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**ISO/IEC JTC 1/SC 29/WG 7 MPEG 3D Graphics Coding**

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| **Title** | **V-PCC Test Model v18** |
| **Source** | **WG 7, MPEG 3D Graphics Coding** |
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**[V-PCC] V-PCC Test Model v18**

1. Introduction

Based on the MPEG-3DG-V-PCC decisions, a new release of the V-PCC test model 18.0 has been delivered.

1. New integrations

The next table presents the integrations that have been made in this new release.

1. **Software manual**
   1. ***Obtaining the software***

The authoritative location of the software is the following git repository:

<http://mpegx.int-evry.fr/software/MPEG/PCC/TM/mpeg-pcc-tmc2.git>.

Each released version may be identified by a version control system tag in the form release-v18.0.

An example:

git clone http://mpegx.int-evry.fr/software/MPEG/PCC/mpeg-pcc-tmc2.git

cd mpeg-pcc-tmc2

It is strongly advised to obtain the software using the version control system rather than to download a zip (or other archive) of a release. The build system uses the version control system to accurately identify the version being built.

Bugs should be reported on the issue tracker set up at :

<http://mpegx.int-evry.fr/software/MPEG/PCC/TM/mpeg-pcc-tmc2/issues/new>.

The codec is supported on Linux, OSX and Windows platforms. The build configuration is managed using CMake. It is strongly advised to build the software in a separate build directory.

Bash scripts can be used to build mpeg-pcc-dmetric project: build.sh to build solutions and clear.sh to clean.

**Linux**

mkdir build

cd build

cmake ..

cmake --build . --config Release --parallel 8

../bin/PccAppEncoder --help

../bin/PccAppDecoder --help

../bin/PccAppMetrics -–help

**OSX**

mkdir build

cd build

cmake ..

cmake --build . --config Release --parallel 8

../bin/PccAppEncoder --help

../bin/PccAppDecoder --help

../bin/PccAppMetrics -–help

**Windows**

mkdir build

cd build

cmake ..

cmake --build . --config Release --parallel 8

../bin/PccAppEncoder --help

../bin/PccAppDecoder --help

../bin/PccAppMetrics --help

### **External dependencies**

According to the CMake options defined in the CMakeLists.txt, the TMC2 required some external dependencies to work:

* USE\_JMAPP\_VIDEO\_CODEC: use JM software to encoder and decoder videos (codecId parameters must be set equal to 0 and the videoEncoderOccupancyPath, videoEncoderGeometryPath and videoEncoderAttributePath but be set the JM applications)
* USE\_HMAPP\_VIDEO\_CODEC: use HM software to encoder and decoder videos (codecId parametesr must be set equal to 1 and the videoEncoderOccupancyPath, videoEncoderGeometryPath and videoEncoderAttributePath but be set the JM applications)
* USE\_JMLIB\_VIDEO\_CODEC: use JM library to encoder and decoder videos (codecId parameter must be set equal to 2)
* USE\_HMLIB\_VIDEO\_CODEC: use HM library to encoder and decoder videos (codecId parameter must be set equal to 3)
* USE\_VTMLIB\_VIDEO\_CODEC: use VTM library to encoder and decoder videos (codecId parameter must be set equal to 4)
* USE\_FFMPEG\_VIDEO\_CODEC: use FFMPEG library to encoder and decoder videos (codecId parameter must be set equal to 5). This mode is only available in the FFMPEG branch.
* USE\_SHMAPP\_VIDEO\_CODEC: use SHM software to encoder and decoder videos (codecId parametesr must be set equal to 6, the videoEncoderGeometryPath and videoEncoderAttributePath using the SHM application, and the videoEncoderOccupancyPath using the HM application)
* USE\_HDRTOOLS: use HDRTools to convert the raw video files.

The video encoder softwares and libraries can be found in the corresponding repositories:

* JM: <https://vcgit.hhi.fraunhofer.de/jct-vc/JM.git>
* HM: <https://vcgit.hhi.fraunhofer.de/jvet/HM.git>
* VTM: <https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM.git>
* SHM: <https://vcgit.hhi.fraunhofer.de/jvet/SHM.git>

Some changes have been made on these libraries to allow to use the three libraries at the same time and to increase the codec efficiencies for the V3C contents. the three codecs must be patch with the files:

* JM: dependencies/jm-modification/PCC\_JM.patch
* HM: dependencies/hm-modification/pcc\_me-ext\_and\_namespace\_for\_HM-16.20+SCM-8.8.patch
* VTM: dependencies/vtm-modification/adaptions\_for\_vtm\_11\_2.patch

By default according the the CMake options, the dependencies are cloned and patched by the cmake process.

