**ISO/IEC JTC 1/SC29/WG1** **N100814**

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| **ISO/IEC JTC 1/SC 29/WG 1**  **(& ITU-T SG16)**  **Coding of Still Pictures**  **JBIG JPEG**  Joint Bi-level Image Joint Photographic  Experts Group Experts Group |

**TITLE:** Exploration Study 7 on JPEG GMIS

**SOURCE:** ICQ subgroup

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**PROJECT:** JPEG GMIS Exploration

**REQUESTED ACTION:** For review

**DISTRIBUTION**: WG1

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**Exploration Study 7 on JPEG GMIS**

### 1. Goals:

* 1. **Explore modeling of inter-image relationships of focus bracketing image sets and utilising this relationship for improved coding [SJU, UNSW]**
* Model PSF of each image, thereby describing the relationship between focal stack images in terms of changes to PSF.[UNSW]
* Utilise PSF models to improve compression of focus bracketing image sets [UNSW]
* Assess compression performance to predictive coding (IPP) explored in ES6 [SJU]
* Assess compression performance achieved by state-of-the-art image encoders for focus bracketing image sets. [SJU]
  1. **Explore metadata representations that can facilitate composing a HDR image from component SDR exposure stack images [UNSW]**
* Determine metadata that can be stored along with the image set and investigate composition process for producing a single HDR image for the set
  1. **Investigate employing a HDR mother image along with associated inter-image relationship metadata for improved coding of SDR exposure stack image sets [SJU, UNSW]**
* Assuming a HDR image is available for the SDR exposure stack, explore coding options in which the HDR image can be utilised for improved compression. [UNSW, SJU]
* Can build on prior schemes of using a single well-exposed SDR mother image, along with metadata describing inter-image changes in intensity.
* Assess compression performance achieved by state-of-the-art image encoders for exposure bracketing image sets. [SJU]
* Reference: Erik Reinhard and Kate Devlin. Dynamic Range Reduction Inspired by Photoreceptor Physiology. IEEE Transactions on Visualization and Computer Graphics (2004).
  1. **Study Compression of image sets comprised of images at different resolution [SJU, UNSW]**
* Identify online image sets or capture new sets [UNSW, SJU]
* Includes images subject to cropping after capture, and images captured by cameras with variations in sensor resolution and orientation.
* Explore compression performance of image sets containing images of different resolution by modeling inter-image relationships using existing framework of homography transforms and Quadtree signalling. [SJU]
* Assess compression performance achieved by state-of-the-art image encoders for image sets comprised of images with different resolution. [UNSW, SJU]
  1. **Study metadata enabled composition of multiple viewpoint image sets [UNSW]**
* Estimate homography transforms between image regions
* Synthesise a stitched image from overlapping images using metadata describing geometrical relationships between images.
* Produce component images by subjecting a high resolution image to geometrical transforms.

### Detailed Description:

Image coding anchors to compare compression performance should Include,

1. JPEG AI
2. JPEG 2000 part 2(ISO/IEC 15444-2)
3. JPEG XL (ISO/IEC 18181-1)
4. VVC (Intra and inter mode for 6.1 and Intra for 6.2)

### Test Conditions

* 1. Dataset

The dataset is organized based on the main use cases listed in the document “wg1n100716-102-REQ-Use Cases and Requirements for JPEG GMIS v2.3”.

The sets of images in the dataset vary in their number of images in a set, content, color, and spatial resolution. All the images in the dataset are in the form of JPEG 1 or RAW.

The JPEG GMIS dataset accompanied by the summary sheet is made available as noted in the document “wg1n100813-103-ICQ-GMIS Dataset Updates and Multi-View Images Set”.

* 1. Performance Evaluation

Compressions are performed on each input image file set and are intended to result in a single compressed output file. If some solutions do not result in a single output file, the output files are saved in a folder. The performance of solutions is evaluated only by compression ratio.

* + - Lossy compression of multiple images:

4 objective metrics (PSNR-Y, PSNR-YUV, PSNR-HVS-M and MS-SSIM ) are to be computed and averaged over a set. The implementation for metrics PSNR, MS-SSIM and PSNR-HVS-M, is available at https://gitlab.com/wg1/jpegai/jpeg-ai-qaf.

* 1. Solution Coding Configuration

The following table is the list of solutions that will be used for this study and their configurations. Lossy compression of multiple images (for RAW sample sets).

|  |  |  |  |
| --- | --- | --- | --- |
| **Codec** | **Employed program** | **Downloadable sites** | **Sample command** |
| JPEG 2000 part 2: JPX lossy | Version 8.0.5 released on June 2, 2022v8.0.5 | https://kakadusoftware.com/ | kdu\_v\_compress -i [INPUT\_VIDEO.yuv] -o [MOTION\_JPEG2000.mj2] -rate <targetbpp>  kdu\_merge -i [MOTION\_JPEG2000.mj2] -o kdu\_compress -i [INPUT\_FILE\_1.bmp] -o [OUTPUT\_FILE\_1.jpx] -jpx\_layers \* Clayers=1 -rate <targetbpp>  kdu\_merge -i [OUPUT\_FILE\_1.jpx, OUTPUT\_FILE\_2.jpx,...,OUTPUT\_FILE\_N.jpx] -o [OUTPUT.jpx] -album2  kdu\_expand -i [OUTPUT.jpx] -o [DECODED.bmp] -jpx\_layer [0...N-1]  (Refer to 3.3.2) |
| JPEG XL part 1 lossy | Version 0.8.2 released on Sep.21, 2022 | https://github.com/libjxl/libjxl/releases/tag/v0.8.2 | cjxl [INPUT\_FILE.png] [OUTPUT\_FILE..jxl] –q <quality> -e 7  djxl [OUTPUT\_FILE.jxl] [DECODED.png]  Support single input files only |
| SJU Framework  wg1m101051 |  |  | See document wg1m101051 |
| UNSW Pred Scheme  wg1m101089 |  |  | See document wg1m101089 |
| VVC | VTM  VVEnc | https://github.com/ChristianFeldmann/VTM    https://www.hhi.fraunhofer.de/en/departments/vca/technologies-and-solutions/h266-vvc/fraunhofer-versatile-video-encoder-vvenc.html  VVEnc | vvc\_enc -c config\_file -c config\_file\_seq -i yuvFile -q QP -wdt width -hgt height -b test.bin -o rec.yuv |

3.3.1. JPEG 2000 part 2: JPX

The entered RGB raw image (png) is first converted into a BMP file format, then each BMP image is encoded into a JPX file format, and then all JPX images are merged into one JPX file.

3.3.2. VVC

VVC encoding, using the VTM software is to be used for generating anchor results for the Intra coding case.

The VVEnc software can be used for performing Inter coding to generate additional anchor results.

### Participants

UNSW

SJU