

Description



Fig. 1. The thumbnail images of the sequences used in our experiment.

We focus on subjective and objective Point Cloud Quality Assessment (PCQA) in an immersive environment and study the effect of geometry and texture attributes in compression distortion. Using a Head-Mounted Display (HMD) with six degrees of freedom, we establish a subjective PCQA database named SIAT Point Cloud Quality Database (SIAT-PCQD). Our database consists of 340 distorted point clouds compressed by the MPEG point cloud encoder with the combination of 20 sequences and 17 pairs of geometry and texture quantization parameters.

Subjective Experiment Settings

The whole workflow before conducting the experiment, which mainly includes preprocessing, encoding, and rendering.

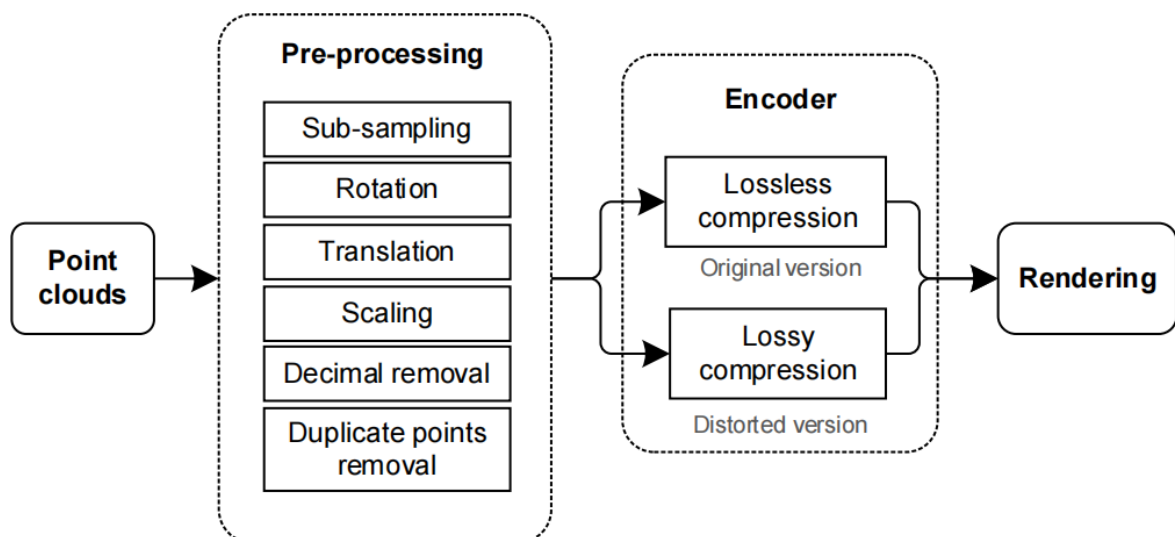


Fig. 2. The workflow before conducting the subjective experiment, including preprocessing, encoding, and rendering.

- **Preprocessing:** The sequences are selected from different repositories, which means their sizes, positions, and orientations vary. However, we desire that point clouds are exhibited in life-size rendering to achieve realistic tele-immersive scenarios. So we normalize sequences

to remain point clouds within a similar bounding box (600, 1000, 400) in the preprocessing stage to deal with this issue. The source models have been processed with sub-sampling, rotation, translation, and scaling, except four sequences Longdress, Redandblack, Loot, and Soldier from the 8i Voxelized Full Bodies Database. Additionally, the point cloud encoder V-PCC fails to deal with decimals, so that the positions of points were through round operation and then the duplicate points were removed. In particular, it is unnecessary to have integer conversion for four upper body figure sequences from the Microsoft database, so we just adjusted their positions and orientations in rendering software.

- **Encoding:** Distorted versions were generated using the state-of-the-art MPEG PCC reference software Test Model Category 2 version 7.0 (TMC2v7.0). The V-PCC method takes advantage of an advanced 2D video codec after projecting point clouds into frames. First, a point cloud is split into patches by clustering normal vectors. The obtained patches would be packed into images, and the gaps between patches would be padded to reduce pixel residuals. Then projected images of sequences are compressed utilizing the HEVC reference software HM16.18. QP determines the step size for transformed coefficients in codecs. In V-PCC, a pair of parameters, namely geometry QP and texture QP, regulate how much detail is saved in the geometry and texture attributes of point clouds. As geometry QP is increased, points deviate from their original positions. As texture QP is increased, some color details are aggregated. Similar to the Common Test Conditions (CTC) document from the MPEG PCC, the gaps of geometry and texture QPs were set as 4 and 5, ranging from 20 to 32 and from 27 to 42. As shown in Table I, geometry QP ranks the first in each pair, while texture QP ranks the second in that pair. And we chose a losslessly compressed version as our reference contents.
- **Rendering:** Point clouds are appropriate to represent the complete view of objects and scenes in immersive applications with 6DoF. Thus, we developed an actively interactive VR experiment software for subjects to observe point cloud models in the 6DoF environment.