The external dependencies could be downloaded, built and linked independenly:

* JM:

git clone checkout <https://vcgit.hhi.fraunhofer.de/jct-vc/JM.git> dependencies/jm19.0\_lib cd dependencies/jm19.0\_lib git patch ../jm-modification/PCC\_JM.patch

* HM:

git clone checkout <https://vcgit.hhi.fraunhofer.de/jvet/HM.git> dependencies/HM-16.20+SCM-8.8

cd dependencies/HM-16.20+SCM-8.8

git patch ../hm-modification/pcc\_me-ext\_and\_namespace\_for\_HM-16.20+SCM-8.8.patch

* VTM:

git clone checkout \

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM.git> \

dependencies/VTM-11.2  
cd dependencies/VTM-11.2

git patch ../vtm-modification/adaptions\_for\_vtm\_11\_2.patch

* HDRTools

git clone -b 0.17-dev <https://gitlab.com/standards/HDRTools.git> dependencies/HDRTools

The pointcloud metrics can be computed inside the TM2 encoder and decoder according to the input parameters:

* computeMetrics: Compute metrics
* uncompressedDataPath: Input pointcloud to encode. Multi-frame sequences may be represented by %04i
* normalDataPath: Input pointcloud to encode. Multi-frame sequences may be represented by %04i
* resolution: Specify the intrinsic resolution
* dropdups: 0(detect), 1(drop), 2(average) subsequent points with same coordinates
* neighborsProc: 0(undefined), 1(average), 2(weighted average), 3(min), 4(max) neighbors with same geometric distance

The computations of the metrics are the same than the distances computed with the pcc\_distortion software that can be found in: <http://mpegx.int-evry.fr/software/MPEG/PCC/mpeg-pcc-dmetric.git>.

The common test conditions use HM reference software to encode the created videos. To respect the CTC, we must use the HM: HM-16.20+SCM-8.8 and apply a patch to this version to activate the 3D motion estimation. The patch can be found in the subfolder: mpeg-pcc-tmc2/dependencies/hm-modification/pcc\_me-ext\_for\_HM-16.20+SCM-8.8.patch.

The next command lines could be used to download HM reference software and apply patch:

svn checkout https://hevc.hhi.fraunhofer.de/svn/svn\_HEVCSoftware/tags/HM-16.20+SCM-8.8/external/HM-16.20+SCM-8.8+3DMC;

cd external/HM-16.20+SCM-8.8+3DMC

svn patch ../../mpeg-pcc-tmc2/dependencies/hm-modification/pcc\_me-ext\_for\_HM-16.20+SCM-8.8.patch

* 1. ***Using the codec***

../bin/PccAppEncoder [--help] [-c config.cfg] [--parameter=value]

../bin/PccAppDecoder [--help] [--parameter=value]

../bin/PccAppMetrics [--help] [--parameter=value]

**3.2.1. Principle**

The encoder takes as input a PLY file describing a point cloud with integer positions and, optionally, per-point integer colour attributes.

The output of the encoder is a binary bitstream encapsulated using the V-PCC annex-B format.

Conversely, the decoder takes as input a compressed bitstream file in V-PCC annex-B format and produces a reconstructed PLY file with position and any present attribute values.

The software may be configured using either command line arguments or from a configuration file specified using the -c|--config= option.

Sample configuration files are provided in the cfg/ directory.

Parameters are set by the last value encountered on the command line. Therefore if a setting is set via a configuration file, and then a subsequent command line parameter changes that same setting, the command line parameter value will be used.

**3.2.2. Common test condition configurations**

The configuration files stored in the ./cfg/ sub-folder could be used to perform the V-PCC common test conditions (CTC) experiments. An example of the usage of this file could be found in ./test/runme\_linux.sh.

The reference software configuration not defined the CTC, please validated your experiments based on the N00038 - V-PCC common test conditions document.

