**MV-HEVC based LF Coding Framework description (Release version 1.0)**

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This document describes the Light Field (LF) Coding scheme presented in manuscript (under review):

Ali Hassan, Waqas Ahmad, Mubeen Ghafoor, Kamran Qureshi, Roger Olsson, and Marten Sjöström, "Two-Dimensional Hierarchical Rate Control Scheme For Light Field Compression Using MV-HEVC", submitted to IEEE Transaction in IEEE Transactions on Circuits and Systems for Video Technology.

**Description**

The coding framework reads the input LF image, generates multiview sequences, encodes the generated sequences using MVHEVC encoder and finally produces the decoded Mat files. The frame work produces results according to first paper when the parameter "RateControl" in config file is set to 0. However when this parameter "RateControl" is set to 1 the frame work produces the results of "Two-Dimensional Hierarchical Rate Control Scheme For Light Field Compression Using MV-HEVC".

**Framework MATLAB Code usage instructions**

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Prerequisites

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The following tool and datasets are required to run the code:

- Matlab
- JPEG Pleno LF Datasets

The LF datasets are available at the following links:

| LF Name | Source | Link |
|---|---|---|
| Bikes | Lytro | https://jpeg.org/plenodb/lf/pleno_lf/Bikes.zip |
| Danger de Mort | Lytro | https://jpeg.org/plenodb/lf/pleno_lf/Danger_de_Mort.zip |
| Fountain Vincent 2 | Lytro | https://jpeg.org/plenodb/lf/pleno_lf/Fountain_Vincent2.zip |
| Stone Pillars Outside | Lytro | https://jpeg.org/plenodb/lf/pleno_lf/Stone_Pillars_Outside.zip |
| Set2 2K sub | Fraunhofer IIS | https://jpeg.org/plenodb/lf/pleno_lf/set2.zip |
| Tarot Cards | Stanford | http://lightfield.stanford.edu/data/tarot_fine_lf/rectified.zip |

**Instructions**

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**Step 1.** The first step is to download the LF datasets from the above links and put them in the "/Datasets/[Source]/" folder as shown in Fig. 1, where the "Source" is either Lytro, Fraunhofer_IIS, or Stanford:

*Note: Rename the downloaded Stanford Tarot Cards LF from "rectified" to "tarot_Stanford".*

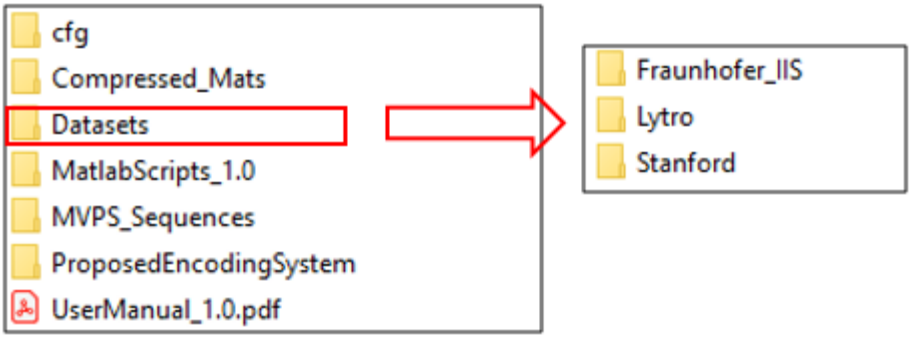


Fig. 1: LF dataset placement hierarchy.

**Step 2.** Next, open the "/RC_MatlabScripts_x/MIUN_RC_LFC.m" file in MATLAB
**Step 3.** Browse to the path in which your Matlab scripts are. This will set the BasePath

```
BasePath=pwd;
```

Fig. 3: Browse to the folder for selection of path

**Step 4.** Set the "Dataset" parameter according to desired input LF.

```
%% Select the Input LF and paths

DATASET              = 2;     % Specify the input LF: 1 For Lytro,
                              %                       2 For Stanford 8 bpp PNG,
                              %                       3 For Fraunhofer IIS
DATASET_NAMES = ["Lytro" "Stanford" "Fraunhofer_IIS"];

Layers =[13 17 11]; % Number of Vertical views
Frames =[13 17 33]; % Number of Horizontal views
```

Fig. 2: Select input LF dataset.

Description of these flag is as follows:

**Step 5.** Generate multiple pseudo video sequence (MPVS) of the selected input LF by setting the *Sequence_Generate* flag to '1' as shown in Fig. 5, and execute the code. The script will ask the user to select the folder "Datasets" in which all your datasets should be downloaded and available. The output folder selection is also asked by user. Please select an output folder in which you want to generate the output files.

