

ISO/IEC JTC 1/SC 29/WG 1
(& ITU-T SG16)

Coding of Still Pictures

JBIG.

Joint Bi-level Image
Experts Group

JPEG

Joint Photographic
Experts Group

TITLE: Use Cases and Requirements for JPEG RF v1.0

SOURCE: JPEG RF

EDITORS: Saeed Mahmoudpour, Stuart Perry

PROJECT: -

STATUS: Final

REQUESTED ACTION: For information

DISTRIBUTION: Public

Contact:

ISO/IEC JTC 1/SC 29/WG 1 Convener – Prof. Touradj Ebrahimi
EPFL/STI/IEL/GR-EB, Station 11, CH-1015 Lausanne, Switzerland
Tel: +41 21 693 2606, Fax: +41 21 693 7600, E-mail: Touradj.Ebrahimi@epfl.ch

Table of Contents

1. Scope	2
2. Use Cases	2
2.1. Immersive Interaction and Communication	3
2.1.1 Real-World Scene Integration in Extended Reality Environments.....	3
2.1.2 Telepresence and Virtual Communication.....	4
2.1.3 Digital Cinematography and VFX.....	5
2.1.4 Retail and Virtual Try-On.....	6
2.1.5 Immersive Storytelling for News and Events.....	7
2.1.6 Computer Graphics and Gaming.....	7
2.2. Spatial Analysis and Operational Environments	8
2.2.1 Simulation and Navigation for Autonomous Systems.....	8
2.2.2 AEC (Architecture, Engineering, and Construction).....	9
2.2.3 Industrial Imaging.....	10
2.2.4 GIS (Geographic Information Systems).....	11
2.3. Scientific Visualization and Digital Heritage	12
2.3.1 Cultural Heritage Digitization.....	12
2.3.2 Medical Imaging.....	13
2.3.3 Scientific Modeling.....	14
3. Requirements	15
3.1 System Requirements	16
3.2 Coding Requirements	16
3.2.1. Core Requirements.....	16
3.2.2. Complementary Requirements.....	16
4. Royalty-Free Goal	17
References	17

1. Scope

The scope of the JPEG RF activity is the creation of a **coding standard** for radiance fields, offering a **compact representation** for models, enabling the **immersive depiction of 3D scenes** given a set of input images from different viewpoints. This standard shall accommodate modern radiance field generation and rendering techniques, efficiently coding models with high compression performance while minimizing the impact on the visual quality of the rendered views, with the goal of supporting a royalty-free baseline.

This activity shall specify a normative decoder capable of converting a codestream with normative syntax and semantics into a set of radiance field parameters from which images depicting a scene from a query camera pose can be synthesized. The remaining stages of the processing pipeline, namely the camera pose estimation, model instantiation, encoding, and view synthesis, may be informatively included in the standard but shall not be a normative component.

2. Use Cases

Several use cases have been identified to leverage radiance field techniques such as Neural Radiance Fields (NeRF), 3D Gaussian Splatting (3DGS), and their variants for immersive visual imaging. This section lists and describes major use cases for radiance fields. The use cases are grouped into three broad application categories:

- The ***Immersive Interaction and Communication*** category includes use cases that enhance human presence, realism, and engagement in digital or hybrid spaces through photorealistic and interactive visualization.
- The ***Spatial Analysis and Operational Environments*** category encompasses use case scenarios where radiance fields help visualize or monitor real-world systems and environments to support spatial understanding, simulation, design validation, and operational decision-making.
- Finally, the ***Scientific Visualization and Digital Heritage*** domain includes use cases that support research, preservation, and analytical work requiring accurate and reproducible 3D representations of physical objects and phenomena.

Please note that these three categories are defined solely for organizational clarity, and the identified use cases are assigned to the category that best reflects their primary purposes, while certain use cases may naturally span or contribute to more than one category.

2.1. Immersive Interaction and Communication

2.1.1 Real-World Scene Integration in Extended Reality Environments

In Extended Reality (XR) environments, users interact with a blended world in which physical surroundings and digital elements coexist seamlessly. As users move through real spaces, such as classrooms, workplaces, or public venues, XR devices dynamically overlay virtual objects or environments that adapt to the user's position, gaze, and context.