**3.2.3. Examples**

This new release is available in MPEG 3DG V-PCC git repository: <http://mpegx.int-evry.fr/software/MPEG/PCC/TM/mpeg-pcc-tmc2.git>

Tag: <http://mpegx.int-evry.fr/software/MPEG/PCC/TM/mpeg-pcc-tmc2/tags/release-v18.0>

**Encoder**

The next command line encodes one streams:

./bin/PccAppEncoder \

--config=cfg/common/ctc-common.cfg \

--config=cfg/condition/ctc-all-intra.cfg \

--config=cfg/sequence/queen.cfg \

--config=cfg/rate/ctc-r1.cfg \

--colorTransform=0 \

--configurationFolder=cfg/ \

--uncompressedDataFolder=People/ \

--compressedStreamPath=S22C2AIR01\_queen.bin \

--frameCount=32

To compute the metrics in the encode, the normal of the source point cloud must be given to the encoder. The next parameter must be added to the previous command:

--normalDataPath=./People/Technicolor/queen\_n/frame\_%04d\_n.ply

**Decoder**

The next command line decodes one streams:

./bin/PccAppDecoder \

--startFrameNumber=0000 \

--compressedStreamPath=S22C2AIR01\_queen.bin \

--reconstructedDataPath=S22C2AIR01\_queen\_dec\_%04d.ply \

--inverseColorSpaceConversionConfig=cfg/hdrconvert/yuv420torgb444.cfg

To compute the metrics in the decoder, the normal of the source point cloud and the source PLY must be given to the decoder. The next parameter must be added to the previous command:

--config=cfg/sequence/queen.cfg \

--uncompressedDataFolder=./People/ \

--normalDataPath=./People/Technicolor/queen\_n/frame\_%04d\_n.ply

**Metrics**

PccAppMetrics could be used to test the PccLibMetrics. For CTC experiments, it’s sugested to used mpeg-pcc-dmetrics: http://mpegx.int-evry.fr/software/MPEG/PCC/mpeg-pcc-dmetric.git.

For example, mpeg-pcc-dmetric and PccAppMetric could be used with the next command line:

../bin/PccAppMetrics \

--uncompressedDataPath=

./People/8i/8iVFBv2/longdress/Ply/longdress\_vox10\_1051.ply\

--reconstructedDataPath=S26C2AIR01\_longdress\_dec\_1051.ply \

--normalDataPath=./People/8i/longdress\_n/longdress\_vox10\_1051\_n.ply \

--resolution=1023 \

--frameCount=1

./mpeg-pcc-demetric/test/pc\_error \

--fileA=People/8i/8iVFBv2/longdress/Ply/longdress\_vox10\_1051.ply \

--fileB=S26C2AIR01\_longdress\_dec\_1051.ply \

--inputNorm=People/8i/longdress\_n/longdress\_vox10\_1051\_n.ply \ --color=1 \

--resolution= 1023

More examples of running could be found in ./test/runme\_linux.sh. These examples can be start based on your system with the following scripts:

./test/runme\_linux.sh

./test/runme\_windows.bat

./test/runme\_osx.sh

**SHVC Information**

The SHVC software used in the program can be obtained from the link below:

<https://hevc.hhi.fraunhofer.de/svn/svn_SHVCSoftware/tags/SHM-12.4/>

The additional Enhanced Layer will be used by SHVC codec according to the number of entries entered in the SHVCLayer in the encoder. SHVCRateX and SHVCRateY refer to the width and height resolution reduction rate of 2D images of additional layers. The decoder uses the video corresponding to the layer entered into the SHVCLayerID. LID 0 has the lowest density, and if 3 layers are used, LID 2 has the same density as V-PCC TMC2 output. Occupancy Map video encode/decode using same version of HM encooder/decoder.

