Towards High Resolution Image and Video Quality Assessment in the Crowd

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Motivation

- Lab studies → time-consuming and expensive
- Non-feasibility of lab studies due to external factors, e.g. COVID-19
- Need for large groundtruth for video quality model development
- Applicability of crowdsourcing studies for quality assessment
  - Focus: high-resolution images/videos **UHD-1/4K**
  - Adaptation of the test design
  - Comparison with lab test required

Proposed Approach

- Challenges
  - Lack of control on the appropriate hardware for seamless playout and display device
  - Varying test environment (lighting, viewing distance): not handled in this study
- Potential solutions
  - Displaying the crop of the most salient regions in a scene
  - Alternatives to playing out lossless versions of videos, e.g.: choose a transcoding setting that doesn't affect the visual quality of the encoded video
- Proposed approach
  - Images: use different patches
  - Videos
    - Display a **pre-defined center crop** of losslessly upscaled videos (AVPVS) → to handle varying display devices in crowdsourcing context (c.f. [1])
    - Encode the pre-defined center crop of AVPVS using H.264 with a pre-defined CRF → handle lack of appropriate playout hardware

High-Resolution Image Quality Assessment

Dataset – Overview

- Source images: 39 UHD-1/4K frames extracted from UHD-1/4K videos cropped to 2160 × 2160, different genres
- Encoding: 1-pass HEVC CRF encoding (HEVC chosen as it outperforms JPEG)
- Processed images: 371 images encoded with H.265
- Test methodology: ACR (*ITU-T* 2014)
- # Participants in lab test: 21

Crowdsourcing Test

- 2160×2160 image sampled into 4 1080×1080
- Test duration: ≈15 minutes
- Pre-test questionnaire
  - Age range; self-judged visual acuity on an ACR-scale
  - Device type used in test (Phone, Tablet, Laptop, Desktop)
  - Test environment ("Alone in a quiet room", "Some noise and distractions" and "Significant noise and distractions")
- Each participant rated 150 randomly selected patches out of 1484 patches
- No training phase

Crowdsourcing Test Results

- Most participants: environment with “less distractions”
- Majority subjects: age range: 18 – 39 years
- # Participants: 238 (recruited via university mailing lists)
- Average ratings per patch: 17

Lab vs. Crowd Test Comparison (1)

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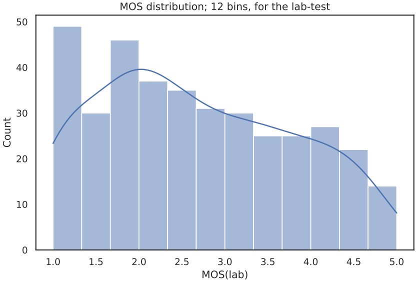
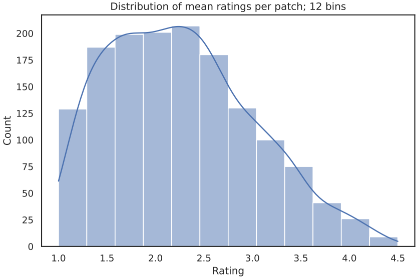
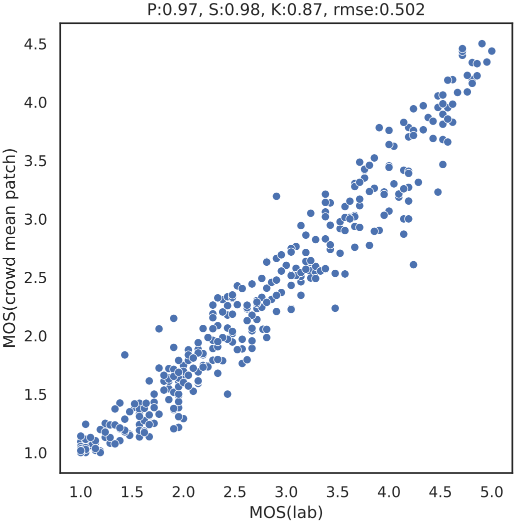

