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# A Spatial-Focal Error Concealment Scheme for Corrupted Focal Stack Video

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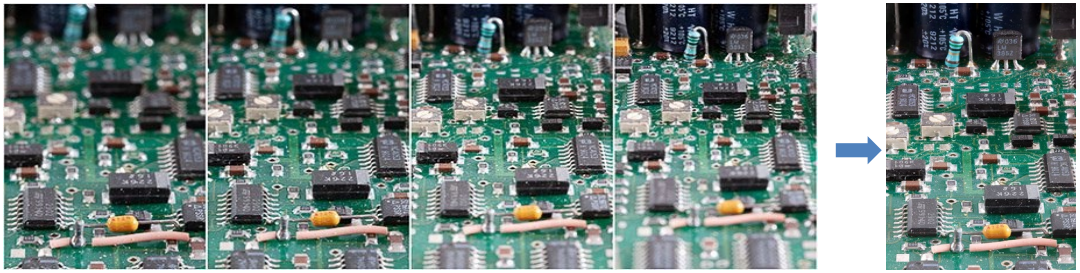
# Outline

- Motivation
- Method
- Experiment
- Summary

# Motivation

- Focal stack photography technology & art

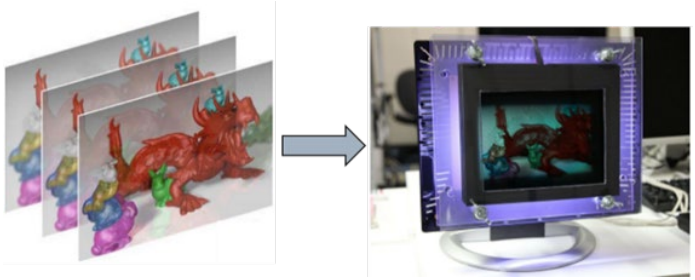
Macro Photography



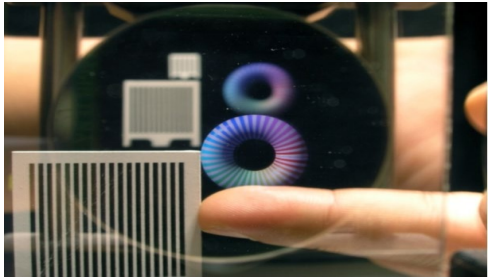

Landscape Photography

# Motivation

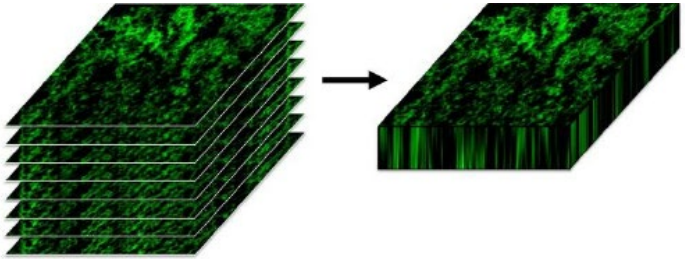
- Focal stack applications in immersive multimedia and life science