**SHVC Running 3layer PccAppEncoder:**

./bin/PccAppEncoder \

--configurationFolder=cfg/ \

--config=cfg/common/ctc-common.cfg \

--config=cfg/condition/ctc-random-access-svc-3L.cfg \

--config=cfg/sequence/longdress\_vox10.cfg \

--config=cfg/rate/ctc-r3.cfg \

--uncompressedDataFolder=Dynamic\_Objects/People/ \

--frameCount=1 \

--videoEncoderGeometryPath=..\bin\win\TAppEncoder.exe \

--videoEncoderAttributePath=..\bin\win\TAppEncoder.exe \

--videoEncoderOccupancyPath=..\bin\win\occupancy\TAppEncoder.exe \

--colorSpaceConversionPath=../external/HDRTools/bin/HDRConvert \

--reconstructedDataPath=S26C03R03\_rec\_%04d.ply \

--compressedStreamPath=S26C03R03.bin \

--SHVCLayer=2 \

--SHVCRateX=2 \

--SHVCRateY=2

**SHVC Running 3layer PccAppDecoder:**

./bin/PccAppDecoder \

--compressedStreamPath=S26C03R03.bin \

--videoDecoderGeometryPath=..\bin\win\TAppDecoder.exe \

--videoDecoderAttributePath=..\bin\win\TAppDecoder.exe \

--videoDecoderOccupancyPath=..\bin\win\occupancy\TAppDecoder.exe \

--colorSpaceConversionPath=../external/HDRTools/bin/HDRConvert \

--inverseColorSpaceConversionConfig=cfg/hdrconvert/yuv420torgb444.cfg \

--reconstructedDataPath=S26C03R03\_dec\_%04d.ply \

--SHVCLayerID=2

1. **Structure of the test model**

This software consists of mutliple executables and libraries. The two main applications are PccAppEncoder and PccAppDecoder, that are the applications used to encode and decode the point clouds. These softwares are directly linked to the two main libraries: PccLibEncoder and PccLibDecoder that containe the main encoder and decoder processes. The processes and the data structures used both by encoder and decoder are in the PccLibCommon library. The VPCC bitstreams data structures are defined in library: PccLibBitstreamCommon. The encoder and decoder bitstreamer writing and reading processes are stored in to separate libraries: PccLibBitstreamWriter and PccLibBitstreamReader.

Additional of these two libraries, the virtual wrapper libraries are used to encode video (PccLibVideoEncoder), to decode video (PccLibVideoDecoder) and to perform color conversion of the video streams (PccLibColorConverter). These libraries are wrappers and are used to launch external applications or libraries: HDRTools, HM Encoder/Decoder (TLibEncoder/TLibDecoder). These libraries defined application program interfaces (API) to easyly launch external processesto perform these tasks without change the VPCC source code. The below figure is the module dependency draph of the VPCC reference software.

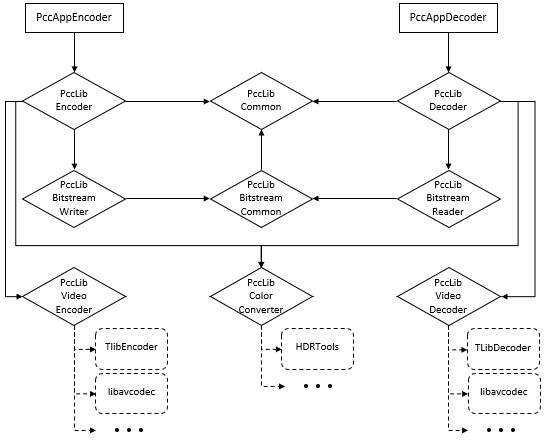


Figure 1 – Structure of the test model

1. **General options**

The next tables show the parameters of the encoder, decoder, and metrics programs.