MOS distribution; 12 bins, for the lab-test


Distribution of mean ratings per patch; 12 bins

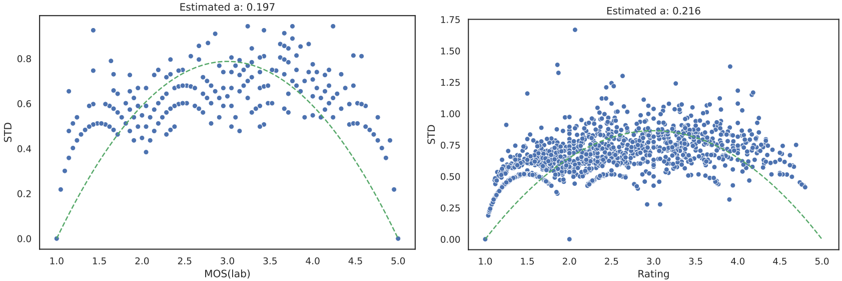
- Participants in crowd test more critical

Lab vs. Crowd Test Comparison (2)



- Correlation: lab and crowd tests: 0.97

Lab vs. Crowd Test Comparison (3)



- SOS analysis: $a_{lab} = 0.197$ and $a_{crowd} = 0.216$

Short-term Video Quality Assessment

Dataset – Overview

test_1 of AVT-VQDB-UHD-1 (*Rao et al.* 2019)

- 540p center crop
- Lab test for comparison
  - Source videos: 6 different videos; each: 10 s ; 3840 × 2160; 60 fps
  - Codecs used: H.264, H.265, VP9
  - Encoding resolutions: 360p to 2160p
- Total number of processed video sequences (PVS): 180
- Participants in lab test: 29
- Outliers in lab test: 0 (Pearson correlation (PCC) $>$ 0.75)

Crowdsourcing Platform and Subject Recruitment

- Used tool: AVrateVoyager[1]
- Subject recruitment
  - $>$ 90% of subjects recruited from university body (staff+students) via email lists
  - Remaining participants from people known to authors

[1] `https://github.com/Telecommunication-Telemedia-Assessment/AVrateVoyager`

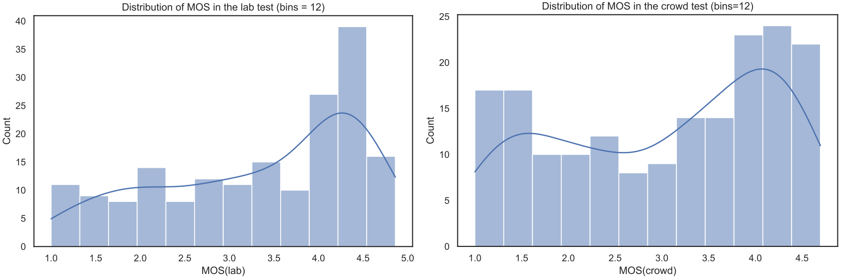
Test Procedure

- Test duration: $\approx$15 minutes
- Pre-test questionnaire
  - Age range; self-judged visual acuity on an ACR-scale
  - Device type used in test (Phone, Tablet, Laptop, Desktop)
  - Test environment (“Alone in a quiet room”, “Some noise and distractions” and “Significant noise and distractions”)
- Checks
  - Minimum device resolution: $720p$
- Each participant rated 30 PVSs randomly selected out of the 180 PVSs
- No training phase

Crowdsourcing Test Results

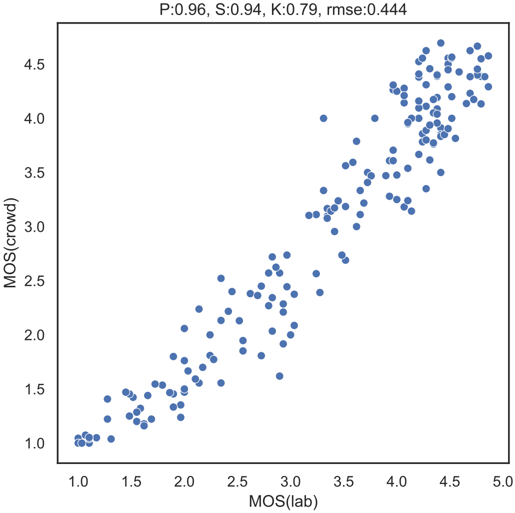
- Most participants: environment with “less distractions”
- Majority subjects: age range: 18 – 39 years
- ≈ 18% of subjects: device with a resolution of full-HD or higher
- # Participants: 175
- Outliers: 19 (PCC > 0.75 as used in lab test)
- Average ratings per PVS: 22.15

