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: Second Call for Evidence on JPEG Pleno Point Cloud Coding

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Second Call for Evidence on JPEG Pleno Point Cloud Coding

Summary

This document contains a Second Call for Evidence (CfE) on JPEG Pleno Point Cloud Coding issued in the context of the JPEG Pleno standardization project, which aims at developing a next generation visual information coding standard that moves beyond coding of 2D planar content by taking advantage of plenoptic representations.

This call addresses in particular coding technologies for static point cloud content that enable scalable decoding of the bitstream and random access to subsets of the point cloud.

Additionally, contributions are encouraged in the form of:

- Use cases and requirements not yet identified;

- Representative data sets for potential applications including those not currently identified by the JPEG Committee. Datasets should be supplied with conditions allowing usage for standardization and organization of special sessions and grand challenges in scientific events;

- Subjective evaluation methodologies and test-bed implementations that can be used to assess various requirements identified (or new requirements if not already identified);

- Objective evaluation methodologies and test-bed implementations that can be used to assess the various requirements identified (or new requirements if not already identified).

This document contains the Second Call for Evidence on JPEG Pleno Point Cloud Coding. In July 2020, an updated Final Call for Evidence on JPEG Pleno Point Cloud Coding will be issued. The Final Call for Evidence may contain an updated schedule, updated submission information and references to an updated JPEG Pleno Point Cloud Coding Common Test Conditions document where the evaluation conditions and processes are described.

Second Call for Evidence on JPEG Pleno Point Cloud Coding

1. Introduction

JPEG Pleno will merge various modalities of plenoptic content under a single framework and in a seamless manner. Efficient and powerful point cloud representation is a key feature of this vision [1]. In this document a *point cloud* refers to a set of data items representing positions of points in space, expressed in a given coordinate system, usually three-dimensional. This geometrical data can be accompanied with per-point attributes of varying nature (e.g. color or temperature). Such data sets are usually acquired with a 3D scanner, LIDAR or created using 3D design software and can subsequently be used to represent and render 3D surfaces. Combined with other types of data (like light field data), point clouds open a wide range of new opportunities for immersive browsing and virtual reality applications.

2. Scope

The scope of this Call for Evidence is the identification of efficient coding solutions for static point clouds supporting advanced flexible data access functionalities.

The JPEG Committee has identified scalability and random access as crucial requirements for point cloud codecs to facilitate many of the emerging applications of plenoptic content collection, processing and visualisation. Therefore, this Second Call for Evidence on JPEG Pleno Point Cloud Coding focuses on efficient point cloud codecs for static point cloud content supporting scalability and random access.

For the purposes of this document, a scalable point cloud encoder should be able to create a bitstream structured in a number of layers. The bitstream structure should allow sequential cumulative decoding such that as successive layers are decoded, additional points are added to the point cloud (number of points scalability) or the quality of the geometry or attribute information increases (geometry and attribute quality scalability).

A point cloud encoder that supports random access decoding produces bitstreams structured such that selective decoding of subsets of the point cloud is possible without requiring full bitstream decoding.

3. Use Cases and Requirements

Point cloud data supports a wide range of applications including computer-aided manufacturing, entertainment, cultural heritage preservation, scientific research and fault detection and analysis. A detailed list of use cases and requirements for this activity identified by the JPEG Committee is given in the JPEG Pleno Point Cloud Use Cases and Requirements document [2].

4. Timeline

The following schedule is planned for the Call for Evidence on JPEG Pleno Point Cloud Coding. This

schedule is changed compared to the First Call for Evidence on JPEG Pleno Point Cloud Coding [2] reflecting delays to this activity caused by the 2020 COVID-19 Pandemic. This schedule is subject to changes in response to received responses to this or next versions of the Call for Evidence:

14/02/2020 First Call for Evidence on JPEG Pleno Point Cloud Coding [2].

30/04/2020 Second Call for Evidence on JPEG Pleno Point Cloud Coding.

10/07/2020 Final Call for Evidence on JPEG Pleno Point Cloud Coding. Release of the final version of the JPEG Pleno Point Cloud Coding Common Test Conditions document.

30/09/2020 Deadline for registration for participation in this Call for Evidence.