To achieve this seamless integration, radiance field technologies provide a powerful way to represent and render both real and virtual content. Real-world scenes or objects can be represented as radiance fields and then inserted into new virtual or mixed-reality contexts, preserving their authentic appearance. This ensures that lighting, reflections, and shadows behave consistently as users view the content from different angles or distances.

The main challenges concern scalability, performance optimization, and interoperability with existing rendering pipelines. Real-time applications demand efficient processing of complex scenes while maintaining visual coherence and responsiveness. Overcoming these constraints will be key to establishing radiance field visualization as a foundation for next-generation immersive simulation and interactive media.

Example: Compositing Virtual Content in Augmented Reality

An example of this use case is the smooth blending of radiance field-generated content into a view of a real-world environment using Augmented Reality (AR) headsets, where the user can freely move around or within the radiance field content and interact with the radiance field content while viewing it in the context of the real environment. A designer could, for example, import a scanned prototype into a collaborative XR workspace, where colleagues visualize and interact with it under realistic lighting conditions or in the context of another radiance field representation of the real-world environment into which the prototype may be placed. Similarly, educators or engineers could place reconstructed real-world environments into virtual training sessions, maintaining photorealism and spatial accuracy.

Example: Immersive Performing Arts and Education

Audiences attend live or recorded classes, rehearsals, or performances reconstructed as radiance fields (e.g., in opera or theatre) and experienced in XR or on mobile/TV. Viewers can move within the scene, switch vantage points (stage, pit, balcony), and interact (Q&A, masterclass feedback) while preserving authentic lighting, materials, and performer expression. Performers and instructors can also review sessions from arbitrary viewpoints, enabling detailed analysis, remote instruction, and new forms of collaborative learning that bridge physical and virtual stages.

2.1.2 Telepresence and Virtual Communication

Immersive communication systems aim to create more natural and engaging remote interactions by representing users as realistic 3D avatars. In this context, radiance field-based representations enable lifelike visualization of participants, helping to overcome the limitations of traditional 2D video calls, such as restricted viewpoint and lack of spatial presence. Recent developments allow user avatars to be pre-generated from a few images and then animated in real time using the person's facial expressions captured during communication. This enables a more expressive and privacy-preserving exchange, as only motion and expression data need to be transmitted rather than full video streams.

A key functional challenge lies in ensuring high visual fidelity for the avatars with low latency. Inappropriate time lags in avatar responses or mismatches with spoken cues will break the sense of immersion and engagement of participants with the telepresence experience.

Example: Teleconferencing

In remote meetings, lightweight volumetric avatars enhance perception of gaze direction and gestures, enabling clearer interactions and a stronger sense of shared presence compared to standard video conferencing. Because only motion and expression parameters need to be transmitted, such systems can deliver more natural interaction without requiring high-bandwidth video streams. An example of more expressive avatars that might enable this use case is illustrated in Figure 1.

Example: Enhanced Telehealth Experiences

A specific example of this use case is more expressive and personal telehealth experiences, using the increased realism and immersiveness provided by radiance field technologies to allow users a closer feeling of connection with doctors or therapists, helping to alleviate feelings of isolation or fear in regard to medical procedures. The ability for the patient and doctor or therapist to be represented by more expressive avatars will allow for a deeper connection and trust between the patient and treating professional, and a greater ability for the treating professional to understand the emotional state of the patient.



Figure 1: Radiance field avatars (bottom) incorporating facial expressions extracted from videos (top) rendered in a mobile device. Source: [1]

2.1.3 Digital Cinematography and VFX

In digital cinematography and visual effects, radiance field representations open new possibilities for virtual production and hybrid filmmaking. Their main functional advantage lies in enabling the seamless integration of live-action footage with digital environments that preserve authentic lighting, shadows, and material responses. This capability supports a range of production tasks, from background replacement and virtual set extension to realistic asset compositing, allowing filmmakers to maintain visual coherence across physical and virtual elements.

