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# Abstract

This document provides Draft use cases for Gaussian splat coding. Two different paradigms are being investigated: the Gaussian splat input coding paradigm with a fixed representation called I-3DGS and the Alternative Gaussian splat paradigm where other potential representations are explored and called A-3DGS. Draft use cases are provided in the context of these tracks.

# Introduction

Gaussian splatting [1] is a recently developed immersive representation that provides photorealistic visual quality for novel view synthesis (with 6 degrees of freedom or 6DoF). Compared to other immersive representations such as meshes, multi-view or point clouds, this representation can handle complex visual content including reflective (non-Lambertian) surfaces or volumetric effects (such as fire, smoke etc.) with high visual quality. This representation is typically learned from single or multiple cameras inputs and yields compelling results with relatively fast training times. Furthermore, Gaussian splatting also allows for real-time rendering with photorealistic visual quality. However, the representation data size is large, and there is a need for efficient compression technologies for Gaussian splatting. In addition, mobile terminals are well deployed, and Gaussian splats are a good candidate for representing immersive content, therefore lightweight compression is also needed. For all these reasons, MPEG started an exploration activity on Gaussian splat coding (GSC) and this document provides draft use cases for it.

# Use cases

This section details the currently considered use cases.

**Use case 1. Telepresence, immersive meeting**

*Experiences where real-time communication with conversational low latency is enhanced with photorealistic rendering and free viewpoint interactivity.*

This use case involves real-time communication with low latency, photorealistic rendering and free view point interactivity. Virtual representations are provided for real-world or synthetic characters. For real-world characters, Gaussian Splatting provides accurate, high-resolution reconstruction, that leads to detailed representations. Gaussian Splatting can be used to capture and visualize in real-time with photorealistic visual quality complex characters. Data can be captured by any type of camera or device, including smartphone video, drone camera captures etc. Depending on the required level of reconstruction quality, the learning of the representation may be adapted from lightweight processing for simple single character, to more computationally expensive processing for scenes with multiple characters.

**Use case 2. Replay broadcasting**

*A use case where instant replays are provided for typically sports content allowing the viewer to change viewpoint with 6-DoF, reliving the action while being immersed in the content from different and freely chosen angles.*

Sports content broadcasting typically offers instant replays to relive an important action, for example from a different angle. More recently, replays may also include a virtual camera path of a 3D reconstructed version of the event highlight, in static or dynamic mode to increase the sense of immersion for viewers or provide a better visualization of the moment from multiple angles thanks to multiple camera captures. Gaussian splatting may lead to higher quality reconstruction and visualization, potentially enabling viewers to interactively change the viewpoint. Capture is typically performed with professional-grade cameras and camera rigs, and higher computational complexity can be allowed for learning the representation to target high quality visualization. Viewing may be offered on televisions and mobile devices for example.

**Use case 3. Consumer and retail**

*Approaches that enable new XR experiences for retail, appreciating objects or goods with enhanced photorealism and free viewpoint.*

Recently, 3D reconstruction of consumer and retail are provided for example through photogrammetry. Gaussian splatting may offer increased visual quality and reduce the needs for high quality captures. The technology may enable simple mobile phone captures to reconstruct the object and offer photorealistic and real-time rendering on websites or mobile apps. Typically, content is static and relates to objects or actors that can be viewed from multiple angles.

**Use case 4. Social media Content Sharing**

*Experiences that enrich social media posts and interactions with editable or relightable immersive content and photorealistic 6DoF rendering.*

User captured 3D scans of objects/persons and scenes can be shared and interactively visualized on phones, laptops, televisions, head-mounted displays, etc.) on social media with typically higher quality and faster than with photogrammetry. This offers the possibility to democratize content creation and sharing by empowering everyone with a smartphone to create assets, to be used in interactive storytelling applications, like in Augmented Reality etc.

**Use case 5. Gaming**

*Experiences where gaming becomes immersive, photorealistic and augmented. Content can be created, captured, uploaded, edited or shared between players.*

The gaming industry can use Gaussian Splatting to obtain photorealistic reconstructions of detailed, complex real-world objects which can then be added as 3D assets into any game environment. This can help to both increase the immersion of the user experience and at the same time reduce the effort for a 3D artist to create a complex 3D asset from scratch. Objects of interest can be scanned by any type of capture device, incl. smartphone video, drone footage, or a professional camera. The learning of the 3D representation can be either lightweight or computationally more demanding, depending on the size of the object or the required level of quality. The rendering of these assets, however, needs to be real-time capable so that they can be integrated into interactive games. Depending on the players and on the pace of the game, rendering times should be in the range of 30-300 fps. The creation and editing of Gaussian Splatting-based 3D assets is mainly done by game developers and modding enthusiasts.