* 1. **Encoder parameters**

|  |  |
| --- | --- |
| **Parameter=Value** | **Usage** |
| help | This help text |
| Global |  |
| config | Configuration file name |
| configurationFolder | Folder where the configuration files are stored,use for cfg relative paths. |
| uncompressedDataFolder | Folder where the uncompress input data are stored, use for cfg relative paths. |
| uncompressedDataPath | Input pointcloud to encode. Multi-frame sequences may be represented by %04i |
| compressedStreamPath | Output(encoder)/Input(decoder) compressed bitstream |
| reconstructedDataPath | Output decoded pointcloud. Multi-frame sequences may be represented by %04i |
| forcedSsvhUnitSizePrecisionBytes | forced SSVH unit size precision bytes |
| startFrameNumber | First frame number in sequence to encode/decode |
| frameCount | Number of frames to encode |
| groupOfFramesSize | Random access period |
| colorTransform | The colour transform to be applied:  0: none  1: RGB to YCbCr (Rec.709) |
| colorSpaceConversionPath | Path to the HDRConvert. If unset, an internal color space conversion is used |
| colorSpaceConversionConfig | HDRConvert configuration file used for RGB444 to YUV420 conversion |
| inverseColorSpaceConversionConfig | HDRConvert configuration file used for YUV420 to RGB444 conversion |
| gridBasedSegmentation | Voxel dimension for grid-based segmentation (GBS) |
| voxelDimensionGridBased  Segmentation | Voxel dimension for grid-based segmentation (GBS) |
| nnNormalEstimation | Number of points used for normal estimation |
| normalOrientation | Normal orientation: 0: None 1: spanning tree,  2:view point, 3:cubemap projection |
| gridBasedRefineSegmentation | Use grid-based approach for segmentation refinement |
| maxNNCountRefineSegmentation | Number of nearest neighbors used during segmentation refinement |
| iterationCountRefineSegmentation | Number of iterations performed during segmentation refinement |
| voxelDimensionRefineSegmentation | Voxel dimension for segmentation refinement  (must be a power of 2) |
| searchRadiusRefineSegmentation | Search radius for segmentation refinement |
| occupancyResolution | Resolution of packing block(a block contain only one patch) |
| enablePatchSplitting | Enable patch splitting |
| maxPatchSize | Maximum patch size for segmentation |
| log2QuantizerSizeX | log2 of Quantization step for patch size X:  0. pixel precision 4.16 as before |
| log2QuantizerSizeY | log2 of Quantization step for patch size Y:  0. pixel precision 4.16 as before |
| minPointCountPerCCPatch | Minimum number of points for a connected |
| Segmentation | component to be retained as a patch |
| maxNNCountPatchSegmentation | Number of nearest neighbors used during connected components extraction |
| surfaceThickness | Surface thickness |
| depthQuantizationStep | minimum level for patches |
| maxAllowedDist2RawPointsDetection | Maximum distance for a point to be ignored during raw points detection |
| maxAllowedDist2RawPointsSelection | Maximum distance for a point to be ignored during raw points selection |
| lambdaRefineSegmentation | Controls the smoothness of the patch boundaries during segmentation refinement |
| minimumImageWidth | Minimum width of packed patch frame |
| minimumImageHeight | Minimum height of packed patch frame |
| maxCandidateCount | Maximum nuber of candidates in list L |
| occupancyPrecision | Occupancy map B0 precision |
| occupancyMapConfig | Occupancy map encoder config file |
| occupancyMapQP | QP for compression of occupancy map video |
| enhancedOccupancyMapCode | Use enhanced-delta-depth code |
| EOMFixBitCount | enhanced occupancy map fixed bit count |
| occupancyMapRefinement | Use occupancy map refinement |
| decodedAtlasInformationHash | Enable decoded atlas information hash: 0. disable  1.MD5 2.CRC 3.Checksum |
| attributeTransferFilterType | Exclude geometry smoothing from attribute transfer |
| flagGeometrySmoothing | Enable geometry smoothing |
| neighborCountSmoothing | Neighbor count smoothing |
| radius2Smoothing | Radius to smoothing |
| radius2BoundaryDetection | Radius to boundary detection |
| thresholdSmoothing | Threshold smoothing |
| patchExpansion | Use occupancy map refinement |
| gridSmoothing | Enable grid smoothing |
| gridSize | grid size for the smoothing |
| thresholdColorSmoothing | Threshold of color smoothing |
| cgridSize | grid size for the color smoothing |
| thresholdColorDifference | Threshold of color difference between cells |
| thresholdColorVariation | Threshold of color variation in cells |
| flagColorSmoothing | Enable color smoothing |
| thresholdColorPreSmoothing | Threshold of color pre-smoothing |
| thresholdColorPreSmoothingLocal | Threshold of color pre-smoothing local |
| Entropy | entropy |
| radius2ColorPreSmoothing | Radius of color pre-smoothing |
| neighborCountColorPreSmoothing | Neighbor count for color pre-smoothing |
| flagColorPreSmoothing | Enable color pre-smoothing |
| bestColorSearchRange | Best color search range |
| numNeighborsColorTransferFwd | Number of neighbors creating Fwd list |
| numNeighborsColorTransferBwd | Number of neighbors creating Bwd list |
| useDistWeightedAverageFwd | Distance weighted average for Fwd list |
| useDistWeightedAverageBwd | Distance weighted average for Bwd list |