The key challenges for this use case involve ensuring temporal stability, consistent lighting fidelity, and efficient data processing for high-resolution scenes. Film production environments demand rapid turnaround and creative flexibility; therefore, radiance field workflows must integrate smoothly with existing pre-visualization, on-set, and post-production pipelines. When effectively implemented, they can substantially reduce production time while enhancing realism and artistic control.

Example: Content Blending for Virtual Reality Experiences

An example of this use case is the smooth blending of computer-generated (CG) content into radiance field-generated footage of real actors for the production of content for virtual reality headsets, where the user can freely move within the scene and view the content from a wide range of angles. Because radiance fields preserve authentic lighting interactions and subtle surface details, digital assets can be composited in a way that remains visually coherent from any viewpoint. This allows CG creatures, props, or effects to blend seamlessly with the captured performance.

Example: Digital Doubles for Virtual Production

Radiance fields can be used to generate highly realistic digital doubles of actors. These volumetric reconstructions preserve subtle lighting and material cues, enabling filmmakers to integrate actors seamlessly into virtual sets or extend performances without additional shooting. This reduces reshoots and supports creative flexibility in complex VFX workflows, and lowers cost barriers for high-fidelity VFX productions.

2.1.4 Retail and Virtual Try-On

In retail and fashion applications, radiance field visualization enables highly realistic digital representations of products and environments, enhancing how customers explore and evaluate items online or in augmented reality. Such systems allow users to view objects from any angle, under varying lighting conditions, and even experience personalized “virtual try-on” interactions that mimic real-world appearance and fit. This functionality can significantly improve consumer confidence, reduce product returns, and create more engaging shopping experiences across digital platforms.

Key challenges include achieving consistent color and material fidelity across devices, maintaining real-time responsiveness in interactive sessions, and protecting proprietary design data. Addressing these issues is essential for scaling radiance field visualization into practical, trustworthy tools for digital commerce and immersive retail experiences.

Example: Clothing Try-on

An example is allowing users to virtually try on clothing with complex material properties, such as satin or velvet, on a realistic model of themselves. A radiance field representation of the user may be produced and composited, with a radiance field representation of the clothing item, into a single scene, perhaps replacing some of the clothing already worn by the user in the representation. The radiance field representation allows the user to view the clothing under

different lighting conditions and from a variety of angles, allowing the user a much better understanding of the fit and appearance of the clothing prior to purchase.

2.1.5 Immersive Storytelling for News and Events

Radiance fields offer new possibilities for immersive journalism by allowing real-world events to be experienced through interactive 3D reconstructions. This approach enables audiences to explore noteworthy real-world environments, ranging from conflict zones to cultural gatherings and natural disasters, with a sense of spatial presence and contextual depth that traditional media cannot convey. For journalists, the utility lies in capturing authentic scenes quickly with standard imaging equipment and delivering them in a form that preserves realism while supporting narrative engagement.

The main challenges concern balancing visual fidelity with ethical and logistical constraints, ensuring rapid capture-to-publication workflows, maintaining data integrity and viewer accessibility, and upholding journalistic transparency in reconstructed environments. When effectively integrated, radiance field technologies can transform storytelling into a more participatory and spatially informed experience, expanding the communicative reach of modern news media.

Example: Environmental and Disaster Coverage

Journalists covering wildfires, floods, deforestation, or other environmental phenomena can use radiance fields to reconstruct affected areas. Viewers can navigate through the landscape virtually, seeing the extent of damage or changes in terrain over time. This spatially rich storytelling allows audiences to grasp scale, cause-and-effect relationships, and the human impact in ways traditional media cannot. In disaster zones, such as after earthquakes or hurricanes, reporters can quickly scan relief centers, affected neighborhoods, or temporary shelters. Radiance fields allow audiences to explore these areas interactively, understanding logistics, living conditions, and the scale of aid efforts. This immersive approach can foster empathy, highlight critical needs, and reduce the risk of misinformation that can arise from selective imagery.