**Use case 6. Movie production**

*Method for creating movies from captured and rendered environments, actors and objects from potentially different sources, allowing editing, relighting, replacing elements, their geometry or appearance in the content.*

For movie production, Gaussian Splatting can be used to reconstruct and represent individual objects, actors, or even larger scenes. In particular, 3D assets of larger scenes can be used in virtual productions where the scene is rendered on an LED wall so as to get a photorealistic, immersive background. These backgrounds can range from rooms and buildings to cities and landscapes including famous places that may be difficult over overly expensive to book exclusively for a film shoot (e.g., cathedrals, palaces, public institutions). Creating a 3D asset from such scenes can help to minimize the on-site time needed (to only the capturing time) and reduce travel expenses for actors and the film crew. Moreover, an arbitrary number of takes can be shot in the studio using the scanned and reconstructed 3D background. Alternatively, Gaussian Splatting-based 3D assets of all kinds can be integrated during post-production. Due to typically very high quality standards, the capturing of the assets is likely to be done with professional equipment. For post-production, the learning of the 3D representation and the rendering can both be done offline with high computational efforts to achieve the best possible quality. For virtual productions, the rendering on an LED wall needs to be real-time capable so that actors can interact with it. Movie directors and VFX artists alike may want to be able to adapt and modify the 3D asset with respect to re-lighting so as to match the lighting situation of the target environment or even add, remove, or change parts of the 3D asset to fit their needs.

**Use case 7. Unbounded scene free navigation**

*Experiences allowing the interactive exploration of unbound large-scale cities or landscapes while enabling detailed representations when the viewer zooms or approaches parts of the environment.*

In this use case, large-scale cities or landscapes are captured and reconstructed from satellite imagery, drones, or vehicles with multiple 360 cameras. Users are offered the possibility to navigate into an environment that seems unbounded and enables to consume the content from a distance as well as zooming in on details, with six-degrees-of-freedom interaction capabilities.

**Use case 8. Immersive Education/Training**

*Approaches extending online education with photorealistic and interactive rendering capabilities, increasing the sense of presence and immersion.*

Gaussian splatting can be used to significantly increase the immersion of remote education and training. In areas such as medical and engineering education and training, where hands-on experience and accurate visualization are important, the technology can create 3D anatomical models, surgical simulations, and mechanical models that can be explored in real time. Learners or trainees can interact with complex structures and simulate real-world training scenarios in virtual reality (VR) or augmented reality (AR). This enhances the quality of immersive education and training, making online learning and training more engaging and effective and can be used in a wide range of education and training areas, such as medical education, engineering and manufacturing, cultural and historical education, military and tactical training, aerospace, and flight simulation.

**Use Case 9. Manufacturing**

*Augmentation of manufacturing processes with photorealistic and editable, interactive rendering.*

Gaussian Splatting can enhance manufacturing workflows by enabling real-time visualization of production lines, machinery, and assembly processes. High-resolution 3D scans of factory environments can be used to optimize layouts, identify inefficiencies, and provide immersive training simulations for workers. Compared to other applications, manufacturing benefits from high-speed data acquisition using LiDAR and depth cameras, with a focus on precision and efficiency. The rendering demands are moderate, as industrial environments often prioritize accuracy over photorealism. Usability is high for factory operators and managers, offering intuitive monitoring and optimization tools.

**Use Case 10. Engineering & Construction**

*Methods to assist engineering and construction projects by designing, simulating and monitoring projects in their environment.*

Construction projects benefit from Gaussian Splatting as it provides highly detailed, real-time 3D representations of building sites. Engineers can overlay designs onto the splatted environment to detect potential conflicts, assess structural integrity, and track progress. Compared to other use cases, data acquisition in construction involves drone scans and ground-based photogrammetry, with a need for both high-resolution and large-scale reconstruction. Gaussian splat learning from multiple camera viewpoints (from multiple mobile devices, or drones) may reduce costs of acquiring the scene information and/or allow for more frequent modeling and inspections. Rendering complexity is higher due to intricate building structures and changing environmental conditions and may require higher fidelity geometry reconstruction. Usability is key for engineers and site managers who require real-time updates and seamless integration with CAD software.