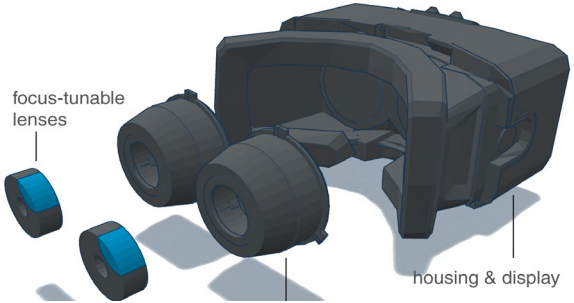
3D volumetric displays



Multifocal plane displays



Z-stacking microscopy reconstruction



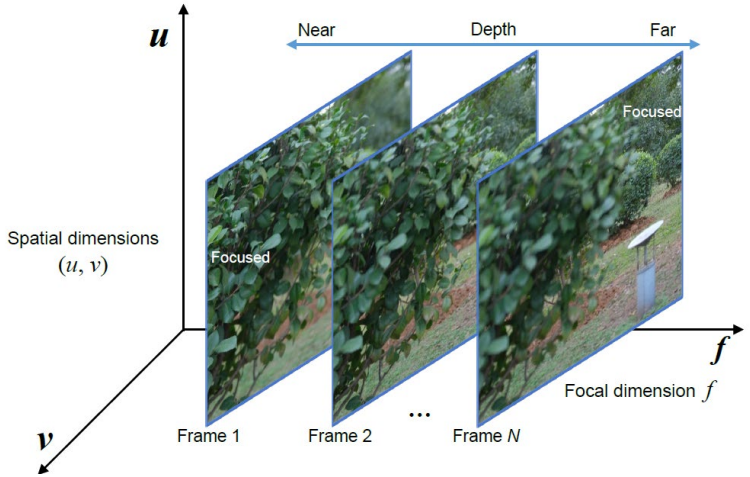

Immersive multimedia

# Motivation

- Focal stack video formation

Features:

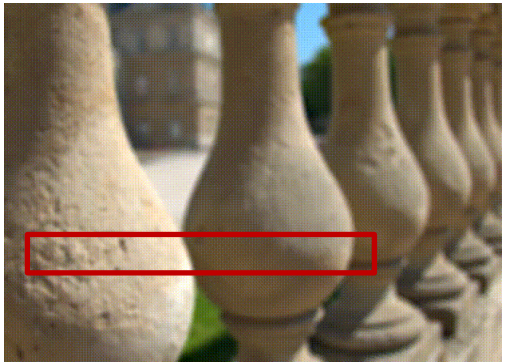
- Focal stack images can be concatenated as video format
- Such video has no significant movement, but has focusing status changes among frames



# Method

- Problem statement: error concealment in focal stack scenario
  - Video segments get corrupt during storage or video packets get lost during transmission, resulting in error video at decoder side
  - Error concealment aims to recover the error by referring the adjacent information
  - Focal stack video is special data type, no specialized error concealment method

Typical error concealment



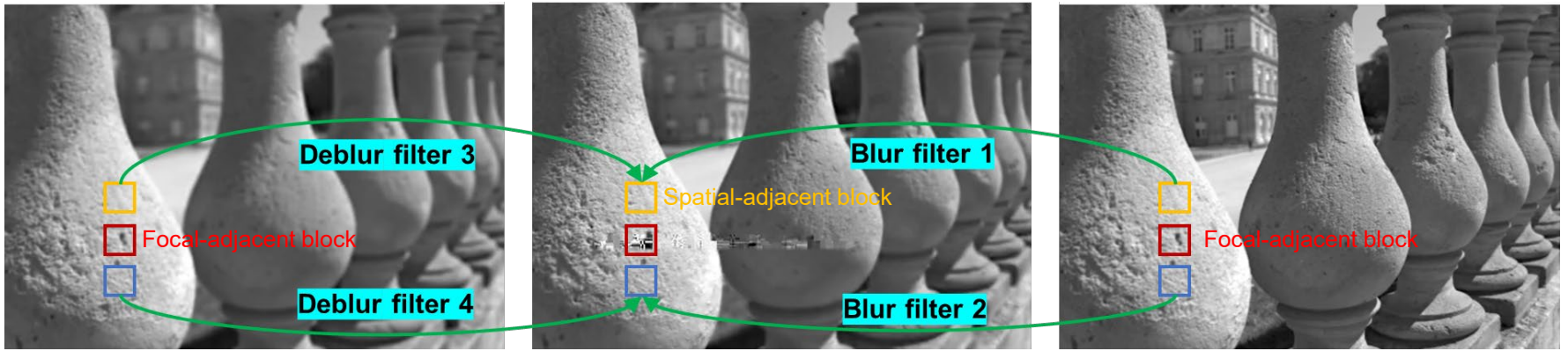
Example of focal stack video error

# Method

- Basic idea: spatial-adjacent & focal-adjacent assisted error concealment

Orange & Blue block: Spatial-adjacent block

Red block: Target error block and its co-located block (focal-adjacent)




Frame from previous GOP

Frame from error GOP

Frame from later GOP

Among spatial-adjacent frames and focal-adjacent frames, we simulate the frame regional changes by using bi-directional prediction (blurring and deblurring)