2.1.6 Computer Graphics and Gaming

Radiance field technologies expand the possibilities of computer graphics and gaming by enabling the realistic display of real-world environments and objects within virtual, augmented, and mixed reality experiences. Their primary functional value lies in creating

immersive, dynamic scenes that blend captured reality with interactive digital elements, enhancing presence and realism for players and trainees alike. Beyond entertainment, these capabilities are relevant to government, industrial, and defense contexts, where realistic 3D reconstructions support mission planning, training, and situational awareness.

The main challenges concern scalability, performance optimization, and interoperability with existing rendering pipelines. Real-time applications demand efficient processing of complex scenes while maintaining visual coherence and responsiveness. Overcoming these constraints will be key to establishing radiance field visualization as a foundation for next-generation immersive simulation and interactive media.

Example: Compositing Real and Virtual Content for Gaming

An example of this is the smooth blending of computer-generated content into radiance field-generated footage of real actors for computer gaming, where the user can freely move within the scene, interact with, and view the content from a wide range of angles. Because radiance fields preserve authentic lighting interactions and subtle surface details, digital assets can be composited in a way that remains visually coherent from any viewpoint. This allows CG creatures, props, or effects to blend seamlessly with the captured performance, whilst lowering cost barriers to the generation of virtual gaming content.

2.2. Spatial Analysis and Operational Environments

2.2.1 Simulation and Navigation for Autonomous Systems

Radiance field technologies can be used to generate high-fidelity digital twins of real environments, enabling more effective simulation and navigation workflows for autonomous systems. These reconstructed environments provide photorealistic geometry, textures, and lighting conditions that are difficult to reproduce with conventional modeling pipelines, offering a more realistic testing ground for perception, mapping, and planning algorithms.

A key functional challenge lies in achieving sufficiently high-fidelity rendering of the physical site to ensure that sensor responses, lighting interactions, and geometric properties closely match real-world conditions. Additional challenges include maintaining accurate depth and occlusion relationships, ensuring temporal consistency when scenes are reconstructed from moving cameras, and enabling real-time rendering so that autonomous systems can react to the environment at operational speeds.

Example: Autonomous Vehicle Training in a Captured Urban Block

An autonomous vehicle manufacturer captures a real city intersection using multi-camera video and reconstructs it with radiance field technologies. The resulting scene preserves fine-grained geometry (e.g., curbs, parked cars, road textures) and realistic lighting. The autonomous driving stack, perception, prediction, and planning, is then trained and validated inside this photorealistic simulation. Because the environment is a faithful replica, the manufacturer can repeatedly test rare scenarios such as a pedestrian emerging between two cars or a cyclist crossing unexpectedly, without staging dangerous real-world trials.

Example: Drone Navigation in Cluttered Indoor Spaces

An inspection drone operator records the interior of a warehouse, and radiance field technologies are used to build a dense, photo-realistic model of narrow aisles, shelving, and obstacles. The drone's SLAM algorithm is then tested in this reconstructed environment to evaluate localization drift and obstacle-avoidance behavior before any real flights take place. Engineers can replay complex flight paths, adjust lighting conditions, or simulate unexpected obstacles to verify algorithm robustness without costly actual flights.

2.2.2 AEC (Architecture, Engineering, and Construction)

Radiance field-based visualization offers a powerful means to enhance spatial understanding and decision-making across architectural and infrastructural projects. Within construction and urban planning workflows, such representations enable stakeholders to examine how planned elements integrate with existing environments, to assess progress on-site, or to identify structural deviations and defects. The functional value lies in supporting design validation, quality assurance, and coordination among multiple actors involved in the project lifecycle.

A key functional challenge lies in integrating digital design data with information captured from the physical site. The visual content may originate from computer-aided design models or from scans of real-world structures, and aligning these sources accurately is essential for meaningful interpretation. Achieving this correspondence can reduce the need for manual inspection and verification, improving efficiency and precision in construction monitoring and asset management.

Example: Urban Planning

One example of this use case is the scanning of a building site and its surroundings to create a radiance field representation. New potential construction models can then be composited into the radiance field and visualised in the context of the surrounding environment, allowing for a deeper understanding of the effect that the proposed construction may have on light and space within the site. The ability of radiance field representations to render novel high-fidelity views of the scene enables urban planning authorities to accurately represent future plans to government and commercial stakeholders as well as affected members of the public.

