Data Compression Conference

Gaussian guided inter prediction for focal stack images compression

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Outline

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- Proposed focal stack images compression scheme
  - Problem statement
  - Gaussian guided inter prediction model
- Experiment
  - Validating experiment
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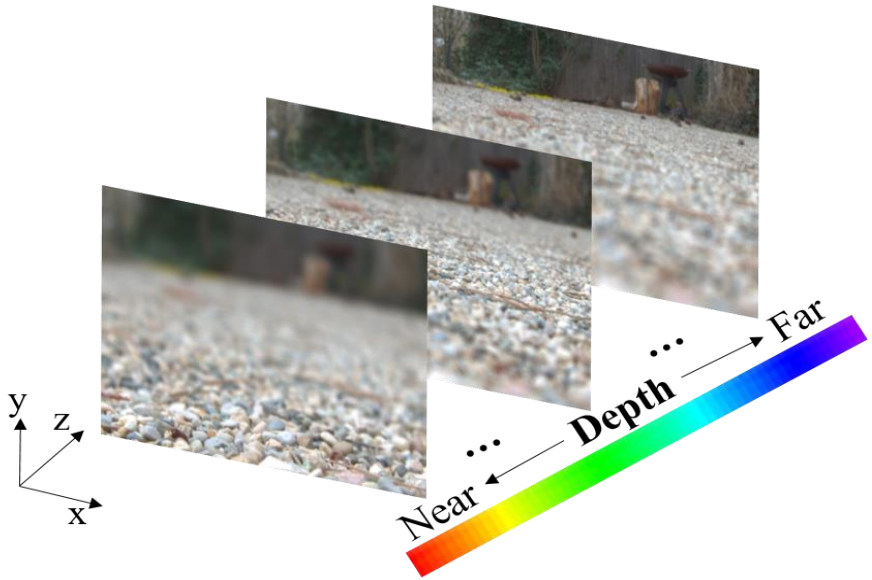
- Summary

Introduction

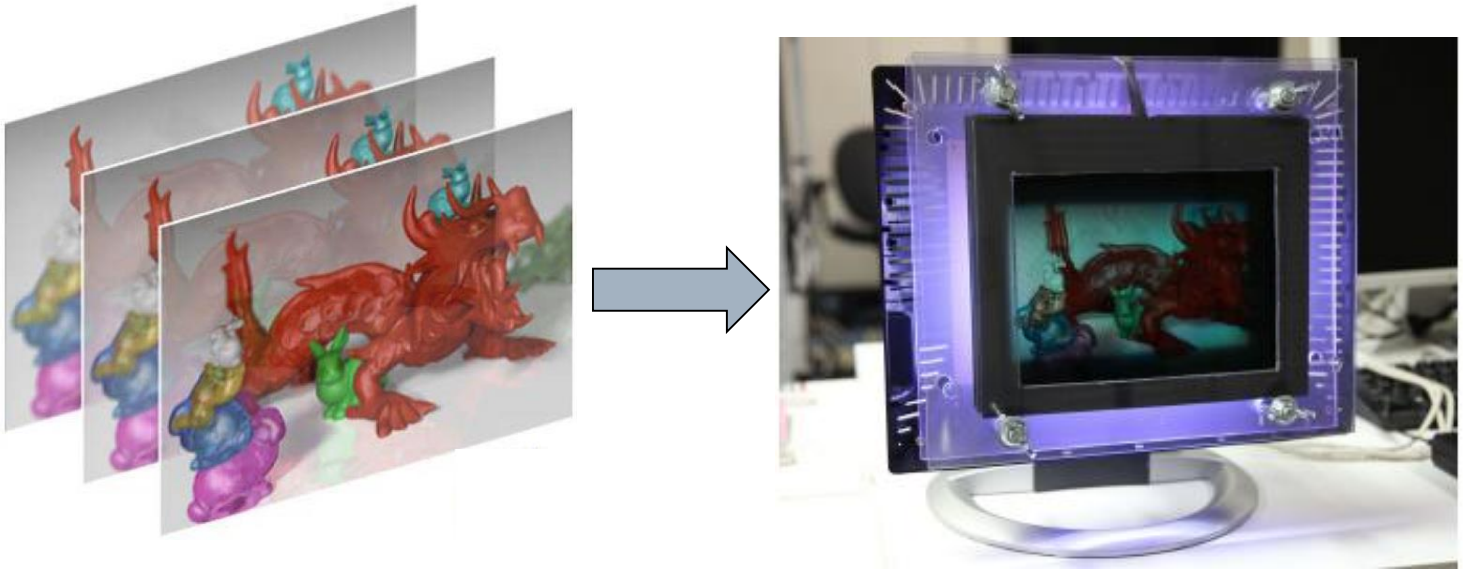
Focal stack images are a set of 2D images focused at different depths