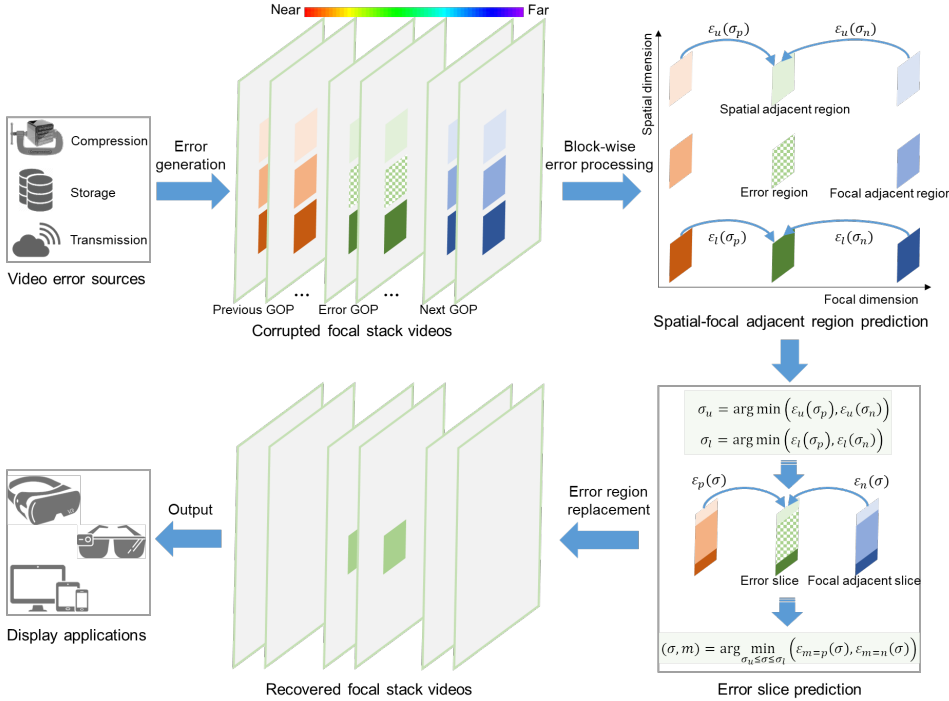
# Method

- Flowchart of the proposed focal stack video error concealment

- Recovering error regions by using the information from spatial-adjacent & focal-adjacent frames

- Simulating the frame regional changes by using bi-directional prediction (blurring & deblurring processing)

- Selecting the optimal prediction mode and parameters by solving optimization problem (minimizing the prediction cost).

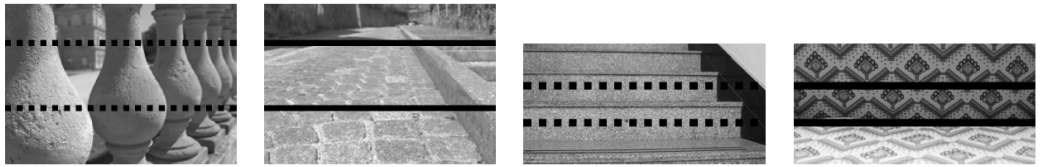


# Experiment

- Experiment settings: 4 videos, 15 frames, 2 resolutions

Table 1: Details of test sequences and error distribution types

| Scene | I01 | I02 | I03 | | I04 | |
|---|---|---|---|---|---|---|
| Scene type | realistic | | synthesized | | | |
| Frame number | 15 | | 15 | | | |
| Resolution | 624x432 | | 1024x512 | | | |
| Error types | block 16 | slice 16 | block 16 | block 32 | slice 16 | slice 32 |
| abbreviation | blk-16 | slc-16 | blk-16 | blk-32 | slc-16 | slc-32 |



(a) I01-blk-16 (b) I02-slc-16 (c) I03-blk-32 (d) I04-slc-32

Figure 3: Thumbnails of Y-component of all test sequences and some examples of error distributions.