Lab vs. Crowd Test Comparison (1)



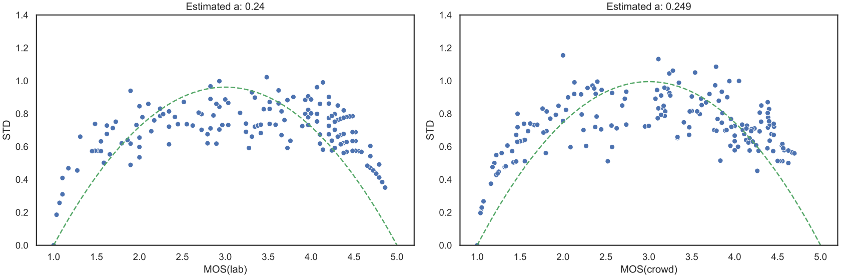
- Participants in crowd test more critical

Lab vs. Crowd Test Comparison (2)



- Correlation: lab and crowd tests: 0.96

Lab vs. Crowd Test Comparison (3)



- SOS analysis: $a_{lab} = 0.240$ and $a_{crowd} = 0.249$

Overall Integral Quality Assessment

Dataset – Overview

test_2 of PNATS-UHD-1-Long (*Ramachandra Rao et al.* 2023)

- $720p$ center crop used
- Lab test for comparison
  - Source videos: 30 different videos; each: 2 min ; 3840×2160
  - Codecs used: H.264, H.265, VP9
  - Encoding resolutions: $360p$ to $2160p$
  - Other impairments: initial buffering, stalling, quality switching
- Total number of processed video sequences (PVS): 30
- # Participants in lab test: 31
- Outliers in lab test: 0 (Pearson correlation (PCC) > 0.75)

Test Procedure

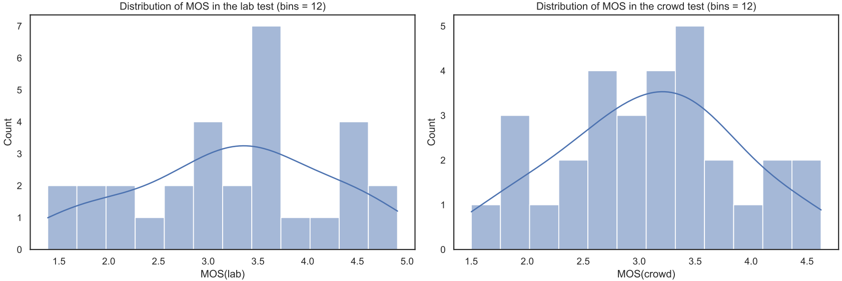
- Used tool: AVrateVoyager[2]
- Test duration: ≈15 minutes
- Pre-test questionnaire + checks: same as short-term video quality test
- Training phase: 1 video *rightarrow* showcasing all impairments
- Test phase: 5 PVSs randomly selected out of the 30 PVSs

[2] `https://github.com/Telecommunication-Telemedia-Assessment/AVrateVoyager`

Crowdsourcing Test Results

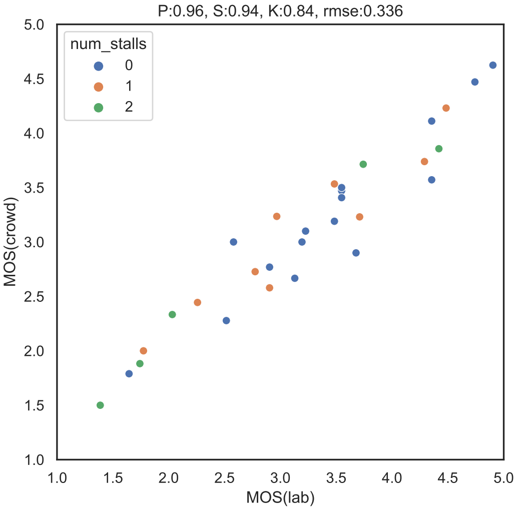
- Participant recruitment via clickworkers
- # Participants: 100
- Most participants: environment with “less distractions”
- $<$ 10% of subjects: device with a resolution of full-HD or higher
- Average ratings per PVS: 17.2