(a)Focal stack images (b)Post-capture refocusing

Fig. 1. Examples of focal stack images

Introduction



(a) Focal stack (b) 3D displays

Fig. 2. Example of 3D displays by focal stack images in [1]

[1] Keita T, Yuto K, Toshiaki F. From Focal Stack to Tensor Light-Field Display[J]. IEEE Transactions on Image Processing, 2018:1-1.

Proposed compression scheme

- Problem statement

Focal stack sequence

Close-up of region

Fig. 3. Blurriness of focal stack

Proposed compression scheme

- Problem statement

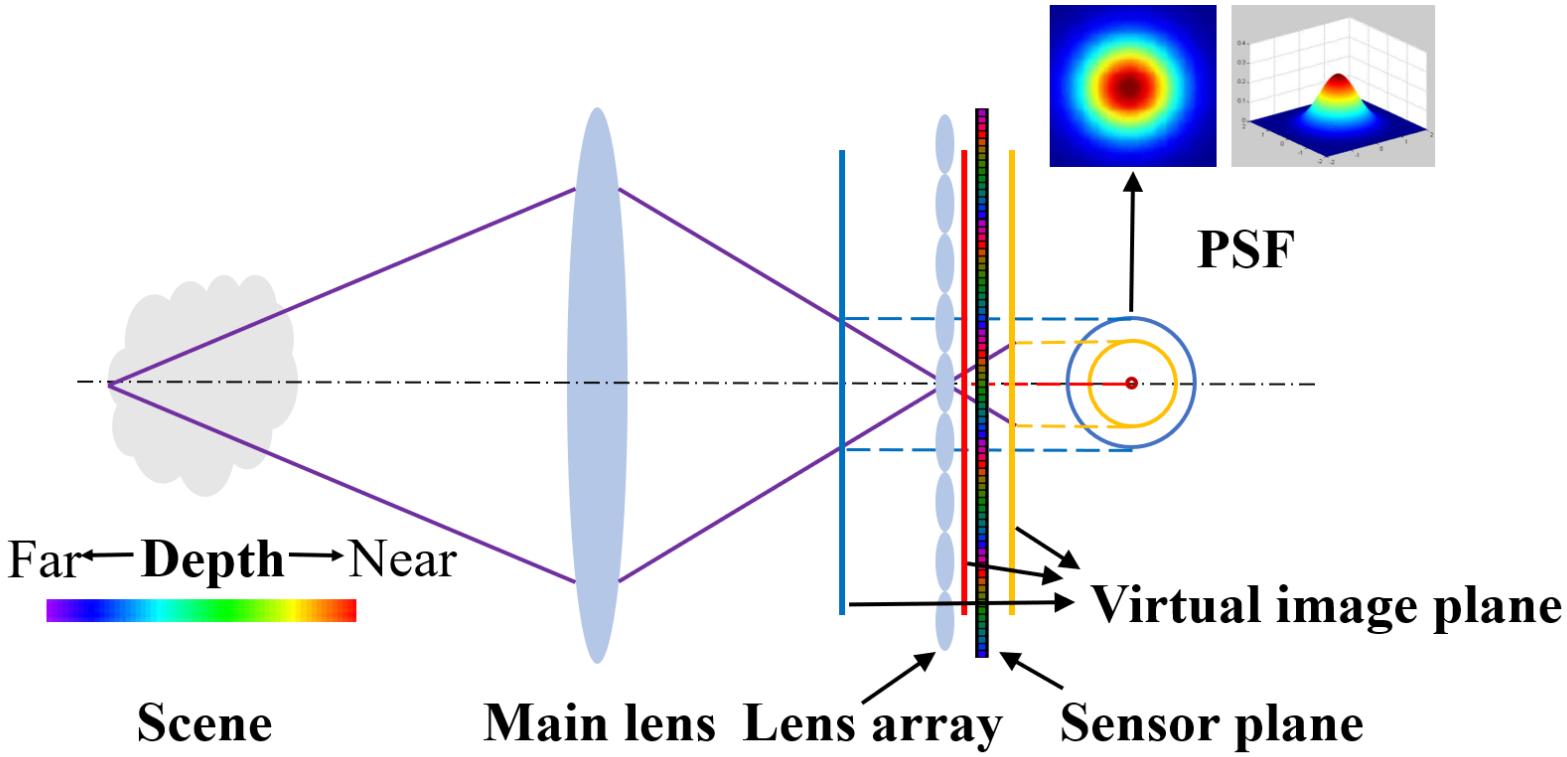


Fig. 4. Imaging model of focal stack

Proposed compression scheme

- Problem statement

PSF proposed in [2]