# Experiment

- Objective performance: PSNR and SSIM

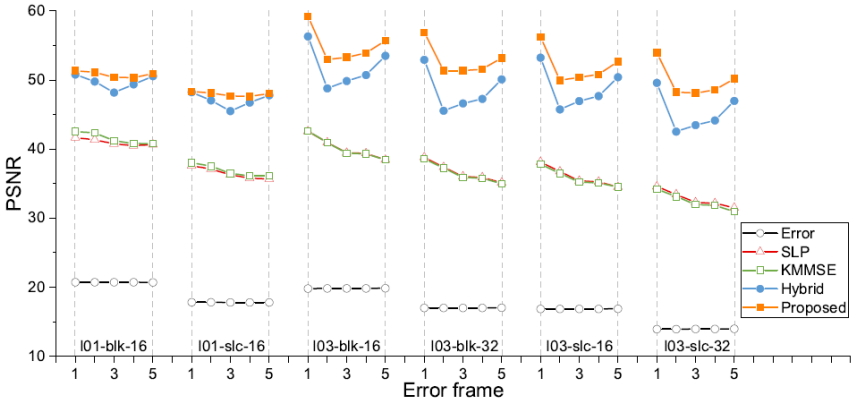
Our proposed scheme is compared with existing methods, achieving the highest PSNR and SSIM.

Table 2: Objective quality comparisons among all the sequences, all error types and all error concealment methods. The average PSNR and SSIM of all five error frames are calculated and presented.

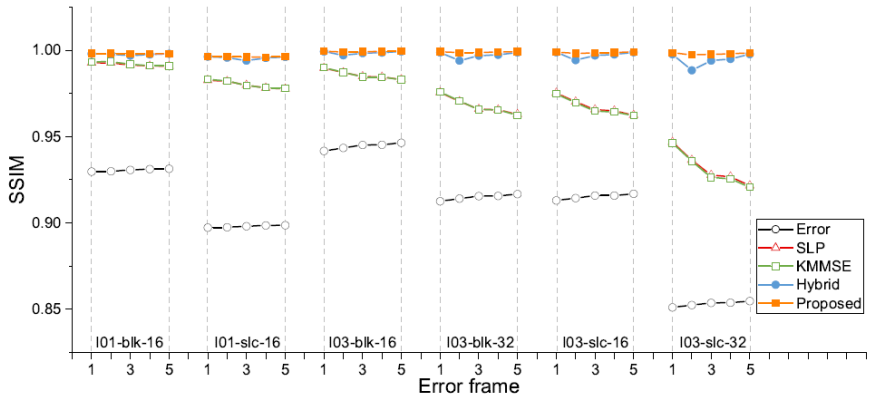
| Scene | Type | Error | | Hybrid | | SLP | | KMMSE | | Proposed | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PSNR | SSIM | PSNR | SSIM | PSNR | SSIM | PSNR | SSIM | PSNR | SSIM |
| I01 | blk-16 | 20.73 | 0.9306 | 49.73 | 0.9978 | 40.98 | 0.9919 | 41.54 | 0.9923 | 50.83 | 0.9982 |
| | slc-16 | 17.82 | 0.8980 | 47.05 | 0.9957 | 36.49 | 0.9802 | 36.86 | 0.9804 | 47.97 | 0.9964 |
| I02 | blk-16 | 18.24 | 0.9270 | 48.26 | 0.9963 | 41.58 | 0.9892 | 41.90 | 0.9897 | 49.42 | 0.9968 |
| | slc-16 | 15.32 | 0.8942 | 45.30 | 0.9928 | 32.90 | 0.9672 | 32.60 | 0.9656 | 46.43 | 0.9936 |
| I03 | blk16 | 19.84 | 0.9445 | 51.83 | 0.9987 | 40.16 | 0.9860 | 40.15 | 0.9860 | **55.02** | **0.9994** |
| | slc-16 | 16.87 | 0.9152 | 48.80 | 0.9975 | 36.01 | 0.9678 | 35.83 | 0.9672 | 52.01 | 0.9989 |
| | blk-32 | 17.01 | 0.9150 | 48.49 | 0.9973 | 36.65 | 0.9682 | 36.51 | 0.9681 | 52.88 | 0.9991 |
| | slc-32 | 13.96 | 0.8531 | 45.35 | 0.9947 | 32.79 | 0.9319 | 32.43 | 0.9310 | 49.81 | 0.9982 |
| I04 | blk-16 | 22.36 | 0.9493 | 49.28 | 0.9987 | 39.20 | 0.9927 | 39.54 | 0.9931 | 53.30 | 0.9994 |
| | slc-16 | 19.33 | 0.9187 | 46.30 | 0.9975 | 29.98 | 0.9630 | 29.98 | 0.9643 | 50.29 | 0.9988 |
| | blk-32 | 18.49 | 0.9176 | 46.08 | 0.9976 | 32.54 | 0.9735 | 33.04 | 0.9765 | 51.18 | 0.9991 |
| | slc-32 | 15.45 | 0.8549 | 42.91 | 0.9954 | 24.84 | 0.9178 | 24.92 | 0.9205 | 48.04 | 0.9981 |

