# On the Performance of Objective Metrics for Omnidirectional Visual Content

Upenik, Evgeniy, Martin Rerabek, and Touradj Ebrahimi. "On the performance of objective metrics for omnidirectional visual content." 9th International Conference on Quality of Multimedia Experience (QoMEX 2017). No. EPFL-CONF-227464. 2017.

# Introduction

- Conventional 2D objective metrics only are able to assess the quality of 360-degree videos under same projection model.

- Objective metrics for 360-degree content are proposed, such as V-PSNR, S-PSNR, Latitude weighted-PSNR, WS-PSNR and CPP-PSNR.

- However, the performance of these objective metrics is unknown.

# Goal

- To assess the performance of objective metrics designed for 360-degree content against subjective metric, namely mean opinion score.
- Additionally, a comparison to the performance of conventional 2D objective metrics has been carried out.

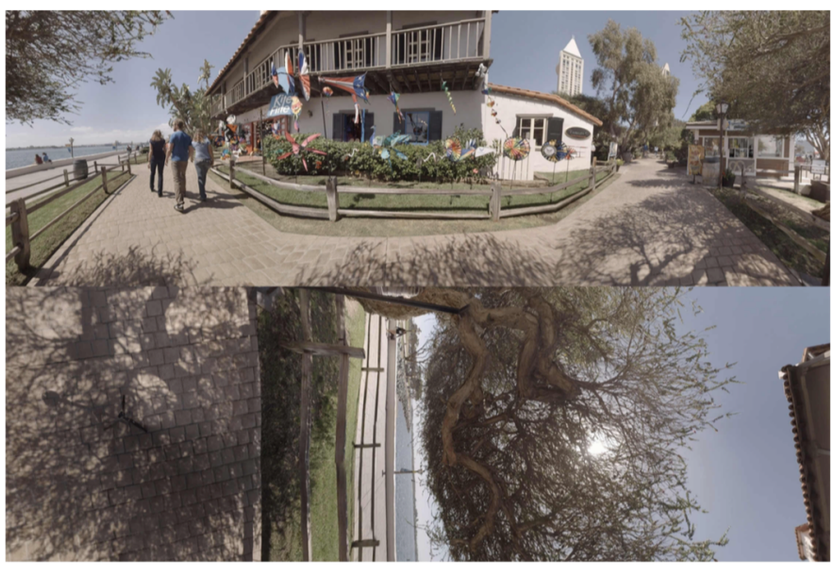
# Dataset

- 4 uncompressed equirectangular images represented in YUV color-space format with 4:2:0 chroma sub-sampling

- down-sample the images to 3000x1500 pixels and then map to cubic projection

- both equirectangular and cubic images are compressed with 3 codecs, namely JPEG JPEG 2000 and HEVC

- 4 target bitrates, 0.25 0.50 0.75 1.00 bits per pixel



# Testbed

- Google Cardboard HMD equipped with mobile platform (iPhone 6)
- Software application developed with Swift

# Experiment

- 25 males, 15 females, 40 subjects in total
- testing images are presented to subjects and voting is performed after each viewing
- images are assessed using ACR-HR method with five-grade quality scale (1-Bad to 5-Excellent)