$$E_{t,w}^{\xi',\eta'} = |\frac{e^{jkz_1}e^{jkz_2}e^{jkz_3}}{j\lambda z_2 M} exp[\frac{jk}{2z_3}(t^2+w^2)] \sum_m \sum_n exp\{\frac{-jk}{2f_2}[((mD_2)^2+(nD_2)^2)]\} \quad (1)$$
$$\iint dudv P_2(u-mD_2, v-nD_2) exp[\frac{jk}{2}(\frac{1}{z_2}+\frac{1}{z_3}-\frac{1}{f_2})(u^2+v^2)]$$
$$exp\{-jk[u(\frac{t}{z_3}-\frac{mD_2}{f_2})+v(\frac{w}{z_3}-\frac{nD_2}{f_2})]\} h_1'(u-\xi', v-\eta')|^2$$

Simplification

2D Gaussian PSF

$$h(x,y;\sigma) = \frac{1}{2\pi\sigma^2} exp(-\frac{x^2+y^2}{2\sigma^2}) \quad (2)$$

[2] Shroff S , Berkner K . Plenoptic System Response and Image Formation[C]// Imaging Systems & Applications. 2013.

Proposed compression scheme

- Problem statement

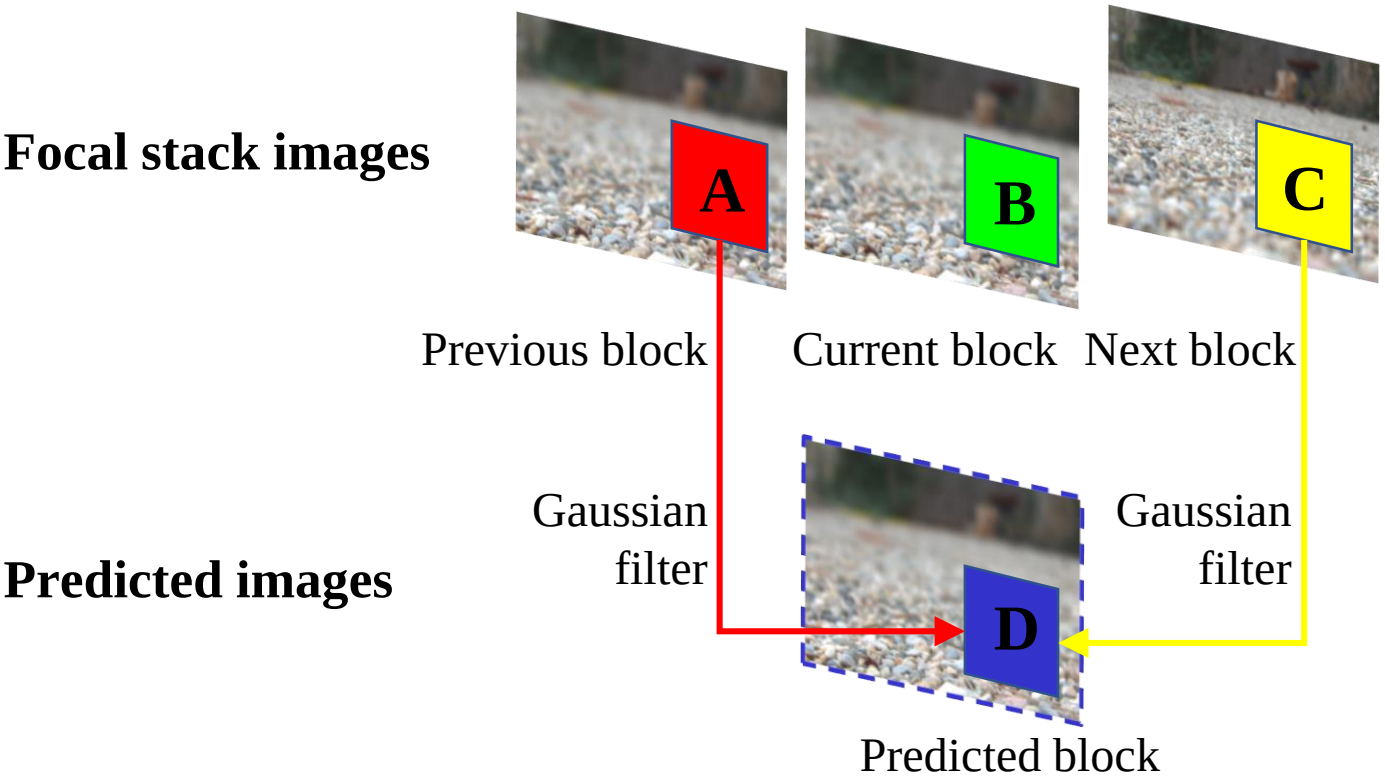


Fig. 5. Representing a stack by its neighboring two stacks

Proposed compression scheme

Problem statement

Solve optimization problem

$$D_0 = A \otimes Gauss(\sigma) \quad (1)$$

$$D_1 = C \otimes Gauss(\sigma) \quad (2)$$

$$\sigma = \arg\min_{\sigma} \frac{1}{M \times M} \|B - D_i\|_2^2 \ , \text{s.t.} \ 0 < \sigma \leq upper\ bound \quad (3)$$

$\boldsymbol{A}$ Previous block $\boldsymbol{B}$ Current block $\boldsymbol{C}$ Next block