Example: Civil Engineering Inspection

Another example of this use case is the creation of a radiance field from a scan of a facility for the purpose of inspection. The support within the radiance field for novel viewpoint rendering allows for an inspector to view the facility from positions that may not be easily reachable in real life, and the rich representation of material properties allows for the detection of colour and texture variations that might indicate water seepage or concrete degradation.

2.2.3 Industrial Imaging

In industrial settings, digital twins are increasingly used to monitor, analyze, and optimize the performance of physical assets throughout their lifecycle. Their value lies in enabling operators to visualize system behavior, detect anomalies, and support predictive maintenance through continuous comparison between real-world and virtual conditions. Radiance fields substantially enhance visualization by providing more realistic and spatially coherent representations of equipment and environments, improving situational awareness for inspection, training, and decision-making.

The main challenges relate to ensuring accuracy, scalability, and integration with existing monitoring systems. Industrial use cases demand reliable alignment between visual and sensor data, efficient handling of large-scale environments, and consistency under variable lighting and motion conditions. Addressing these factors will determine whether radiance field representations can extend current digital-twin frameworks beyond geometric accuracy toward perceptual realism and operational usability.

Example: Surface Inspection

An example of this is the ability of radiance field representations to accurately capture glossy surfaces or surfaces with complex properties, allowing imperfections in surface coatings to be

more easily detected by inspectors. The ability of radiance field representations to be relit under different environmental conditions can help inspectors and quality control experts understand how the surface might appear in a number of different target environments.

Example: Robot Path Planning in Industrial Facilities

A factory floor is scanned once, and a radiance field model is generated to support the deployment of a new mobile robot. The robot's navigation pipeline uses the reconstructed space to precompute viable routes, test collision-avoidance logic around machinery, and validate docking maneuvers at charging stations. This reduces downtime on the production line because tuning occurs within the photorealistic simulation rather than on the live floor.

2.2.4 GIS (Geographic Information Systems)

Geographic Information Systems (GIS) are essential for analyzing and visualizing spatial relationships across natural and built environments. Their primary value lies in integrating multiple layers of geographic, environmental, and infrastructural data to support planning, monitoring, and decision-making. Incorporating radiance field representations into GIS can enhance these capabilities by enabling free-viewpoint, photorealistic visualization of large areas reconstructed from aerial and ground imagery. This allows users to explore geographic contexts with a level of immersion and visual fidelity not achievable through conventional mapping or orthographic projection.

The main functional challenges concern scalability, data alignment, and interoperability. Radiance field models must efficiently cover extensive territories while maintaining geometric accuracy and consistent integration with existing geospatial datasets. Addressing these issues would position radiance field visualization as a powerful complement to traditional GIS, supporting more intuitive spatial analysis and stakeholder communication.

Example: GIS Inspection

Radiance field representations can enhance GIS inspection tasks by providing photorealistic, free-viewpoint visualizations of terrain, vegetation, and built infrastructure. Inspectors can move virtually through the reconstructed environment to examine erosion patterns, structural changes, or vegetation overgrowth with greater clarity than traditional orthophotos or point clouds allow. This supports faster identification of anomalies and more intuitive spatial assessment. Figure 2 depicts an example where a radiance field model was used to model a visual representation of a geographical location inside a map. The support for rapid novel viewpoint rendering allows for easy visualisation and examination of geographical features.



Figure 2: Visualization of a radiance field model representation within GIS. Source: [3]

2.3. Scientific Visualization and Digital Heritage

2.3.1 Cultural Heritage Digitization

Radiance field-based visualization can play a transformative role in the preservation and interpretation of cultural heritage. Its primary value lies in enabling accurate and immersive digital representations of monuments, archaeological sites, and artifacts, which can be explored and studied without risking damage to fragile or inaccessible locations. Such reconstructions support multiple functions such as virtual access for education and tourism, precise condition monitoring for conservation, and reliable digital archiving for future reference.