# Subjective Results

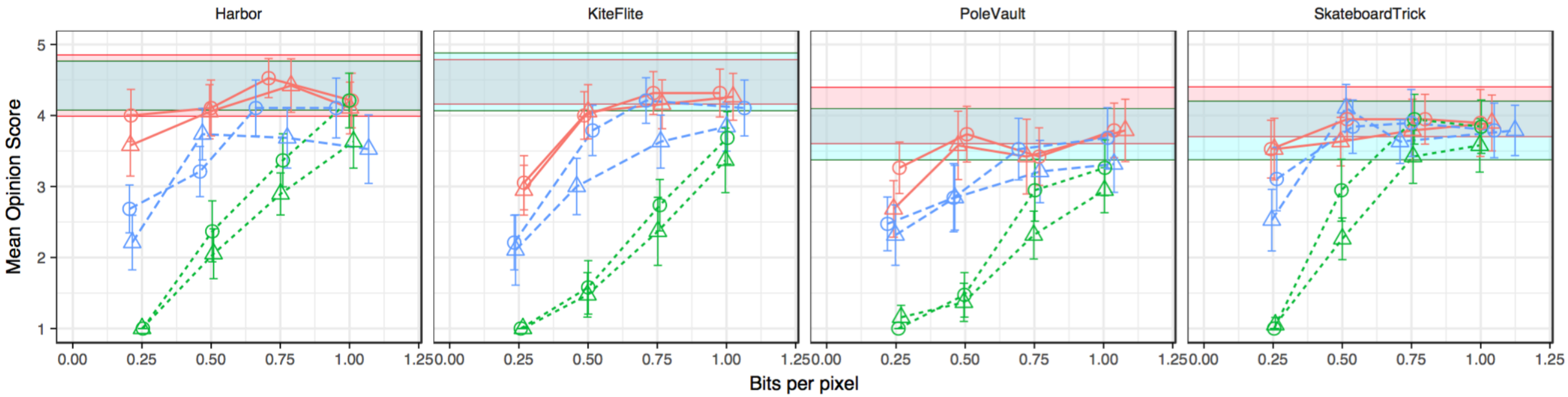



Fig. 3: MOSs with CIs obtained using ACR-HR method for compressed omnidirectional images. Red (solid) line represents HEVC encoded content, blue (long-dashed) - JPEG 2000, and green (short-dashed) - JPEG. Equirectangular projection is depicted with circles and cubic mapping - with triangles. Filled area between two horizontal lines corresponds to the 95% confidence interval of the hidden reference for each projection (red for equirectangular, cyan for cubic).

- Higher performance of HEVC and JPEG 2000 when compared to JPEG at lower bitrates
- Lower scores for cubic mapping at medium bitrates and same scores as for equirectangular mapping at high and low bitrates

# Objective Evaluation

- Conventional 2D objective metrics:
  - PSNR
  - SSIM
  - MS-SSIM
  - Visual Information Fidelity in pixel domain (VIFp)
- Objective metrics designed for 360-degree visual content
  - Spherical PSNR (S-PSNR)
  - Weighted S-PSNR (only for Equirectangular)
  - CPP-PSNR (CPP is equal area projection)