Oct/2020 Start of the 89th JPEG Meeting; Review of progress on activity.

1/12/2020 Deadline for submission of responses to this Call for Evidence. JPEG Committee begins subjective evaluation of submissions.

16/01/2021 Start of the 90th JPEG Meeting; Presentation of submissions, together with review of subjective evaluation results from experiments performed by the JPEG Committee. Decision on future actions regarding point cloud coding standardization in JPEG.

5. Submission Composition and Requirements

In this section we will describe the elements that should be delivered to the JPEG Committee when answering this CfE as well as the resources available to submitters and the submission process. The timeline for the submission process is laid out in Section 4.

5.1. Submission Elements

Submissions should include enough information for the JPEG Committee to be able to fully understand the encoding method being proposed, as well as being able to fully characterize the performance of the proposed solution. Concretely, the submitters are **required** to provide:

- A detailed technical description of the encoding and decoding algorithms;
- At least a decoder implementation (an encoder may also be submitted);
- Easy to follow but complete instructions on how to use the implementation(s) provided, including parameter values to be used and configuration files, if called for by the implementations;
- Bitstreams representing each of the test contents listed in the JPEG Pleno Point Cloud Coding Common Test Conditions [4], in the compressed format associated with the proposed solution;

- Decoded point clouds obtained from the bitstreams provided, corresponding to each test point cloud;
- Objective quality values for each of the decoded point clouds, computed using the measures listed in the JPEG Pleno Point Cloud Coding Common Test Conditions document [4].

Additionally, submitters shall:

- Provide a description of the evidence in a document following a template which will be sent to the submitters after registration (a template for a JPEG meeting numbered input document);
- Give a detailed presentation of the submission during the 90th meeting, January 2021, where one of the contributors should be physically present at the meeting to present the submission and answer questions and requests for clarifications.

The next sub-sections provide more details about the required and optional information sought by the JPEG Committee.

5.1.1. Technical Description

Each submission shall include a document with a detailed description of the proposed algorithm, including a high-level description of the evidence with block diagrams of the encoder and decoder. The use of black-box components should be avoided, except for well-known algorithms (e.g. the Fast Fourier Transform). This presentation shall be in a text document format (Word or PDF). The presentation shall additionally clearly explain how the submitted algorithm meets the focus areas of scalability and random access including information about the organisation of the bitstream to support scalability and random access. Submitters are encouraged to list all features, benefits and performance advantages of their proposed technologies, including complexity issues.

5.1.2. Coded Bitstreams

Submitters of coding technologies need to submit coded bitstreams for each of the test content at each of the target bit rates described in the JPEG Pleno Point Cloud Coding Common Test Conditions [4].

5.1.3. Decoding Software and Usage Information

Submitters of coding technologies need to submit statically linked Linux executables compatible with the UBUNTU LTS18.04 distribution. Any auxiliary packages or software on which the submitted implementation(s) depend has to be clearly identified (including version numbers) and, if not publicly available, also supplied.

Submitters can choose to use executable compression or similar tools to prevent reverse engineering or disassembly of the submitted executables.

Submitters should include detailed instructions on the use of the decoder supplied, including command lines or scripts and instructions to run the decoder and any auxiliary software. If configurations depend on the specific bitstream to be decoded, then per-bitstream information should be provided.

Submitters of codecs must provide clear instructions on how to decode bitstreams at various levels of scalability and on how to extract specific random access sets of points.

5.1.4. Decoded Point Clouds

Submitters are required to provide decoded point clouds corresponding to each bitstream supplied. In the case of random-access and scalability compatible bitstreams, the submitters should also include decoded point clouds for each scalability level and random access point/configuration deemed necessary to demonstrate the performance of the solution proposed, in terms of those functionalities.

5.1.5. Objective Metrics Results

The submitters need to submit tables and plots of each of the objective metrics defined in JPEG Pleno Point Cloud Coding Common Test Conditions [4], computed on each of the test contents at each of the test rates defined in [4].

