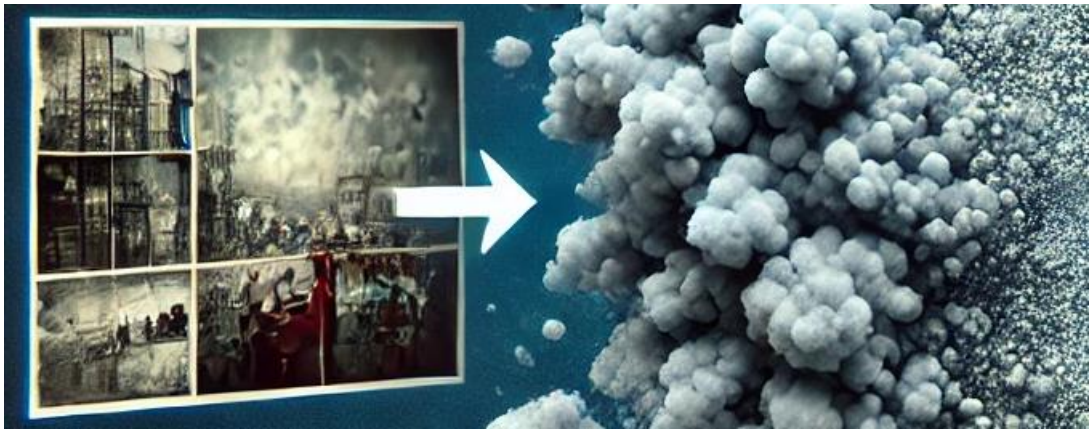
3D Gaussian Splatting Compression



Background

Achieving a realistic 3D representation of the world remains a crucial and ambitious goal, often considered the ultimate objective for the future of graphics technology. One approach to achieving this is to construct scenes from scratch using computer graphics techniques, while another approach involves scanning and reconstructing real-world scenes. The state-of-the-art technique, 3D Gaussian Splatting (3DGS) [1], represents a scene by distributing Gaussian ellipsoids (or splats) throughout a 3D space. Additionally, 3DGS supports real-time rendering on high-end GPUs, offering an encouraging outlook for future applications on mobile and VR devices.

Problem Specification

Early implementations of 3DGS faced substantial challenges with file sizes [2]. Storing all attributes at full precision often resulted in multi-gigabyte files, prompting a surge of research into compression techniques. Compressing 3DGS attributes offers several advantages: it enables faster transmission over slower networks and supports the creation of more complex scenes.

Suggested Method

Vector quantization techniques play a key role in many compression strategies, aiming to reduce data complexity by grouping similar data points and representing them with a common approximation. In this process, the original high-dimensional dataset is divided into clusters—such as with K-Means [3] and LBG [4]—and each cluster is approximated by a representative feature. These techniques [5], [6] can be applied to compress unstructured Gaussian attributes, including position, covariance matrix, opacity, and color.

Relevant Articles

[1] B. Kerbl, G. Kopanas, T. Leimkühler, and G. Drettakis, '3D Gaussian Splatting for Real-Time Radiance Field Rendering', ACM Transactions on Graphics, vol. 42, no. 4, Jul. 2023.

[2] P. Papantonakis, G. Kopanas, B. Kerbl, A. Lanvin, and G. Drettakis, 'Reducing the Memory Footprint of 3D Gaussian Splatting', Proc. ACM Comput. Graph. Interact. Tech., vol. 7, no. 1, May 2024.

[3] S. Lloyd, ‘Least squares quantization in PCM’, IEEE Transactions on Information Theory, vol. 28, no. 2, pp. 129–137, 1982.

[4] Y. Linde, A. Buzo, and R. Gray, ‘An Algorithm for Vector Quantizer Design’, IEEE Transactions on Communications, vol. 28, no. 1, pp. 84–95, 1980.

[5] K. L. Navaneet, K. P. Meibodi, S. A. Koohpayegani, and H. Pirsiavash, ‘Compact3D: Smaller and Faster Gaussian Splatting with Vector Quantization’, arXiv preprint arXiv:2311. 18159, 2023.

[6] Z. Fan, K. Wang, K. Wen, Z. Zhu, D. Xu, and Z. Wang, ‘LightGaussian: Unbounded 3D Gaussian Compression with 15x Reduction and 200+ FPS’, arXiv [cs.CV]. 2023.