Compression of 3D Objects with Multistage Color-Depth Panoramic Maps

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A new representation method, the *multistage color-depth panoramic map* (or *panomap*), is proposed for compressing 3D graphic objects in this paper. The idea of the proposed method is to transform a 3D graphic object, including both the shape and color information, into a single image. Existing image compression techniques can then be applied for compressing the panomap structure, which can achieve a highly efficient representation due to its regularity.

Given a 3D graphic object, V, assume that a pseudo cylinder (or sphere) is constructed to cover this object. Projecting color and depth of the object onto the surface of the cylinder, a 4-channel cylindrical image can be constructed. More specifically, consider a pixel $p=(r_p, g_p, b_p, d_p)$ in the cylindrical image, let the intersection point of **Surface**(V) and $\overline{pO_p}$ be s, where O_p is the orthographic projection of p into the middle axis of the cylinder. Then, r_p, g_p, b_p are assigned as the three components of the color of s, and d_p is set to be the distance between p and s. This cylindrical image is termed as the *main panomap* of this object. The main panomap completely record the color and depth information of an object if it is convex. However, some points are not recorded in the main panomap when the object is concave along any of its cross sections. To solve this problem, K residual panomaps ($K\geq 0$) are used to record all the other intersection points on the line $\overline{pO_p}$, such that every pixel of the $(K+1)^{th}$-stage residual panomap is empty (i.e., its value is (0,0,0,0)). Therefore, a textured 3D object can be completely represented with the main panomap accompanied with K residual panomaps.

Note that empty pixels of every residual panomap can be ignored during the surface reconstruction process. A compact representation is thus proposed to record the non-redundant blocks of residual panomaps based on the property that if a pixel is empty in the k^{th}-stage residual panomap, it is also empty in the $(k+1)^{th}$-stage residual panomap. An index sequence is constructed to index all the non-redundant blocks. The non-redundant blocks are then appended to the tail of the main panomap in turn, and a rectangular image, the *compact multistage panomap* (CMP), is thus formed. Complete color/depth information can be recovered by combining the CMP and index sequence. The CMP can be further compressed to achieve more efficient representation. In our experiments, compressing the color part of a CMP with a lossy method (JPEG) and the depth part with a lossless one (PNG) achieves good reconstruction quality with low bits rates. More details can be found in [1].

[1] C. Tsai, et al. (2002), "Compression of 3D Objects with Multistage Color-Depth Panoramic Maps," *TR-IIS-02-001*, Tech. Rep. of Inst. Info. Sci., Acad. Sinica, Taipei, Taiwan. http://www.iis.sinica.edu.tw/LIB/TechReport/tr2002/threebone02.html