$\boldsymbol{D}$ Predicted block $\boldsymbol{\sigma}$ Gaussian kernel

Proposed compression scheme

- Gaussian guided inter prediction model

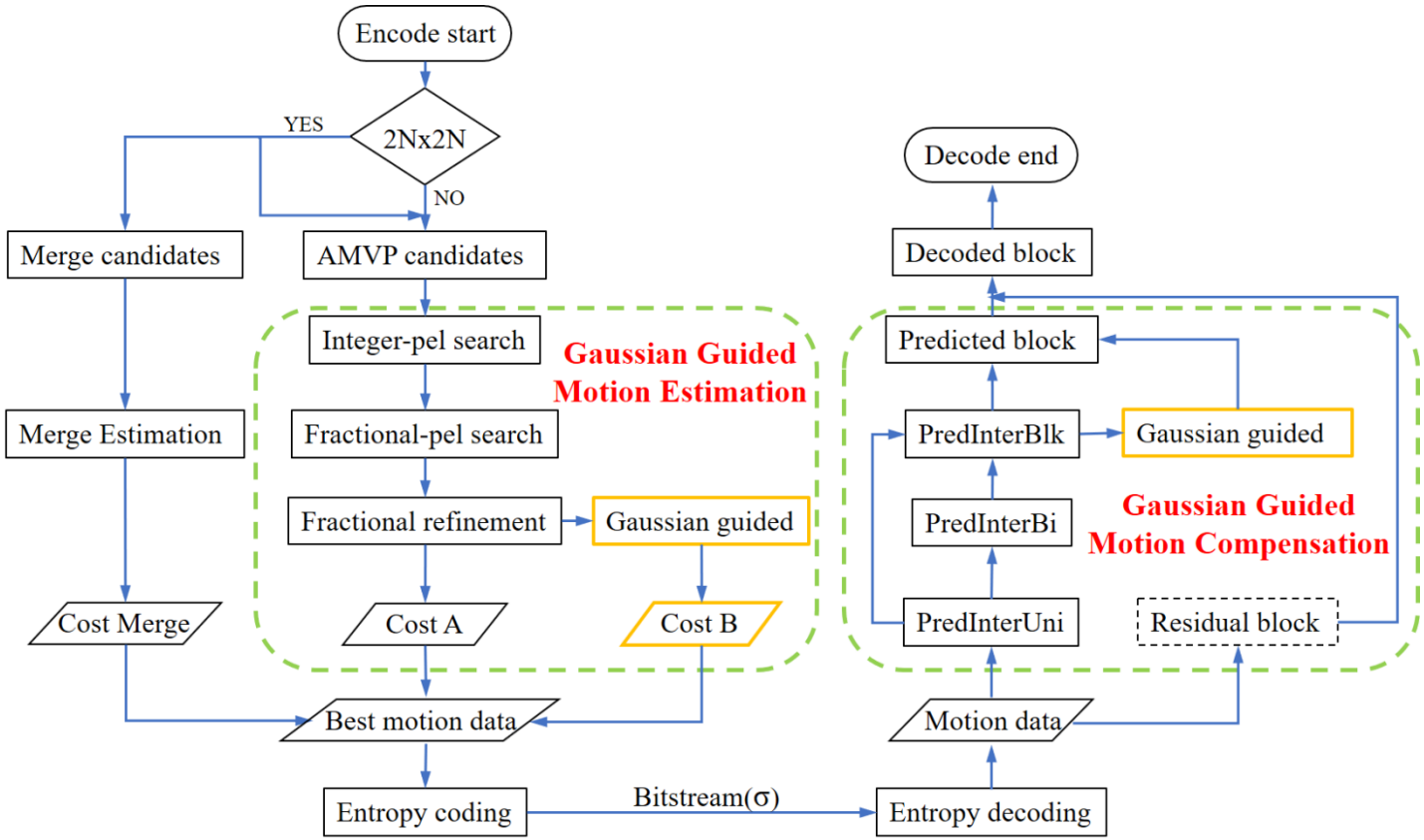


Fig.6. Overview of proposed compression scheme

Experiment

- Validating experiment

Test conditions: Low Delay B (LDB), Low Delay P (LDP) and Random Access (RA), QP = 22, 27, 32, 37
Anchor: HEVC Test Model--HM 16.20

(a) I01 Stone Pillars Outside

(b) I02 Houses Lake

(c) I03 Red White Building

(d) I04 Yan Krios standing

Scene ID	Category	Scene name	Slope min	Slope max	Slope number
I01	Urban	Stone Pillars Outside	-1.0	0.5	17
I02	Landscapes	Houses Lake	-1.0	0.5	17
I03	Buildings	Red White Building	-1.0	0.5	17
I04	People	Yan Krios standing	-0.7	0.5	17