skipAvgIfIdenticalSourcePoint Skip avgeraging if target is identical to a

|  |  |  |
| --- | --- | --- |
| PresentFwd | | Fwd point |
| skipAvgIfIdenticalSourcePoint | | Skip avgeraging if target is identical to a |
| PresentBwd | | Bwd point |
| distOffsetFwd | | Distance offset to avoid infinite weight |
| distOffsetBwd | | Distance offset to avoid infinite weight |
| maxGeometryDist2Fwd | | Maximum allowed distance for a Fwd point |
| maxGeometryDist2Bwd | | Maximum allowed distance for a Bwd point |
| maxColorDist2Fwd | | Maximum allowed pari-wise color distance for  Fwd list |
| maxColorDist2Bwd | | Maximum allowed pari-wise color distance for  Bwd list |
| excludeColorOutlier | | Exclude color outliers from the NN set |
| thresholdColorOutlierDist | | Threshold of color distance to exclude outliers from the NN set |
| videoEncoderOccupancyPath | | Occupancy video encoder executable path |
| videoEncoderGeometryPath | | Geometry video encoder executable path |
| videoEncoderAttributePath | | Attribute video encoder executable path |
| videoEncoderOccupancyCodecId | | Occupancy video encoder codec id |
| videoEncoderGeometryCodecId | | Geometry video encoder codec id |
| videoEncoderAttributeCodecId | | Attribute video encoder codec id |
| videoEncoderInternalBitdepth | | Video encoder internal bitdepth |
| byteStreamVideoEncoderOccupancy | | Attribute video encoder outputs byteStream |
| byteStreamVideoEncoderGeometry | | Attribute video encoder outputs byteStream |
| byteStreamVideoEncoderAttribute | | Attribute video encoder outputs byteStream |
| geometryQP | | QP for compression of geometry video |
| attributeQP | | QP for compression of attribute video |
| auxGeometryQP | | QP for compression of auxiliary geometry video : default=4 for lossy raw points, geometryQP for lossless raw points |
| auxAttributeQP | | QP for compression of auxiliary attribute video |
| geometryConfig | | HM configuration file for geometry compression |
| geometry0Config | | HM configuration file for geometry 0 compression |
| geometry1Config | | HM configuration file for geometry 1 compression |
| attributeConfig | | HM configuration file for attribute compression |
| attribute0Config | | HM configuration file for attribute 0 compression |
| attribute1Config | | HM configuration file for attribute 1 compression |
| rawPointsPatch | | Enable raw points patch |
| noAttributes | | Disable encoding of attributes |
| attributeVideo444 | | Use 444 format for attribute video |
| useRawPointsSeparateVideo | | Compress raw points with video codec |
| attributeRawSeparateVideoWidth | | Width of the MP’s attribute in separate video |
| geometryMPConfig | | HM configuration file for raw points geometry compression |
| attributeMPConfig | | HM configuration file for raw points attribute compression |
| nbThread | | Number of thread used for parallel processing |
| keepIntermediateFiles | | Keep intermediate files: RGB, YUV and bin |
| absoluteD1 | | Absolute D1 |
| absoluteT1 | | Absolute T1 |
| multipleStreams | | number of video(geometry and attribute) streams |
| deltaQPD0 | | qp adjustment for geometry0 video: 0, +3, -3... |
| deltaQPD1 | | qp adjustment for geometry1 video: 0, +3, -3... |
| deltaQPT0 | | qp adjustment for attribute0 video: 0, +3, -3... |
| deltaQPT1 | | qp adjustment for attribute1 video: 0, +3, -3... |
| constrainedPack | | Temporally consistent patch packing |
| levelOfDetailX | | levelOfDetail : X axis in 2D space (should be greater than 1) |
| levelOfDetailY | | levelOfDetail : Y axis in 2D space (should be greater than 1) |
| groupDilation | | Group Dilation |
| offsetLossyOM | | Value to be assigned to non-zero occupancy map positions (default=0) |
| thresholdLossyOM | | Threshold for converting non-binary occupancy map to binary (default=0) |
| prefilterLossyOM | | Selects whether the occupany map is prefiltered before lossy compression (default=false) |
| shvcLayerIndex | | Decode Layer ID number using SHVC codec |
| shvcRateX | | SHVCRateX: reduce rate of each SHVC layer X axis in 2D space (should be greater than 1) |
| shvcRateY | | SHVCRateY: reduce rate of each SHVC layer Y axis in 2D space (should be greater than 1) |
| patchColorSubsampling | | Enable per patch color sub-sampling |