Lab vs. Crowd Test Comparison (1)



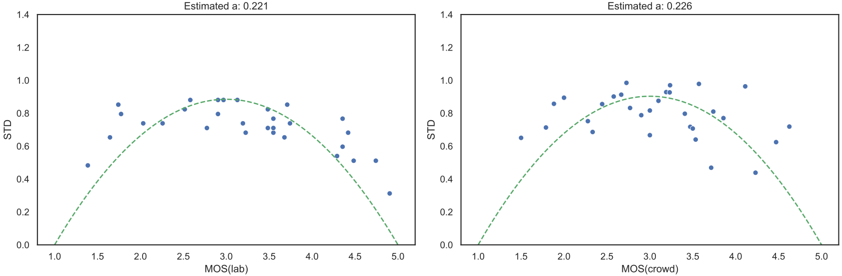
- Participants in crowd test more critical

Lab vs. Crowd Test Comparison (2)



- Correlation: lab and crowd tests: 0.96

Lab vs. Crowd Test Comparison (3)



- SOS analysis [3]: $a_{lab} = 0.221$ and $a_{crowd} = 0.226$

Conclusion

- Proposed method to assess quality of high-resolution images and videos in crowd
- Results show good correlation between lab and crowd tests
  - High PCC; similar SOS parameter values
  - Data publicly available

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[2] T. Hoßfeld et al. “Best Practices for QoE Crowdtesting: QoE Assessment With Crowdsourcing”. In: *IEEE Transactions on Multimedia* 16.2 (2014), pp. 541–558.

[3] T. Hoßfeld et al. “SOS: The MOS is not enough!” In: *2011 third international workshop on quality of multimedia experience*. IEEE. 2011, pp. 131–136.

[4] V. Hosu et al. “KonIQ-10k: An Ecologically Valid Database for Deep Learning of Blind Image Quality Assessment”. In: *IEEE Transactions on Image Processing* 29 (2020).

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[9] R. R. Ramachandra Rao et al. “PNATS-UHD-1-Long: An Open Video Quality Dataset for Long Sequences for HTTP-based Adaptive Streaming QoE Assessment”. In: *2023 15th International Conference on Quality of Multimedia Experience (QoMEX)*. 2023, pp. 252–257.

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[13] Z. Sinno et al. “Large-Scale Study of Perceptual Video Quality”. In: *IEEE Transactions on Image Processing* (2019).

[14] M. Uhrina et al. “QoE on H.264 and H.265: Crowdsourcing versus Laboratory Testing”. In: *2020 30th International Conference Radioelektronika (RADIOELEKTRONIKA)*. 2020, pp. 1–6.

Thank you for your attention

...... are there any questions?

Back-up

Crowdsourcing for Video Quality Assessment – Overview

- Best practices for crowdsourcing QoE testing (*Hoßfeld et al.* [2])
- Crowdsourcing as a viable alternative for perceptual assessment of image, video and audiovisual content (*Hosu et al.* [4], *Hosu et al.* [5], *Sinno et al.* [13])
- *Keimel et al.* [7], *Ribeiro et al.* [11]: Different crowdsourcing platforms
- *Shahid et al.* [12], *Rainer et al.* [8]: Crowdsourcing in HTTP-based adaptive streaming (HAS) context
- *Uhrina et al.* [14]: Investigation of feasibility of unpaid
  crowdsourcing approach as an alternative for lab-based tests;
  reports a correlation of > 0.92 between lab and “crowd” tests