M.

Engineering Office Wing

Room 430

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Abstract

A new progressive lossy-to-lossless coding framework for 2.5-dimensional (2.5-D) triangle meshes with arbitrary connectivity is proposed by combining ideas from the previously proposed average-difference image-tree (ADIT) method and the Peng-Kuo (PK) method with several modifications. The proposed method represents the 2.5-D triangle mesh with a binary tree data structure, and codes the tree by a top-down traversal. The proposed framework contains several parameters. Many variations are tried in order to find a good choice for each parameter considering both the lossless and progressive coding performance. Based on extensive experimentation, we recommend a particular set of best choices to be used for these parameters, leading to the mesh-coding method proposed herein.

The lossless and progressive coding performance of the proposed method are evaluated by comparing with other methods, namely, the general-purpose compression algorithm Gzip, the 3-D mesh-coding method Edgebreaker, and the modified scattered data coding (MSDC) method for the 2.5-D meshes with Delaunay connectivity. The experimental results show that the proposed method outperforms Gzip with the lossless coding bit rate of the proposed method being 5 to 6 times lower than that of Gzip. Moreover, Gzip cannot achieve progressive coding functionality. The proposed method also outperforms the Edgebreaker method by using 8.1% less bits on average in terms of the lossless coding if the mesh connectivity does not deviate too far from a preferred-direction Delaunay triangulation, with the edge-flipping distance no larger than 37.38%. Here the distance 37.38% means, 37.38% of edges need to be flipped before transforming the triangulation of the original mesh to be preferred-direction Delaunay. In addition, the Edgebreaker method cannot perform progressive coding. For progressive performance, we compare the proposed method with the MSDC method by testing on the meshes with Delaunay connectivity. Since the direct comparison between different meshes is tricky to performance, instead, we generate image approximations from the meshes and then compare the mean squared errors of the image approximations in terms of peaksignal-to-noise ratio (PSNR) metric.

Therefore, the experiments measure the progressive performance using PSNR values of image reconstructions during the progressive decoding procedure. The experimental results show that the proposed method can yield image approximations of considerable higher quality in terms of PSNR than those obtained with the MSDC method. For example, in order to obtain similar-quality image approximations (i.e., with the PSNR being 75% of the maximum PSNR obtained for lossless reconstruction), the bit rate used by the proposed method is 55% to 86% of that used by the MSDC method.

During the course of the work described herein, the author discovered that the PK method cannot, in practice, handle meshes with large-valence vertices. The proposed framework provides a divide-and-conquer approach by introducing a parameter to avoid the combinatorial blowup in the PK method when handling large-valence vertices. With the partitioning scheme, the proposed method improves the previous PK method to be more practically useful. Besides the problem of large-valence vertices, the author also discovered another problem of the PK method. When the PK method updates the faces of the 3-D dataset, in certain circumstances, some extra faces can be generated in the lossless reconstructed mesh that do not exist in the original. In our work, the face information is not concerned in the 2.5-D dataset. If we consider the basic linear interpolation on the mesh, however, the proposed framework provides a method to generate the faces without having the extra-face problem.