5.1.6. Optional Submission Elements

Additionally, this CfE encourages contributions on several **optional** elements, notably:

- **Use cases and requirements** not yet identified;
- **Representative data sets** for potential applications including those not currently identified by the JPEG Committee. Datasets should be supplied with conditions allowing usage for standardization and organization of special sessions and grand challenges in scientific events;
- **Subjective evaluation methodologies and test-bed implementations** that can be used to assess the various requirements identified (or new requirements if not already identified);
- **Objective evaluation methodologies and test-bed implementations** that can be used to assess the various requirements identified (or new requirements if not already identified).

5.1.7. Resources Available to Submitters

Submitters to this Call for Evidence will be given access to:
1. Voxelised test point clouds in the PLY file format (*.PLY).
2. Software for computation of objective metrics as defined in [4].
3. JPEG Pleno Point Cloud Use Cases and Requirements document [2].
4. JPEG Pleno Point Cloud Coding Common Test Conditions document [4].

5.2. Submission Registration and Delivery

This section describes the steps that submitters must perform in order to respond to this call.

5.2.1. Submission Registration

Individuals or teams who desire to submit solutions should inform the JPEG Committee of their intention by sending an email to the persons listed in Section 9. Submitters will then be given instructions regarding how to submit the required materials and where to download the test content described in Section 5.1.

To allow the JPEG Committee to adequately prepare for subjective evaluation of submissions, submitters should provide documentation with the following information when registering for the CfE in the form of a text document or presentation slides:

- A high-level description of the evidence including block diagrams of the encoder and decoder;
- Arguments on why the evidence meets the requirements set forth in this CfE.

5.2.2. Final Submission

Once informed about how to submit a proposal, submitters must send all materials listed in Sections 5.1.1 through 5.1.6 to the JPEG Committee no later than the submission deadline as per the timeline detailed in Section 4.

Additionally, submitters shall give a detailed presentation of the submission during the 90th JPEG meeting, January 2021, where one of the contributors should be physically present at the meeting to present the submission and answer questions and requests for clarifications. Presentations can be in PowerPoint or PDF.

Prior to the 90th JPEG Meeting, January 2021, the JPEG Committee will perform subjective evaluation of submissions according to the JPEG Pleno Point Cloud Coding Common Test Conditions [4]. Hence it is vital that submitters provide the information detailed in Section 5.1 by the submission deadline detailed in Section 4.

6. IPR Conditions (ISO/IEC Directives)

Proponents are advised that this call is being made in the framework and subject to the common patent policy of ITU-T/ITU-R/ISO/IEC and other established policies of these standardization organizations. The persons named below as contacts can assist potential submitters in identifying the relevant policy information.

7. Evaluation Conditions and Processes

Evaluation of submissions will be performed following the conditions and processes defined in the JPEG Pleno Point Cloud Coding Common Test Conditions defined in [4] and updated versions of the same document to be released starting in July 2020 (88th JPEG meeting), as well as additional specifications arising from future meetings of the JPEG Committee.

8. 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 Pleno Point Cloud Coding standard.

9. Participation and Contacts

The Ad Hoc Group on JPEG Pleno Point Cloud Coding has been established at the 87th JPEG meeting in order to develop activities and progress with the planned work. All interested parties are encouraged to register to the email reflector of the AhG.

E-mail reflector: jpeg-pointcloud@jpeglists.org

To subscribe to the reflector, please visit http://jpeg-pointcloud-list.jpeg.org; in case of problems, please contact lists@jpeg.org.

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References

[1] Schelkens, P., Ebrahimi, T., Gilles, A., Gioia, P., Oh, K.-J., Pereira, F., Perra, C., Pinheiro, A., "JPEG Pleno: Providing representation interoperability for holographic applications and devices", *ETRI Journal*, Volume 41, Issue 1, pp. 93-108, February 2019.

[2] ISO/IEC JTC1/SC29/WG1 N86012, "JPEG Pleno Point Cloud – Use Cases and Requirements v1.3", Sydney, Australia, January 2020.

[3] ISO/IEC JTC1/SC29/WG1 N86013, "First Call for Evidence on JPEG Pleno Point Cloud Coding", Sydney, Australia, January 2020.

[4] ISO/IEC JTC1/SC29/WG1 N87037, "JPEG Pleno Point Cloud Coding Common Test Conditions v3.2", Online, April 2020.