| maxNumRefAtalsList | | maximum Number of Reference Atlas Frame list, default: 1 |
| maxNumRefAtlasFrame | | maximum Number of Reference Atlas Frame per list, default: 1 |
| pointLocalReconstruction | | Use point local reconstruction |
| mapCountMinus1 | | Numbers of layers (rename to maps?) |
| singleMapPixelInterleaving | | Use single layer pixel interleaving |
| removeDuplicatePoints | | Remove duplicate points( |
| surfaceSeparation | | surface separation |
| highGradientSeparation | | Separate high gradient points from a patch |
| minGradient | | Minimun gradient for a point to be separated |
| minNumHighGradientPoints | | Minimum number of connected high gradient points to be separated from a patch |
| packingStrategy | | Patches packing strategy(0: anchor packing, 1(default): flexible packing, 2: tetris packing) |
| useEightOrientations | | Allow either 2 orientations (0(default): NULL  AND SWAP), or 8 orientation (1)) |
| safeGuardDistance | | Number of empty blocks that must exist between the patches (default=1) |
| attributeBGFill | | Selects the background filling operation for attribute only (0: patch-edge extension, 1(default): smoothed push-pull algorithm), 2:  harmonic background filling |
| lossyRawPointsPatch | | Lossy raw points patch(0: no lossy raw points patch, 1: enable lossy raw points patch  (default=0) |
| minNormSumOfInvDist4MPSelection | | Minimum normalized sum of inverse distance for raw points selection: double value between 0.0 and 1.0 (default=0.35) |
| globalPatchAllocation | Global temporally consistent patch allocation.(0: anchor’s packing method(default), 1: gpa algorithm, 2: gtp algorithm) | |
| globalPackingStrategyGOF | Number of frames to pack globally (0:(entire  GOF)) | |
| globalPackingStrategyReset | Remove the reference to the previous frame  (0(default), 1) | |
| globalPackingStrategyThreshold | Matched patches area ratio threshold (decides if connections are valid or not, 0(default)) | |
| patchPrecedenceOrder | Order of patches | |
| lowDelayEncoding | Low Delay encoding (0(default): do nothing, 1: does not allow overlap of patches bounding boxes for low delay encoding) | |
| geometryPadding | Selects the background filling operation for geometry (0: anchor, 1(default): 3D geometry padding) | |
| apply3dMotionCompensation | Use auxilliary information for 3d motion compensation.(0: conventional video coding,  1: 3D motion compensated) | |
| usePccRDO | Use HEVC PCC RDO optimization | |
| geometry3dCoordinatesBitdepth | Bit depth of geomtery 3D coordinates | |
| geometryNominal2dBitdepth | Bit depth of geometry 2D | |
| nbPlrmMode | Number of PLR mode | |
| patchSize | Size of Patch for PLR | |
| enhancedProjectionPlane | Use enhanced Projection Plane(0: OFF, 1: ON) | |
| minWeightEPP | Minimum value | |
| additionalProjectionPlaneMode | additional projection plane mode: 0:none 1:Y-Axis 2:X-Axis 3:Z-Axis 4:All-Axis 5:apply to portion | |
| partialAdditionalProjectionPlane | The value determines the partial point cloud. It’s available with only additionalProjectionPlaneMode(5) | |
| numMaxTilePerFrame | number of maximum tiles in a frame | |
| uniformPartitionSpacing | indictation of uniform partitioning | |
| tilePartitionWidth | uniform partition width in the unit of 64 pixels | |
| tilePartitionHeight | uniform partition height in the unit of 64 pixels | |
| tilePartitionWidthList | non uniform partition width in the unit of 64 pixels | |
| tilePartitionHeightListnon | uniform partition height in the unit of 64 pixels | |
| tileSegmentationType | tile segmentaton method : 0.no tile partition 1. 3D ROI based 2.2D Patch size based | |
| enablePointCloudPartitioning | enablePointCloudPartitioning | |
| roiBoundingBoxMinX | roiBoundingBoxMinX | |
| roiBoundingBoxMaxX | roiBoundingBoxMaxX | |
| roiBoundingBoxMinY | roiBoundingBoxMinY | |
| roiBoundingBoxMaxY | roiBoundingBoxMaxY | |
| roiBoundingBoxMinZ | roiBoundingBoxMinZ | |
| roiBoundingBoxMaxZ | roiBoundingBoxMaxZ | |
| numTilesHor | numTilesHor | |
| tileHeightToWidthRatio | tileHeightToWidthRatio | |
| numCutsAlong1stLongestAxis | numCutsAlong1stLongestAxis | |
| numCutsAlong2ndLongestAxis | numCutsAlong2ndLongestAxis | |
| numCutsAlong3rdLongestAxis | numCutsAlong3rdLongestAxis | |
| mortonOrderSortRawPoints | mortonOrderSortRawPoints | |

