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VQEG

Benchmarking Virtual Reality Video Quality Assessement

VQEG Imersive Media Group (IMG)

Wuhan University

Zhenzhong Chen, Yingxue Zhang

zzchen@whu.edu.cn
grace@whu.edu.cn

We establish a **subjective video quality database** for **virtual reality**. Panoramic videos with different levels of **compression impairments** are viewed and rated through VR HMD by non-expert subjects. We believe that the database can facilitate related applications.

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CONTENTS

1 Subjective Quality Assessment Test

Sequences

Test design

Rating data processing and analysis

Sequences

- Coding impairments to generate test sequences:
  - HM-16.14 with 360-Lib
  - 5 QP values, i. e., 22, 27, 32, 37, 42
- 60 sequences are generated from the 10 references
  - 6 for training, 3 for stabilizing, 48 for testing.

Sequences from [J. Boyce, E. Alshina, A. Abbas, Y. Ye, "JVET common test conditions and evaluation procedures for 360° video", Joint Video Exploration Team of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, JVET-D1030, 4th Meeting, Oct. 2016.]

Example of Original sequence (AerialCity 3840*1920 30fps 8bit erp)

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Example of Compressed sequence with QP32

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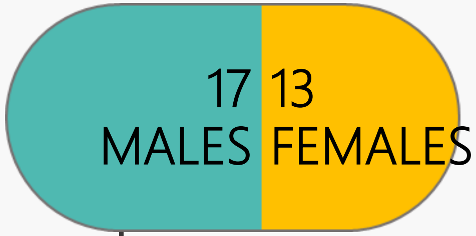
Example of Compressed sequence with QP42

Test Design

Subjects, devices and assessment procedure

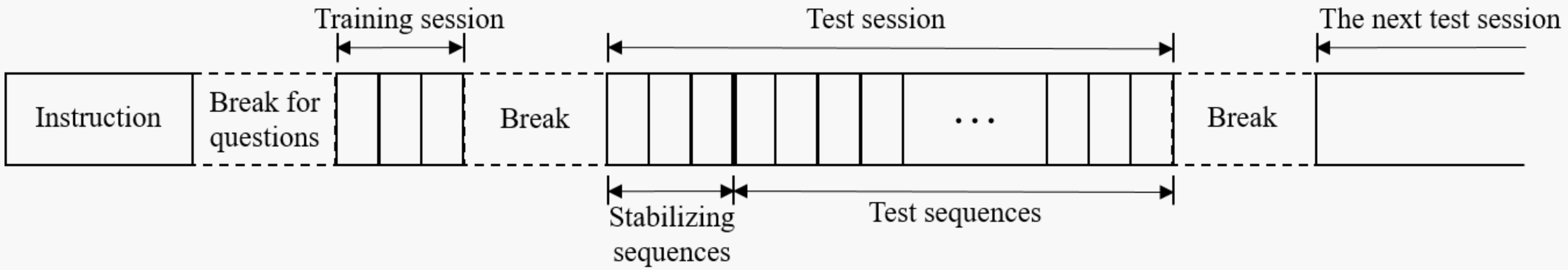
- Subject: 30



- Non-expert
- undergraduate and graduate students
- Normal or corrected-to-normal visual acuity

- Devices: HTC VIVE

The entire assessment procedure is completed with the HMD on.



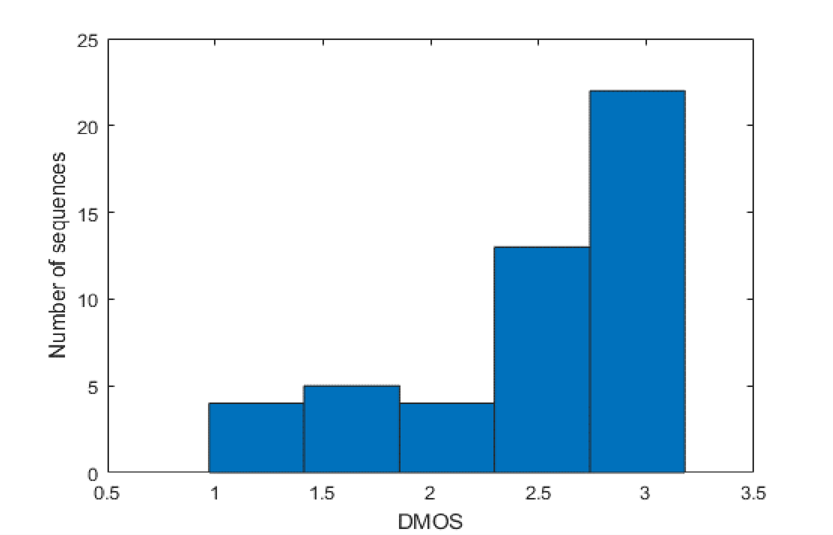
- Length of each break: 10 ~20 minutes
- Length of each sequence: 10 seconds
- Length of each session: no more than 10 minutes

view all directions freely

Rating Data Processing and Analysis

Subject reliability

- As specified in [ITU-R BT. 500], A subject will be discarded if more than a specific percentage of his/her rating scores are out of the expected normal range.
- The ratings of 3 subjects are discarded by the post-experiment screening process setting the percentage to 5%.