TABLE I
SUMMARY OF PRE-PROCESSED TEST SEQUENCES.

Sequence	Category	Source	Pre-processing	#Points	Geometry Precision	Bounding Box	(geometry QP, texture QP)
Redandblack [39]	Full body figures	MPEG ¹ /JPEG ²	No	729, 133	10 bits	(393, 977, 232)	
Longdress [39]	Full body figures	MPEG ¹ /JPEG ²	No	765, 821	10 bits	(356, 1003, 296)	
Loot [39]	Full body figures	MPEG ¹ /JPEG ²	No	784, 142	10 bits	(352, 992, 354)	
Soldier [39]	Full body figures	MPEG ¹ /JPEG ²	No	1, 059, 810	10 bits	(360, 1016, 405)	
The20sMaria [40]	Full body figures	MPEG ¹	Yes	950, 423	10 bits	(405, 908, 324)	
UlliWegner [41]	Full body figures	MPEG ¹	Yes	598, 448	10 bits	(376, 997, 258)	(20,27), (20,37),
Ricardo [42]	Upper body figures	JPEG ²	No	960, 703	10 bits	(446, 364, 178)	(20,47), (28,27),
Phil [42]	Upper body figures	JPEG ²	No	1, 660, 959	10 bits	(441, 464, 394)	(28,37), (28,47),
Andrew [42]	Upper body figures	JPEG ²	No	1, 276, 312	10 bits	(392, 444, 297)	(36,27), (36,37),
Sarah [42]	Upper body figures	JPEG ²	No	1, 355, 867	10 bits	(486, 467, 348)	(36,47), (24,32),
Facade	Inanimate objects	MPEG ¹	Yes	292, 169	10 bits	(555, 375, 75)	(32,42), (0,0),
House_without_roof	Inanimate objects	MPEG ¹	Yes	581, 213	10 bits	(488, 481, 455)	(20,0), (28,0),
ULB_Unicorn	Inanimate objects	MPEG ¹	Yes	1, 086, 944	10 bits	(571, 361, 303)	(36,0), (0,27),
Romanoillamp [43]	Inanimate objects	JPEG ²	Yes	343, 186	10 bits	(517, 355, 352)	(0,37), (0,47)
Biplane [44]	Inanimate objects	JPEG ²	Yes	400, 972	10 bits	(439, 569, 410)	
Nike	Inanimate objects	Sketchfab ³	Yes	186, 960	10 bits	(303, 213, 303)	
Banana	Inanimate objects	Sketchfab ³	Yes	145, 243	10 bits	(201, 337, 102)	
Grass	Inanimate objects	Sketchfab ³	Yes	724, 725	10 bits	(494, 159, 434)	
Bush	Inanimate objects	Sketchfab ³	Yes	1, 211, 816	10 bits	(587, 400, 435)	
AngelSeated	Inanimate objects	Sketchfab ³	Yes	770, 184	10 bits	(543, 942, 305)	

Bold number denotes lossless compression.

¹ <https://mpeg.chiariglione.org/tags/point-cloud>

² <https://jpeg.org/plenodb/>

³ <https://sketchfab.com/>

Files

DMOS.xlsx: subjective scores obtained from our experiment.

reference point clouds.zip: the reference point clouds.

distorted point clouds.zip: the distorted point clouds.

README.pdf

Citation

If you use our database for academic research, please cite our papers or documents:

```
@unpublished{wu2020subjective,  
  title={Subjective Quality Database and Objective Study of Compressed Point Clouds with 6DoF  
Head-mounted Display},  
  author={Xinju Wu and Yun Zhang and Chunling Fan and Junhui Hou and Sam Kwong},  
  year={2021},  
  note={Manuscript submitted to IEEE Transactions on Circuits and Systems for Video  
Technology}  
}
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@misc{wu2020subjective,  
  title={Subjective Quality Study and Database of Compressed Point Clouds with 6DoF Head-  
mounted Display},  
  author={Xinju Wu and Yun Zhang and Chunling Fan and Junhui Hou and Sam Kwong},  
  year={2020},  
  eprint={2008.02501},  
  archivePrefix={arXiv},  
  primaryClass={eess.IV}  
}
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@techreport{M6065,  
  title={面向人眼视觉任务的点云主观质量评价数据集},  
  author={吴鑫菊, 张云, 樊春玲, 朱林卫, 李娜, 皮金勇},  
  year={2021},  
  number={M6065},  
  institution={AVS}  
}
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For any commercial purpose, please contact Prof Yun Zhang at yun.zhang@siat.ac.cn.