|  |  |
| --- | --- |
| pbfEnableFlag | Enable patch block filtering |
| pbfFilterSize | pbfFilterSize |
| pbfPassesCount | pbfPassesCount |
| pbfLog2Threshold | pbfLog2Threshold |
| computeChecksum | Compute checksum |
| computeMetrics | Compute metrics |
| normalDataPath | Input pointcloud to encode. Multi-frame sequences may be represented by %04i |
| resolution | Specify the intrinsic resolution |
| dropdups | 0(detect), 1(drop), 2(average) subsequent points with same coordinates |
| neighborsProc | 0(undefined), 1(average), 2(weighted average), 3(min), 4(max) neighbors with same geometric distance |
| tierFlag | Tier Flag |
| profileCodecGroupIdc | Profile Codec Group Idc |
| profileToolsetIdc | Profile Toolset Idc |
| profileReconstructionIdc | Profile Reconstruction Idc |
| levelIdc | Level Idc |
| avcCodecIdIndex | Index for avc codec |
| hevcCodecIdIndex | Index for hevc codec |
| shvcCodecIdIndex | Index for shvc codec |
| vvcCodecIdIndex | Index for vvc codec |
| oneV3CFrameOnlyFlag | One V3C Frame Only Flag |
| * 1. **Decoder parameters** |  |
| Parameter=Value | Usage |
| help | This help text |
| Global |  |
| c,config | Configuration file name |
| compressedStreamPath | Input  compressed bitstream |
| reconstructedDataPath | Output decoded pointcloud. Multi-frame sequences may be represented by %04i |
| startFrameNumber | Fist frame number in sequence to encode/decode |
| colorTransform | The colour transform to be applied:  0: none  1: RGB to YCbCr (Rec.709) |
| colorSpaceConversion | Path to the HDRConvert. If unset, an |
| Path | internal color space conversion is used |
| inverseColorSpaceConversion | HDRConvert configuration file used for |
| Config | YUV420 to RGB444 conversion |
| videoDecoderOccupancyPath | Occupancy video decoder executable |
| videoDecoderGeometryPath | Geometry video decoder executable |
| videoDecoderAttributePath | Attribute video decoder executable |
| byteStreamVideoCoderOccupancy | Occupancy video decoder inputs byteStream |
| byteStreamVideoCoderGeometry | Geometry video decoder inputs byteStream |
| byteStreamVideoCoderAttribute | Attribute video decoder inputs byteStream |
| nbThread | Number of thread used for parallel |
|  | processing |
| attributeTransferFilterType | Exclude geometry smoothing from attribute |
|  | transfer |
| keepIntermediateFiles | Keep intermediate files: RGB, YUV and bin |
| shvcLayerIndex | Decode Layer ID number using SHVC codec |
| patchColorSubsampling | Enable per-patch color up-sampling |
| Metrics |  |
| computeChecksum | Compute checksum |
| computeMetrics | Compute metrics |
| uncompressedDataFolder | Folder where the uncompress input data are |
|  | stored, use for cfg relative paths. |
| startFrameNumber | Fist frame number in sequence to |
|  | encode/decode |
| frameCount | Number of frames to encode |
| groupOfFramesSize | Random access period |
| uncompressedDataPath | Input pointcloud to encode. Multi-frame sequences may be represented by %04i |
| reconstructedDataPath | Output decoded pointcloud. Multi-frame sequences may be represented by %04i |
| normalDataPath | Input pointcloud to encode. Multi-frame sequences may be represented by %04i |
| resolution | Specify the intrinsic resolution |
| dropdups | 0(detect), 1(drop), 2(average) subsequent points with same coordinates |
| neighborsProc | 0(undefined), 1(average), 2(weighted average), 3(min), 4(max) neighbors with same geometric distance |
| nbThread | Number of thread used for parallel |
|  | processing |
| minimumImageHeight | Ignore parameter |
| flagColorPreSmoothing | Ignore parameter |
| surfaceSeparation | Ignore parameter |
| Conformance |  |
| checkConformance | Check conformance |
| path | Root directory of conformance files + prefix: S26C03R03 |
| level | Level indice |
| fps | Frame per second |
| * 1. **Metrics parameters** |  |
| **Parameter=Value** | **Usage** |
| help | This help text |
| computeChecksum | Compute checksum |
| computeMetrics | Compute metrics |
| startFrameNumber | Fist frame number in sequence to |
|  | encode/decode |
| frameCount | Number of frames to encode |
| uncompressedDataPath | Input pointcloud to encode. Multi-frame |
|  | sequences may be represented by %04i |
| reconstructedDataPath | Output decoded pointcloud. Multi-frame |
|  | sequences may be represented by %04i |
| normalDataPath | Input pointcloud to encode. Multi-frame |
|  | sequences may be represented by %04i |
| resolution | Specify the intrinsic resolution |
| dropdups | 0(detect), 1(drop), 2(average) subsequent |
|  | points with same coordinates |
| neighborsProc | 0(undefined), 1(average), 2(weighted |
|  | average), 3(min), 4(max) neighbors with |
|  | same geometric distance |
| nbThread | Number of thread used for parallel |
|  | processing |
| minimumImageHeight | Ignore parameter |
| flagColorPreSmoothing | Ignore parameter |
| surfaceSeparation | Ignore parameter |

1. **References**

[1] “Common Test Conditions for PCC”, ISO/IEC JTC1/SC29/WG07 MPEG/N00038, Jul. 2020, Online.

[2] “V-PCC Test Model v18”, ISO/IEC JTC1/SC29/WG07 MPEG/N00311, Apr. 2022, Online.