Histogram of the DMOS uniformly spaced in 5 bins between the minimal and maximal values.

DMOS calculation

DMOS lies in the range [0.9, 3.2], corresponding to mean Z-score range of [-1.92, 0.84], which covers approximately 77% of the area of standard normal distribution and thus is considered to be a reasonable distribution of the subjective scores.

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2 Performance Evaluation of Objective Quality Assessment Models

State-of-the-art objective models

Correlation analysis

Statistical Evaluation

State-of-the-art Objective Models

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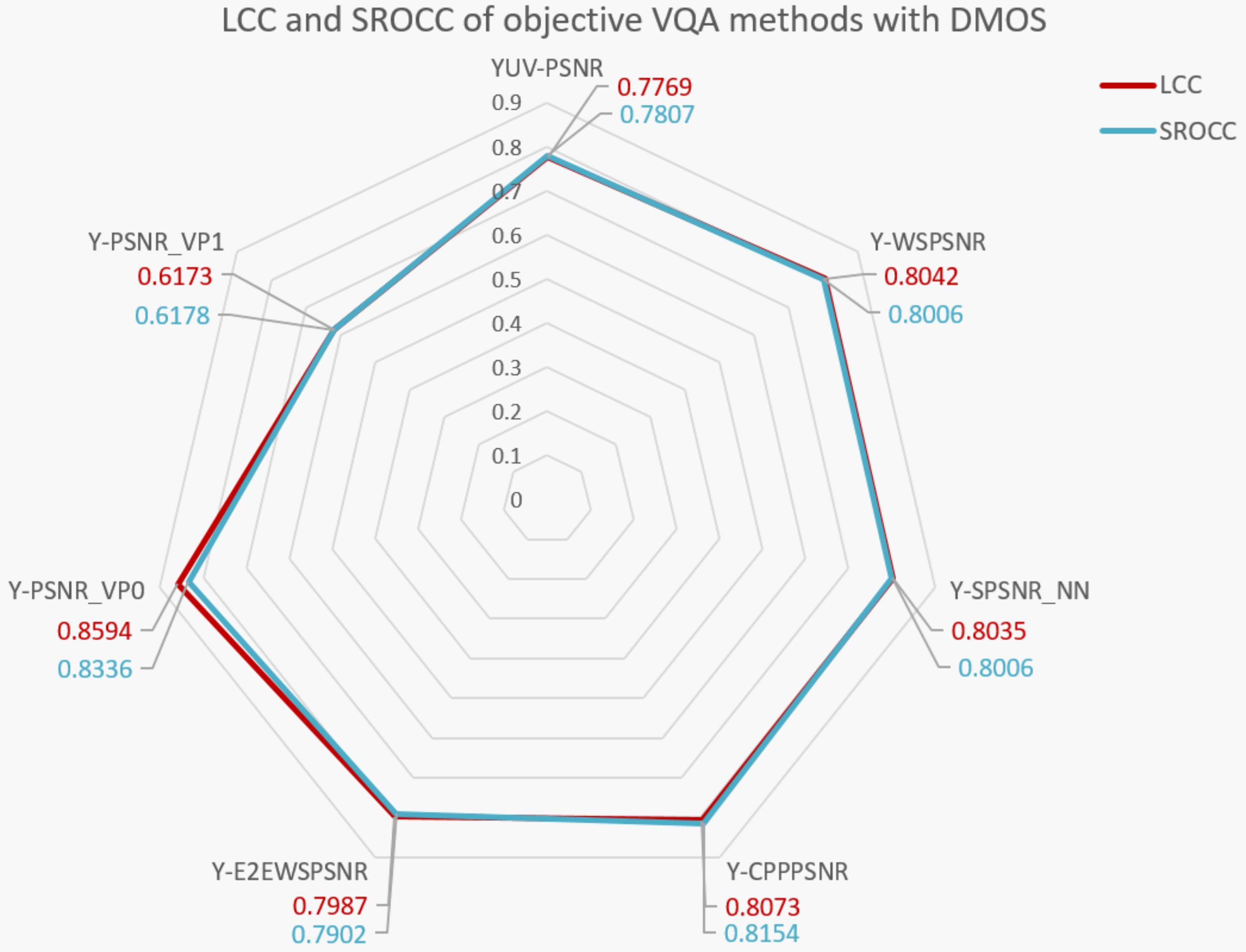
Objective model	Description
PSNR	Peak Signal-to-Noise Ratio. Calculates PSNR based on all samples with equal weight.
WS-PSNR	Weighted to Spherically uniform PSNR. Calculates PSNR based on all samples with a weighted parameter, depending on the sample area on the spherical surface.
S-PSNR-NN	Spherical PSNR without interpolation. Calculates PSNR based on a point set evenly sampled on the sphere surface, whose value is taken from the nearest neighbor integer sample positions to avoid the impact due to interpolation filters.
CPP-PSNR	PSNR for Carster Parabolic Projection. Compares quality across different projection methods using Carster Parabolic Projection format.
E2E-WSPSNR	End to End WS-PSNR. Proposes end to end assessment for comparing compression performance of different projection.
PSNR-VP0 and PSNR-VP1	Calculates PSNR on 2D displays with the two viewports (VPs) rendered from the decoded bit stream with predefined parameters.