A major challenge for this use case is ensuring that digital reproductions remain both faithful and practical to manage at scale. Heritage sites often require the integration of imagery collected under diverse conditions and from multiple vantage points, which can introduce inconsistencies in lighting, geometry, and texture. Moreover, very large or complex scenes demand efficient ways to access and navigate specific areas of interest. Addressing these functional challenges is essential to guarantee that radiance field representations serve as trustworthy, sustainable tools for heritage preservation, research, and public engagement.

Example: Cultural Heritage Preservation

One example of this use case is the visualisation and preservation of a digital record of key historical sites in regions that may be unreachable or unsafe for research teams or members of the public. Radiance field models enable immersive exploration and study of intricate architectural details, artworks, and artifacts. They support long-term preservation for research, education, and virtual tourism, while allowing global access to cultural heritage and aiding reconstruction in case of damage from natural disasters, conflict, or environmental changes.

Example: Archaeological Reconstruction

Another example is enabled by the potential for editing and modification of radiance fields. Vegetation may be removed from a radiance field representation of an archaeological site for research and reconstruction purposes without the destruction of the natural environment. The radiance field may be modified to reconstruct ancient buildings and structures, as well as study the effect of changes in climate or the watercourse paths during or since the archaeological sites' occupation.

2.3.2 Medical Imaging

Radiance fields offer new possibilities for medical practice by enhancing how clinicians perceive, interpret, and interact with patient data. Such systems can provide spatially accurate, high-fidelity representations of anatomical structures, enabling improved visualization during diagnosis, treatment planning, and remote procedures. They also allow artificial indicators, such as overlays highlighting areas of medical relevance, to be composited directly into the clinician's field of view, supporting more informed and precise decision-making.

The primary functional challenges concern reliability, interpretability, and safety. Medical applications require real-time responsiveness, stable reconstruction under varying imaging conditions, and absolute fidelity in representing biological detail. Ensuring that visualized tissues and materials retain diagnostically relevant properties, such as transparency, reflectivity, and color accuracy, is essential for clinical trust. Addressing these issues determines whether radiance field representations can evolve from research prototypes into dependable tools for telemedicine, surgical guidance, and advanced medical training.

Example: Enhanced Pre-operative Imaging and Planning

Radiance-field reconstructions can integrate data from modalities such as CT, MRI, and endoscopic video into a unified 3D representation of a patient's anatomy. Surgeons can explore this continuous volumetric model from any angle, revealing spatial relationships, such

as tumor boundaries, vascular pathways, or nerve proximity, that are difficult to interpret from slices alone. The ability to interactively “fly through” tissues, adjust translucency, or toggle anatomical overlays improves surgical planning and may reduce the risk of complications by providing a clearer understanding of patient-specific anatomy before entering the operating room.

Example: Virtual Surgical Training

An example of this would be the creation of a real-time radiance field of a patient to allow a doctor to remotely operate. In this scenario, the continuous representation of the scene allows the doctor to move freely without being restricted to the particular viewpoints of the cameras used to capture the scene. The ability to represent complex material appearance allows the doctor to recognise tissues and membranes more accurately, as transparency and gloss are accurately represented.

Example: Digital Pathology and Tissue Analysis

Radiance-field models can reconstruct high-resolution 3D representations of stained tissue samples from standard microscopy image stacks. Instead of navigating through individual 2D slices, pathologists can examine a continuous volumetric model that preserves fine cellular structures, layer boundaries, and staining variations. This enables more accurate assessment of tumor margins, inflammatory regions, or microvascular patterns. By interactively adjusting viewpoint, zoom, or virtual staining overlays, clinicians can identify diagnostically relevant features that may be difficult to detect in conventional 2D slide inspection.

2.3.3 Scientific Modeling

In scientific research, 3D modeling plays a critical role in visualizing complex phenomena and supporting simulations across disciplines such as physics, biology, and environmental science. These models enable researchers to analyze spatial relationships, test hypotheses, and communicate findings through intuitive visual representations. Incorporating radiance field-based data into this context offers new possibilities for creating high-fidelity digital replicas of real-world objects and environments, thus bridging observational data and computational modeling.