**Use Case 11. Spatial Journalism**

*A journalistic approach that uses spatial dimensions and interactive visualizations to contextualize and enhance storytelling, providing audiences with immersive engagement.*

Journalists can use Gaussian Splatting to create detailed, immersive reconstructions of newsworthy locations. Whether covering war zones, environmental disasters, or cultural events, reporters can provide audiences with interactive 3D environments that offer deeper engagement and understanding. Unlike other use cases, data acquisition is often done in uncontrolled environments using mobile or handheld devices, with a need for rapid processing. Rendering prioritizes realism while keeping computational costs low for online accessibility. Usability is geared toward both media professionals and the general public, making interactive content easy to navigate.

**Use Case 12. Location-Based Entertainment/Gaming**

*Experiences where entertainment evolves based on a participant’s physical location, integrating real-world settings with dynamic, location-specific gameplay or activities*

Gaming and entertainment industries can leverage Gaussian Splatting to create ultra-realistic, location-based experiences. Theme parks, escape rooms, and AR-based mobile games can integrate real-world 3D reconstructions to enhance user immersion. This application requires highly optimized rendering for real-time interactivity, with a balance between visual quality and computational efficiency. Data acquisition may involve high-fidelity scans, but optimization techniques are necessary to make the content usable on various gaming platforms.

**Use Case 13. Virtual Tours**

*Immersive explorations of locations, allowing users to navigate and interact with environments remotely, offering a sense of presence in spaces such as museums, campuses, or cities.*

Museums, real estate companies, and tourism boards can use Gaussian Splatting to offer highly detailed virtual tours of exhibits, properties, and destinations. Unlike traditional VR tours, this technology enables smoother navigation and more lifelike textures, improving user experience and engagement. Compared to other applications, data acquisition prioritizes visual detail over real-time capture speed. Rendering needs to balance high-quality textures with efficient streaming for web-based or VR experiences.

**Use Case 14. Virtual Room Tours**

*Detailed showcases of individual rooms, enabling remote exploration and a realistic understanding of spatial features and layouts, commonly used in real estate.*

For real estate, interior design, and hospitality industries, Gaussian Splatting provides photorealistic room tours with accurate lighting, textures, and depth perception. This use case differs from general virtual tours by requiring ultra-high-resolution scans of confined spaces, with a focus on realism and lighting accuracy. Computational complexity is moderate, as the environments are typically static, allowing for pre-optimized rendering. Usability is tailored for real estate clients and designers who need intuitive, visually accurate models.

**Use Case 15. Building Information Modeling (BIM)**

*A process for creating and managing detailed representations of a building’s characteristics throughout its lifecycle, enabling better collaboration, visualization, and decision-making*

BIM can integrate Gaussian Splatting for real-time visualization of construction progress, crack detection, and facility management. The ability to generate realistic 3D site conditions helps architects, engineers, and contractors streamline collaboration and maintain project accuracy. Compared to other fields, data acquisition in BIM involves structured scans using professional-grade equipment for precision. Rendering complexity is high due to layered datasets and interoperability with architectural tools. Usability is centered around engineers and planners needing accurate, up-to-date models.

**Use Case 16. Digital Twins**

*Virtual representations of real-world entities or systems, continuously synchronized with real-time data to analyze, monitor, and optimize their physical counterparts.*

Gaussian Splatting provides accurate, high-resolution reconstruction, that lead to detailed representations of physical environments. Gaussian Splatting can be used to capture and visualize in real-time with photorealistic visual quality complex infrastructure projects. Structures composed of fine geometric details such as power lines, wires, or telecom towers, can be efficiently captured and rendered with Gaussian Splatting, which allows site assessment time and related costs, significantly. Data can be captured by any type of camera or devices, including smartphone video, drone camera captures etc. Depending on the required level of reconstruction quality, the learning of the representation may be adapted from lightweight to more computationally expensive processing times for example for larger scale sites or objects. Rendering must support high accuracy with dynamic elements such as sensor overlays. Usability is optimized for industrial and municipal stakeholders who rely on real-time analytics.