Y. Sun, A. Lu, and L. Yu, "AHG8: WS-PSNR for 360 video objective quality evaluation," Joint Video Exploration Team (JVET) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 2016.
J. Boyce, E. Alshina, A. Abbas, and Y. Ye, "JVET common test conditions and evaluation procedures for 360◦ video," Joint Video Exploration Team (JVET) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 2017.
V. Zakharchenko, E. Alshina, K. P. Choi, A. Singh, and A. Dsouza, "AHG8: Suggested testing procedure for 360-degree video," Joint Video Exploration Team (JVET) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 2016.
Hendry, M. Coban, G. V. der Auwera, and M. Karczewicz, "AHG8: On 360 video quality evaluation," Joint Video Exploration Team (JVET) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 2017.
A. Abbas, "AHG8: Viewport Recommendations for CTC Content," Joint Video Exploration Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11, JVET-D0195, 2016

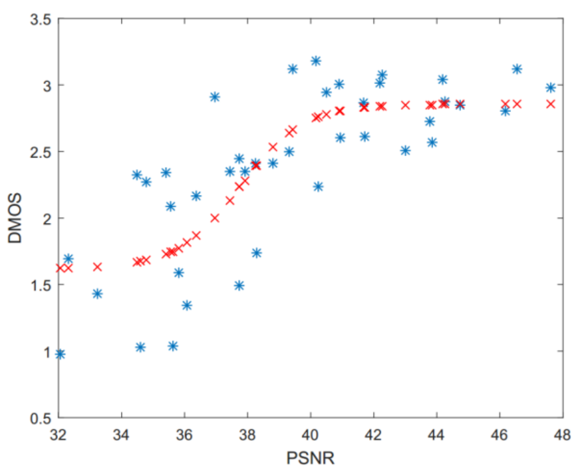
Correlation Analysis

Algorithm	LCC	SROCC
PSNR	0.7769	0.7807
WS-PSNR	0.8042	0.8006
S-PSNR-NN	0.8035	0.8006
CPP-PSNR	0.8073	0.8154
E2E-WSPSNR	0.7987	0.7902
PSNR-VP0	**0.8594**	**0.8336**
PSNR-VP1	0.6173	0.6178