Note: The MPVS script add a dummy frame infront of each layer. We have used dummy frame in the proposed work to handle encoding of the central frame first. The proposed encoding scheme skip the first frame (added dummy frame) and encodes the input LF by following proposed prediction structure. This dummy frame doesn't contribute to encoder complexity, overall bitrate since it is not included in the bitstream.

```
%% Select the required outputs from the framework

Sequence_Generate    = 1;     % This flag enables the generation of multiView
                              % sequences of the selected input LF.
Config_Write         = 0;     % This flag enables the generation of the configuration
                              % file used for LF encoding using MV-HEVC.
MAT_Generation       = 0;     % This flag enables the generation of the Mat file
                              % from Multiple YUV file.
```

Fig. 5: Parameters for specifying the required output to be generated using the framework.

**Step 6.** Generate the configuration file for encoding of the generated MPVS by setting *Config_Write* flag to '1' shown in Fig. 5, and execute the code. Specify the output folder in which you desire to write your config file.

**Step 7.** To encode select the desired encoding folder e.g Lytro, Stanford etc. Copy and paste the generated sequences in the Input_Sequences folder.

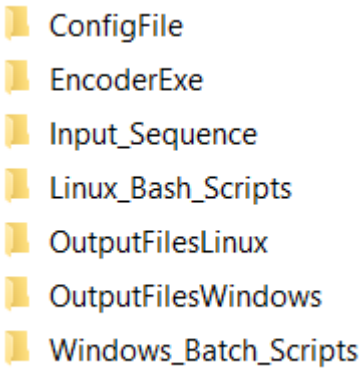


Fig. 6: Contents of "/ProposedEncodingSystem/Lytro/" folder.

**Step 7.1** The batch files ("**[LF].bat**") can be modified to specify the desired target bitrate (or a list of comma separated rates) to encode the MPVS using the '*nums*' parameter shown in Fig. 7 (sample of "Lytro/Bikes.bat" LF batch file):

**NOTE:** The target bitrate is specified for single layer in bits per second. Since we use frame/sec = no. of frame in a layer, the target bitrate is specifies bits/sec for single layer. The MV-HEVC calculates target bitrate for entire LF by multiplying the target bitrate of single layer with total no. of layers.

```
set W=624
set H=434
set InpSeqPath=..\Input_Sequence\
set PAthEncoder=..\EncoderExe\
set ratio=5

mkdir Debug\MyLog

set /a count=0

set nums=5085937,678125,135625,33906,6781

set InputSeq=Bikes
```

Fig. 7: Batch file of Lytro/Bikes LF.

**Step 7.2** Make sure the config file name is same in 'EncodingBatch' file. Open 'EncodingBatch.bat' file and search for 'ConfigName'. Compare with the name of the config file in ConfigFile folder.
**Step 7.3** To start the encoding process, run the batch file corresponding to the source LF. The encoded bitstream and reconstructed YUV files will be generated in the "OutputFilesWindows" folder.

**Step 8.** Compressed MAT files can be generated from the reconstructed YUV files of the MPVS using the third flag, *Mat_Generation* shown in Fig. 5 in step 4 above. The MAT files will be generated in the folder user specifies. During MAT file generation the script also perform PSNR and SSIM estimation as defined in JPEG pleno common test conditions. The Mat files contains LF structure, PSNR_Y_mean, PSNR_YUV_mean, SSIM_mean and Rate in bytes for compressed LF.

**Step 8.1** Inside the function generate_MAT correctly specify the input path to folder with respective QP for YUV sequences and bit file. Also specify the input path of log file ('QP_#.txt').

The **Write_PPM** flag will enable the writing of decoded views in .PPM format in similar to Groundtruth format. (Lytro 10 bpp, Franhoufer 10 bpp and Stanford 8 bpp)

**Ratio.txt file:**
In rate control work a hierarchical bit allocation scheme is used, where depending upon angular resolution of LF, multiple levels are defined. The ratio of bits assigned to each subsequent level are defined in the Ratio File, given as an input parameter to the encoder. The ratio.txt file given along with the Encoder has the five finalized ratios in accordance with five JPEG Pleno rates. The ratio for each rate is found empirically. For more details please refer to the paper "Two dimensional hierarchical bit allocation scheme for Light Field image compression using MV-HEVC".

**Example:** Lytro sequences with four quality levels.

| | | | |
|---|---|---|---|
| 100 | 50 | 25 | 12.5 |

Frames belonging to level 1 has a quality ratio of 100%. Frames belonging to level 2 have half the quality of frames in level 1. Similarly the quality ratio of level 2 : level 3 and level 3 : level 4 is defined.

**Summary**

The proposed coding framework reads the input LF images, generates Multiview Sequences, encodes the generated sequences and finally produces decoded Mat files as LF structure along bitrate in Bytes.

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If there are any issues with the usage of the LF coding framework, please contact Waqas Ahmad <Waqas.Ahmad@miun.se>.