# Experiment

- Objective performance: PSNR and SSIM visualization




(a) PSNR

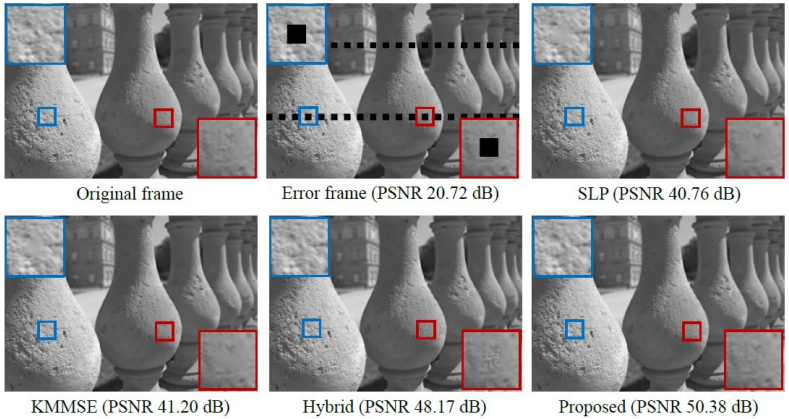



(b) SSIM

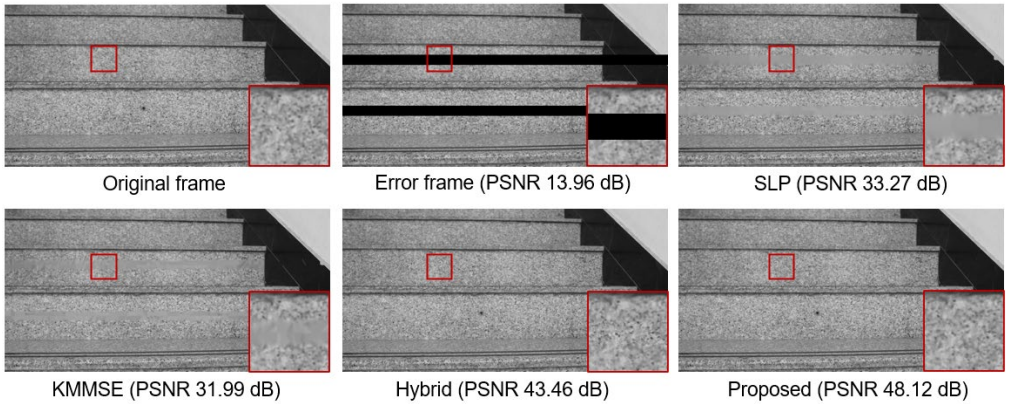
Visualization of objective quality comparison among all methods. The PSNR and SSIM curves of proposed scheme are the highest, showing the best PSNR and SSIM performance.

# Experiment

- Subjective performance




(a) I01 block error




(b) I03 slice error

The proposed scheme obtain the best subjective quality. The recovered error regions are consistency with adjacent regions in sharpness and textures, also have no block effect.

# Summary

- Proposed the error concealment method for focal stack video
- Making use of the information from both spatial-adjacent and focal-adjacent regions
- Simulating the focusing status bi-directionally changes by blurring and deblurring
- Achieving the best objective and subjective quality with sharpness consistency and without blocking effect
- Benefiting computational photography, 3D displays and Immersive multimedia

# Any comment

Please feel free to contact us
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