論文内容の要旨

論文題目 Geometry Compression of Time-Varying Meshes

(3 次元映像の幾何情報圧縮)

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This thesis proposes an algorithm for geometry compression of time-varying meshes (TVMs). We have made two major observations called temporal and spatial redundancy. It leads to the compression of TVMs. Temporal redundancy comes from the fact that each TVMs is a sequence of mesh models where the shape (geometry) of neighboring models are highly correlated with each other. Spatial redundancy means that vertices exist only on the surface of model. Building on these observations, this thesis proposes two different approaches to compress TVMs.

The first algorithm is inspired by 2-D video compression, in which motion estimation plays an important role to achieve higher compression performance. As inter-frame coding of 2-D video compression removes temporal redundancy, we follow a similar framework for efficient compression of TVMs. Standard motion estimation uses a block matching algorithm (BMA). We advocate the use of BMA and extend it to TVMs. In our extend BMA (EBMA), a cubic block is used as a matching unit. Efficient motion compensation in the 3-D space is achieved by matching the mean normal vectors calculated from partial surfaces in cubic blocks. Our experiments show that mean normal vector is a suboptimal matching criterion. After motion compensation, residuals are transformed by the discrete cosine transform, uniformly quantized, and then encoded. The extracted motion vectors are also entropy coded after differential pulse code modulation.

The second approach employs a two-step decomposition to decouple the global and local redundancy in TVMs. Each decomposition step consists of three subsequent processes: quantization, bit-streamization, and run-length encoding (RLE). This decomposition process is applied to TVMs hierarchically.

The former decomposition step converts the original each frame of TVMs into a set of blocks and the block positions are represented by binary sequences. The distribution of blocks is biased and sparse in the 3-D space. We denote this as global redundancy. This global redundancy is converted into long runs of zeros as a binary sequence. Therefore, it is efficiently encoded by RLE. Further compression is achieved by

removing temporal redundancy. Removal of temporal redundancy can be done by simple Boolean operation which produces binary sequences that have longer runs of zeros. Therefore, further compression is obtained by RLE.

In the latter decomposition step, vertices in each block are quantized and represented by binary sequences. As neighboring vertices in each block are highly correlated each other, therefore, the distribution is biased in each block. We call this as local spatial redundancy. Similar to the former decomposition, these also yield long runs of zeros and can be efficiently encoded by RLE.

In order to quantify the distortion of our compression methods, we propose image-domain-based evaluation measure. This evaluation method uses a rendered image of each TVMs and manipulates PSNR. All virtual viewpoints of TVMs are considered for a reliable evaluation. This allows us to take into account the characteristics of human visual perception.