Video-based compression for plenoptic point clouds

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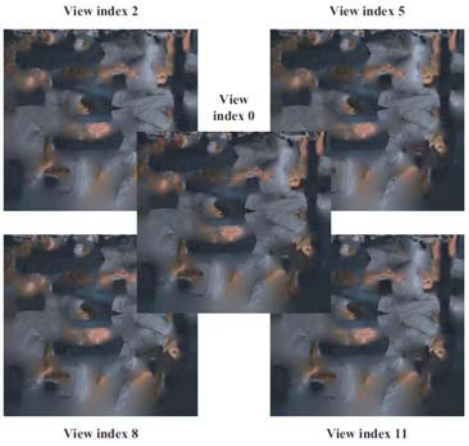
Abstracts

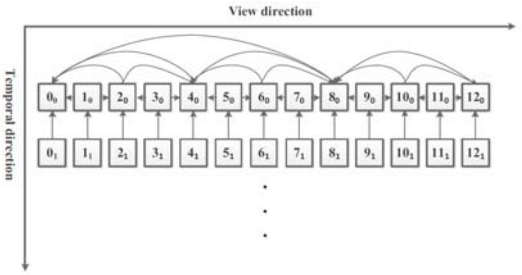
The plenoptic point cloud that has multiple colors from various directions, is a more complete representation than the general point cloud that usually has only one color. It is more realistic but also brings a larger volume of data that needs to be compressed efficiently. The state-of-the-art method to compress the plenoptic point cloud is an extension of the region-based adaptive hierarchical transform (RAHT). As far as we can see, in addition to RAHT, the video-based point cloud compression (V-PCC) is also an efficient point cloud compression method. However, to the best of our knowledge, no works have used a video-based solution to compress the plenoptic point cloud yet. In this paper, we first extend the V-PCC to support the plenoptic point cloud compression by generating multiple attribute videos. Then based on the observation that these videos from multiple views have very high correlations, we propose encoding them using multi-view high efficiency video coding. We further propose a block-based padding method that unifies the unoccupied attribute pixels from different views to reduce their bit cost. The proposed algorithms are implemented in the V-PCC reference software. The experimental results show that the proposed algorithms can bring significant bitrate savings compared with the state-of-the-art method for plenoptic point cloud compression.

Video-based plenoptic point cloud compression

- We use a similar process as in V-PCC to convert the plenoptic point cloud to the geometry and attribute videos. The main differences from the original V-PCC is that there will be multiple attribute videos.

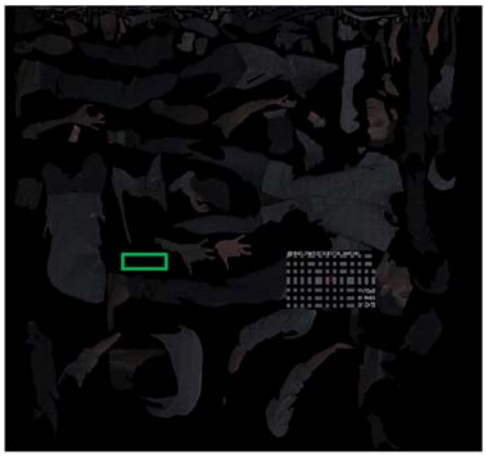


- The generated attribute frames from various view angles are very similar despite some pixel differences. Therefore, we propose using MV-HEVC to exploit the correlations from multiple views to compress them more efficiently. (Using 13 views as an example)



Block-based group padding for unoccupied pixels

- In the V-PCC, the unoccupied pixels are padded in a way that they will cost bits as few as possible. Similarly, in the plenoptic point cloud compression, we also need to minimize the bits cost. There are two kinds of unoccupied pixels: isolated unoccupied pixels and continuous unoccupied pixels.



- Block-based group padding: we propose a block-based group padding for unoccupied pixels. For each pixel, we first find a block with the pixel as the center pixel. Only when all the pixels in the block are unoccupied, we will pad the pixel. In this way, the isolated unoccupied pixels will not be padded and we can still keep the spatial continuity for the blocks including both occupied and unoccupied pixels. For the large continuous unoccupied pixels, we can reduce the prediction residue so as to compress them more efficiently.

Experimental results

- Performance comparison between the proposed Multiview solution and the V-PCC solution (huge gain)

Name	BD-AttrRate			BD-TotalRate				
	Luma	Cb	Cr	D1	D2	Luma	Cb	Cr
Boxer	-62.4%	-67.1%	-69.2%	-22.9%	-22.6%	-23.1%	-26.7%	-26.0%
Loot	-67.1%	-71.8%	-73.3%	-24.5%	-24.3%	-22.7%	-27.5%	-27.4%
Soldier	-73.6%	-75.1%	-76.1%	-33.3%	-33.0%	-32.6%	-37.0%	-37.2%
Thaidancer	-82.6%	-83.5%	-83.2%	-78.5%	-78.6%	-77.3%	-79.1%	-78.8%
Longdress	-86.5%	-86.6%	-86.5%	-51.2%	-50.9%	-53.0%	-55.6%	-55.4%
Redandblack	-78.1%	-78.1%	-79.1%	-36.3%	-36.0%	-36.1%	-41.1%	-38.9%
Average	-74.4%	-76.8%	-77.7%	-42.1%	-41.9%	-41.7%	-45.2%	-45.0%

- Performance comparison with/without the block-based padding

Name	BD-AttrRate			BD-TotalRate				
	Luma	Cb	Cr	D1	D2	Luma	Cb	Cr
Boxer	-18.7%	-13.8%	-16.5%	-3.1%	-3.0%	-3.2%	-2.5%	-2.6%
Loot	-16.5%	-15.7%	-15.0%	-2.5%	-2.4%	-2.6%	-2.3%	-2.1%
Soldier	-9.6%	-7.7%	-7.4%	-1.6%	-1.5%	-1.8%	-1.6%	-1.4%
Thaidancer	-13.3%	-12.2%	-12.6%	-9.6%	-9.6%	-9.6%	-9.2%	-9.5%
Longdress	-8.1%	-8.2%	-8.2%	-1.4%	-1.4%	-1.7%	-1.8%	-1.8%
Redandblack	-13.6%	-13.6%	-14.1%	-2.3%	-2.3%	-2.3%	-2.7%	-2.5%
Average	-13.3%	-11.5%	-13.6%	-3.6%	-3.6%	-3.8%	-3.5%	-3.5%

- Some example R-D curves (better than the state-of-the-art)
  - The proposed multi-view solution performs much better especially in the low bitrate case