The functional advantage lies in improving the realism and contextual accuracy of simulations, allowing for more precise interaction between measured and synthetic elements. However, key challenges remain in integrating radiance field data with existing scientific workflows, ensuring geometric and radiometric consistency. When effectively addressed, these capabilities can expand the use of immersive, data-driven models for experimentation, education, and cross-disciplinary analysis.

Example: Fluid Simulation

Radiance field representations can enhance fluid simulations by enabling objects within the simulation to retain detailed geometry and material appearance. When objects such as rocks, vegetation, coral structures, or engineered surfaces are reconstructed from real data, their fine-scale curvature, roughness, and translucency influence how fluid flows around them. This may support more accurate modeling of turbulence, splashing behavior, sediment transport, or erosion effects than would be possible with simplified meshes. Figure 3 illustrates an example of this use case in a fluid simulator embedding objects modeled with a radiance field representation.



Figure 3: A radiance field model employed inside a fluid dynamics simulation. Source: [2]

3. Requirements

This section presents the overall set of requirements derived from the above-described use cases. Depending on their type, the requirements are classified as coding or system requirements. Requirements are split between “core requirements,” which are essential for the standard, characterized by a “shall” definition, and “complementary requirements,” which are desirable but not mandatory and will be decided depending on their cost, characterized by a “should” definition.

3.1 System Requirements

1. **Scenes of Various Scales:** The standard shall support the coding of radiance fields models representing scenes of different scales.
2. **Radiance Field Models of Various Sizes:** The standard shall support the coding of radiance field models of different sizes.
3. **Metadata:** The standard shall provide appropriate description tools, i.e., metadata, for efficient search, retrieval, and filtering.

3.2 Coding Requirements

3.2.1. Core Requirements

4. **Compression Efficiency:** The standard shall support the efficient compression of the radiance fields, e.g., as measured in terms of coding rate versus some quality metric.
5. **Lossy Coding:** The standard shall support lossy coding of radiance fields to achieve high compression efficiency at a range of quality levels, without significantly impairing the rendering quality if a sufficient rate is available.
6. **Lossless Coding:** The standard shall support mathematically lossless coding, defined as a mode in which the decoder reconstructs a radiance field that is identical to the encoder's input representation, i.e., bit-exact within the same parameterization and numerical precision, so that all renderings produced from the decoder match those from the input. This notion of losslessness is with respect to the encoded input data, irrespective of any inaccuracies that data may have relative to the underlying real scene.

3.2.2. Complementary Requirements

7. **Random Access:** The standard should allow the selective decoding of a portion of the radiance field without requiring the decoding of the entire bitstream.
8. **Progressive Decoding:** The standard should support a bitstream which is ordered in a way that allows the reconstruction of a coarse version of the model using the initial portion of the bitstream, and progressively improving the capability levels of the model as more bits are decoded.

9. **Scalable Coding:** The standard should support a bitstream which contains multiple layers (e.g., base and enhancement layers) that allow decoding the model at different capability levels.
10. **Real-time Decoding:** The standard should enable real-time decoding, even in the case of resource-constrained devices (e.g., mobile AR/VR headsets and smartphones) by supporting low-complexity profiles, scalable decoding, and efficient memory usage, ensuring smooth interactive rendering within typical mobile performance and latency constraints.

4. Royalty-Free Goal

The royalty-free patent licensing commitments made by contributors to previous standards, e.g. JPEG 2000 Part 1, have arguably been instrumental to their success. JPEG expects that similar commitments would be helpful for the adoption of a JPEG RF Coding standard.

References

- [1] <https://www.qualcomm.com/developer/blog/2024/12/driving-photorealistic03d-avatars-in-real-time-on-device-3d-gaussian-splatting>, April 2025.
- [2] Feng, Yutao, et al. "Gaussian splashing: Dynamic fluid synthesis with gaussian splatting." arXiv e-prints (2024): arXiv-2401.
- [3] <https://dev.to/gisbox/efficient-rendering-gaussian-splatting-to-3dtiles-with-gisbox-2m49>, viewed on April 2025