Experiment

- Validating experiment

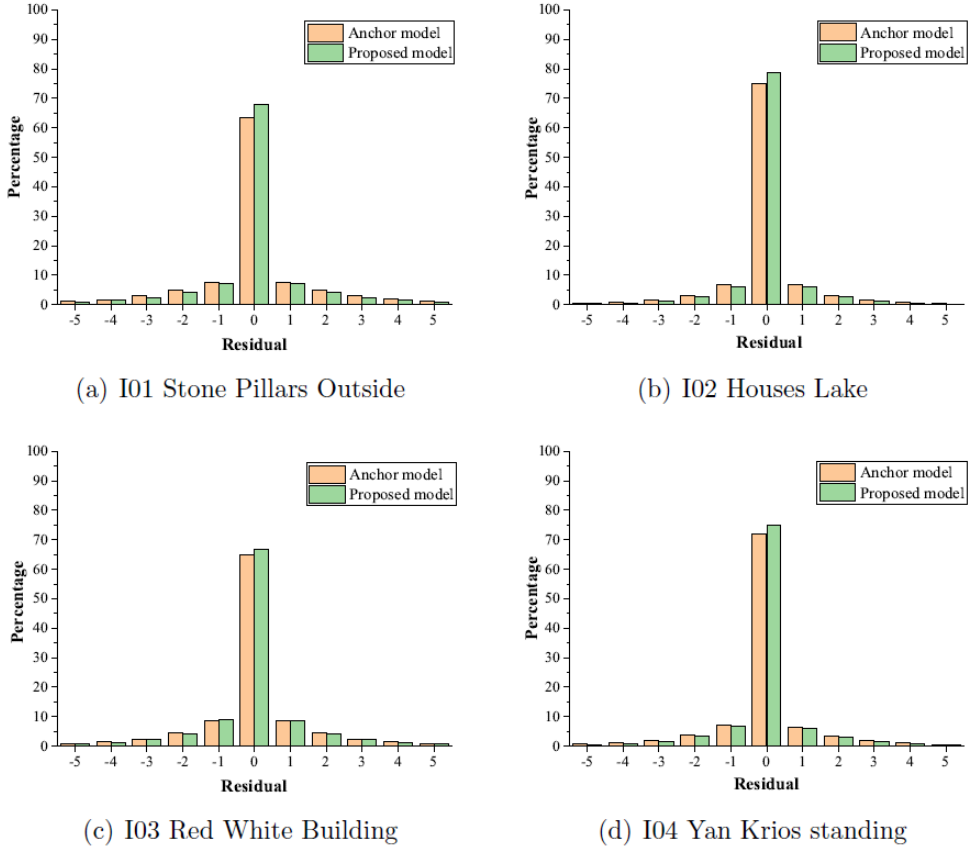
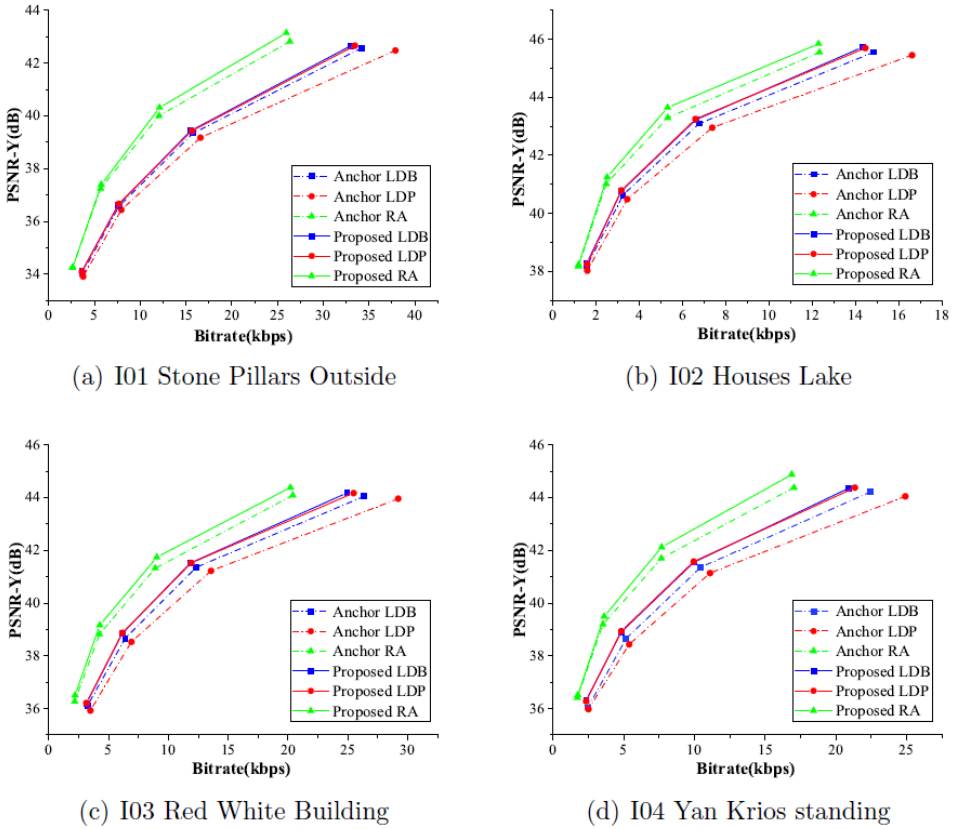


Fig. 7. Comparison of residual distributions between proposed model and anchor.

Experiment

- Experimental result



(a) I01 Stone Pillars Outside (b) I02 Houses Lake

(c) I03 Red White Building (d) I04 Yan Krios standing

Fig.8. RD performance of proposed model for focal stack sequences.

Experiment

- Experimental result

Table 1: Comparison in term of BDBR(in %) and BDPSNR(in dB) between proposed model and HEVC anchor

Scene	BDBR			BDPSNR		
	LDB	LDP	RA	LDB	LDP	RA
I01	-3.50	-11.13	-4.88	0.136	0.439	0.194
I02	-6.09	-16.18	-7.01	0.207	0.568	0.244
I03	-7.83	-18.19	-8.98	0.312	0.767	0.328
I04	-10.98	-20.89	-8.32	0.431	0.820	0.316
Average	-7.10	-16.60	-7.30	0.272	0.649	0.271
Average of all		-10.33			0.397	

Summary

We propose a Gaussian guided inter prediction model for focal stack images compression

- Simplify the blurriness of focal stack image as a 2D Gaussian point spread function (PSF).
- On encoder side, implement Gaussian guided motion estimation and motion compensation, and set Gaussian parameter as supplementary syntax element.
- On decoder side, parse Gaussian parameter and recover compressed focal stack images

Any question?
please contact Kejun Wu

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