**Use Case 17. Structure Inspection**

*A method for assessing detailed structural components, ensuring accuracy, safety, and efficiency in identifying defects or vulnerabilities in critical assets like powerlines, antennas, and bridges.*

By using Gaussian Splatting, engineers and inspectors can create real-time, high-resolution 3D models of bridges, tunnels, and buildings. These models help in identifying cracks, wear and tear, and other structural concerns, reducing manual inspections and improving safety assessments. Unlike other applications, data acquisition in structure inspection requires specialized sensors like thermal or ultrasonic imaging. Rendering focuses on both high detail and anomaly detection, with usability designed for field inspectors using AR and remote collaboration tools.

**Use Case 18. Enhanced GIS Visualization**

*An advanced approach to geographic data representation, utilizing interactive layers, real-time information, and immersive tools to improve spatial analysis and decision-making.*

Geographic Information Systems (GIS) can integrate Gaussian Splatting to provide richer, more detailed visualizations of topographic and urban landscapes. This can improve urban planning, environmental monitoring, and infrastructure development through interactive 3D representations. Compared to traditional GIS, Gaussian Splatting allows for more immersive and interactive visualizations. Data acquisition often comes from aerial scans and satellite imagery, with rendering optimized for large-scale datasets. Usability is aimed at planners and policymakers who need intuitive geospatial tools.

**Use Case 19. Historical Sites Preservation**

*Efforts to document, conserve, and restore culturally significant locations, ensuring their authenticity and longevity through innovative visualization and analysis techniques.*

Cultural heritage organizations can employ Gaussian Splatting to digitally preserve historical sites with high fidelity. The technology enables the capture of intricate architectural details and artifacts, ensuring future generations can explore and study them even if the physical site degrades over time. This application differs in its emphasis on high-quality, long-term data storage, with data acquisition relying on careful, high-resolution scanning. Rendering prioritizes extreme detail over computational speed. Usability is tailored to historians, researchers, and the public. For researchers, high visual and geometric fidelity may be an asset, while for the public quality may be tuned to allow for rendering on mobile devices or web applications.

**Use Case 20. Environmental Analysis**

*The assessment and study of environmental conditions through detailed simulations, enabling precise insights into ecosystems, urban areas, and climate impacts for planning and conservation.*

Gaussian Splatting aids environmental scientists in visualizing and analyzing ecosystems, deforestation, and climate change effects. By creating real-time, interactive 3D representations of natural landscapes, researchers can monitor changes and make data-driven conservation decisions. Unlike other cases, data acquisition is often done over time, requiring multi-temporal analysis. Rendering must support complex terrain and vegetation modeling. Usability is designed for scientists and policymakers who require long-term trend analysis.

**Use Case 21. Disaster Assessment**

*The evaluation of damage and changes caused by disasters, supporting response and recovery efforts with detailed analyses of terrain, infrastructure, and affected areas.*

First responders and disaster management teams can leverage Gaussian Splatting for rapid 3D mapping of disaster-affected areas. This enables more effective response planning, damage assessment, and coordination of rescue efforts. Compared to other use cases, data acquisition is urgent and must be performed in harsh conditions using drones or mobile devices. Rendering must support fast processing and deployment. Usability is crucial for emergency responders who need real-time situational awareness.

**Use Case 22. Urban Planning**

*Design and management of urban spaces using detailed simulations and visualizations to analyze spatial relationships, optimize infrastructure, and engage communities effectively.*

City planners can use Gaussian Splatting to create immersive 3D models of urban environments, allowing them to test infrastructure changes, assess traffic patterns, and engage stakeholders in interactive planning processes. Data acquisition involves large-scale city scans, with a focus on integration with zoning and infrastructure databases. Rendering must support both detailed and broad-scale views. Usability is tailored for urban planners, architects, and decision-makers who need interactive visualizations, for example composing captured scenes and environments with other designed 3D objects and/or digital twins, for example allowing for simulations and highlighting monitored or sensed data on the 3D reconstructed scene.

# References

[1] Bernhard Kerbl, Georgios Kopanas, Thomas Leimkühler, and George Drettakis. 2023. 3D Gaussian Splatting for Real-Time Radiance Field Rendering. ACM Transactions on Graphics 42, 4 (July 2023). https://repo-sam.inria.fr/fungraph/3d-gaussian-splatting/