# Results

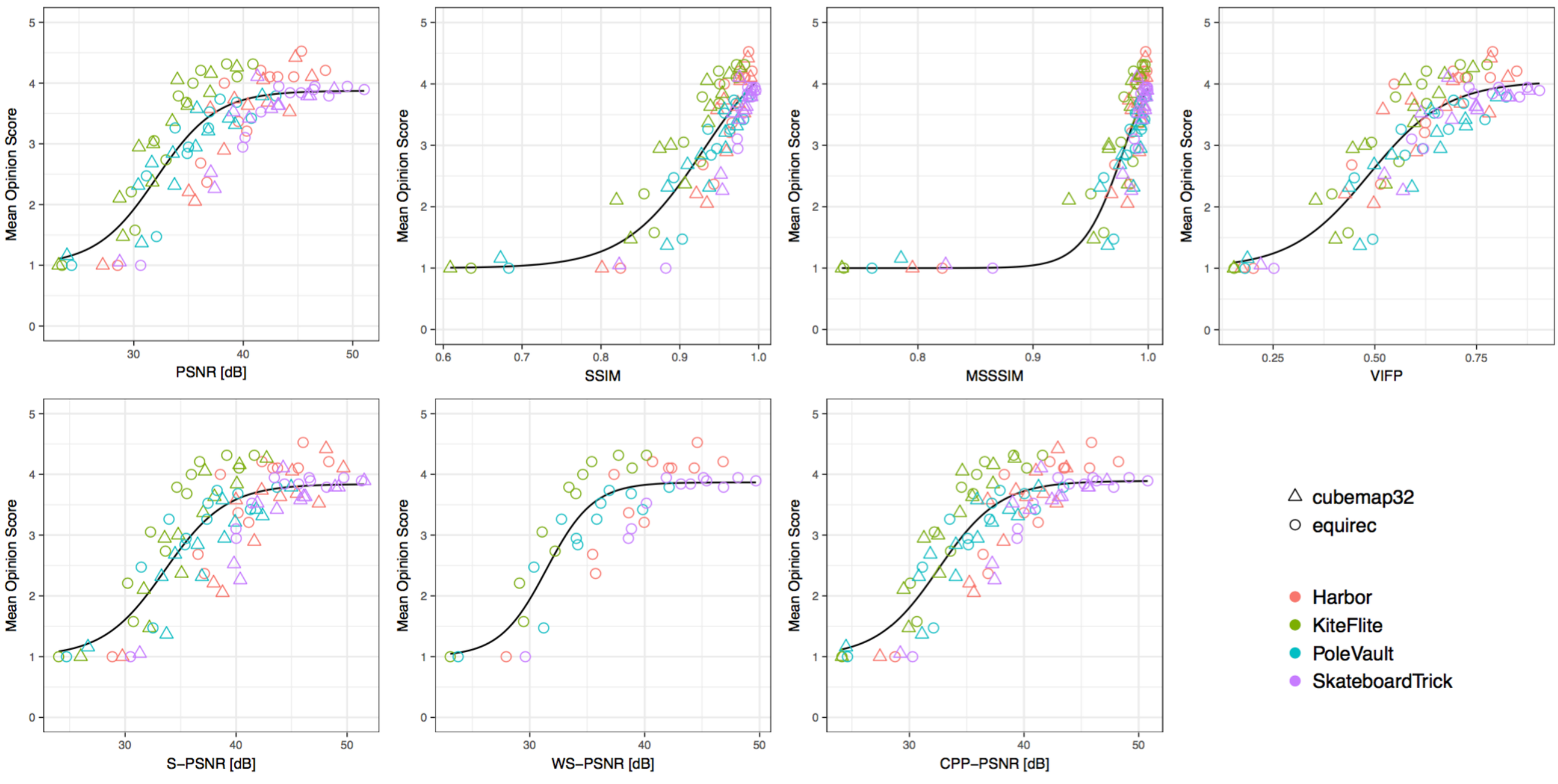



Fig. 4: Mapping of objective scores to subjective ratings. Triangles represent cubic projection, circles represent equirectangular projection. Different contents are marked with colors: ”Harbor” - red, ”Kite Flite” - green, ”Pole Vault” - cyan, ”Skateboard Trick” - magenta. Solid black line depicts a logistic fitting.

# Results

*A* - for equirectangular projection, on all the contents,
*B* - for cubic projection, on all the contents,
*C* - for both projections, on all the contents,
*D* - for both projections, each content separately.

TABLE III: Standard performance indexes. Subcolumns A, B, and C, represent the results for equirectangular, cubic, and both projections computed over all the contents, respectively. Subcolumn D shows an average of coefficients computed for each content separately.

| Metric | PLCC | | | | SROCC | | | | RMSE | | | | OR | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *A* | *B* | *C* | *D* | *A* | *B* | *C* | *D* | *A* | *B* | *C* | *D* | *A* | *B* | *C* | *D* |
| PSNR | 0.8714 | 0.8437 | 0.8553 | 0.9487 | 0.7176 | 0.7731 | 0.7567 | **0.8909** | 0.4804 | 0.5103 | 0.5008 | 0.2929 | 0.4375 | 0.4375 | 0.4167 | **0.2396** |
| SSIM | 0.8898 | 0.8632 | 0.8740 | 0.9459 | 0.7365 | 0.7927 | 0.7709 | 0.8821 | 0.4464 | 0.4790 | 0.4689 | 0.3050 | **0.3958** | 0.4583 | 0.4167 | 0.2812 |
| MSSSIM | 0.9059 | 0.8661 | 0.8860 | 0.9123 | 0.7539 | 0.7796 | 0.7814 | 0.8394 | 0.4143 | 0.4755 | 0.4483 | 0.3887 | 0.4583 | 0.4167 | 0.4271 | 0.3229 |
| VIFP | **0.9116** | **0.8875** | **0.8994** | 0.9319 | **0.7608** | **0.8029** | **0.7953** | 0.8538 | **0.4025** | **0.4374** | **0.4221** | 0.3395 | **0.3958** | **0.3958** | 0.4167 | 0.3125 |
| S-PSNR | 0.8766 | 0.8482 | 0.8392 | 0.9168 | 0.7376 | 0.7836 | 0.7307 | 0.8214 | 0.4715 | 0.5035 | 0.5257 | 0.3705 | 0.4583 | 0.4375 | 0.4271 | 0.3021 |
| WS-PSNR | 0.8748 | - | - | **0.9583** | 0.7297 | - | - | 0.8648 | 0.4746 | - | - | **0.2544** | 0.4375 | - | - | 0.2500 |
| CPP-PSNR | 0.8800 | 0.8521 | 0.8658 | 0.9467 | 0.7403 | 0.7745 | 0.7697 | 0.8843 | 0.4654 | 0.4975 | 0.4838 | 0.2966 | 0.4375 | 0.4167 | **0.4062** | 0.2500 |

- Overall, objective metrics designed specifically for omnidirectional visual content do not show better performance when compared to common objective quality evaluation measures.

# Conclusions

- In this paper, they conduct a subjective evaluation experiment on 360-degree images.
- Analysis of the obtained subjective and objective scores indicates moderate performance of investigated metrics for 360-degree visual content.