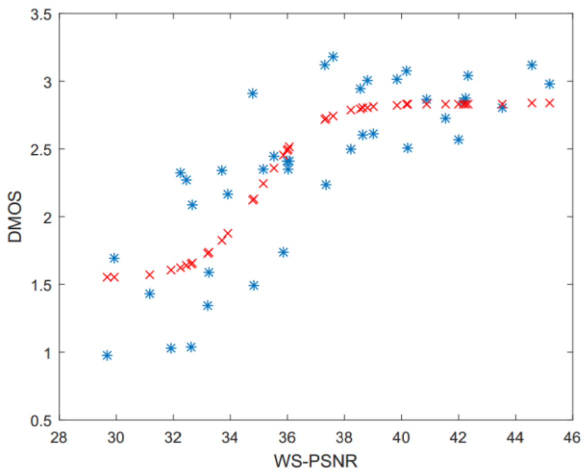


Correlation Analysis

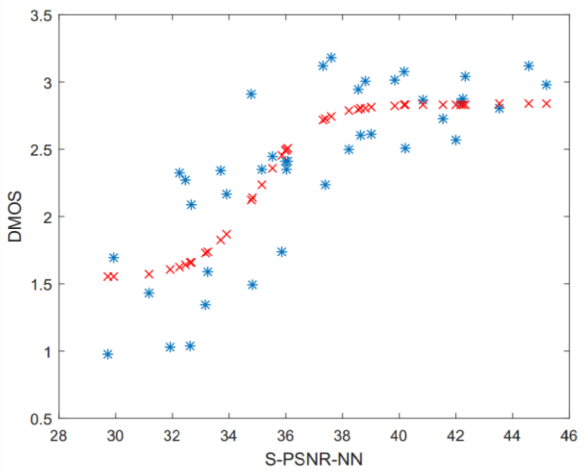
Fitting results



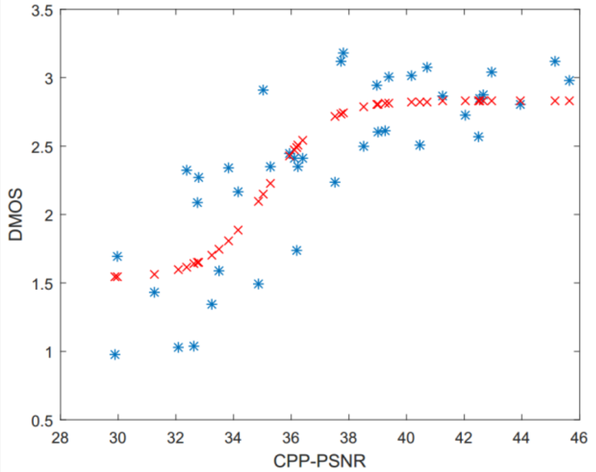
PSNR



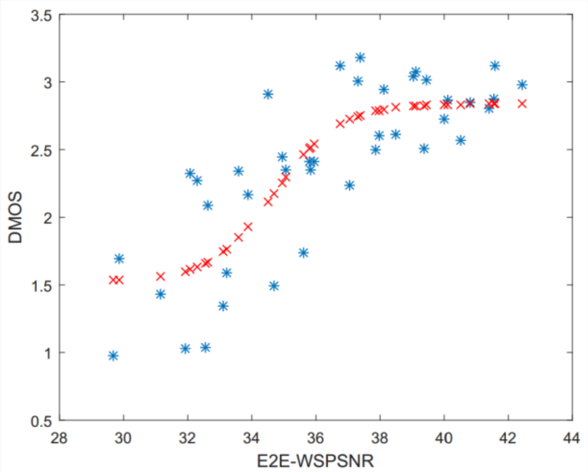
WS-PSNR



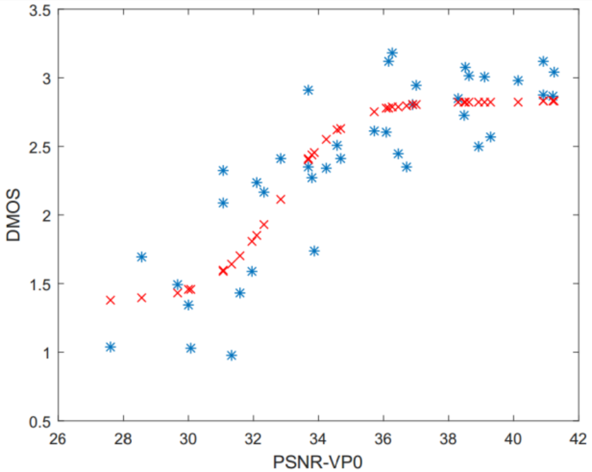
S-PSNR-NN



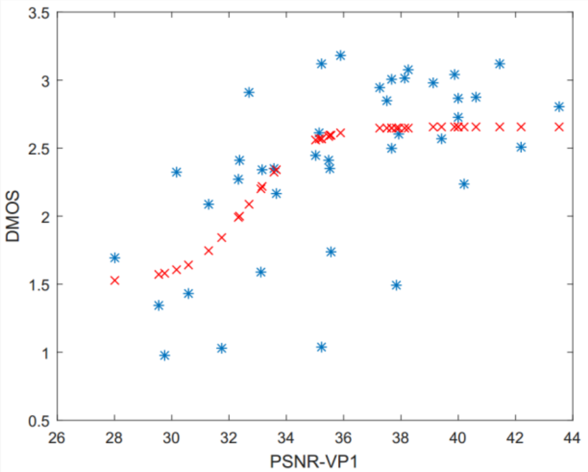
CPP-PSNR



E2E-WSPSNR



PSNR-VP0



PSNR-VP1

Statistical Evaluation

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Variance of the residual between the **objective model prediction** and **individual rating scores**

Prediction model	Variance
Null Model	0.3311
PSNR	0.4862
WS-PSNR	0.4693
S-PSNR-NN	0.4698
CPP-PSNR	0.4674
E2E-WSPSNR	0.4728
PSNR-VP0	0.4334
PSNR-VP1	0.5733
Number of samples	*1080*
Threshold F-ratio	*1.1054*

Variance of the residual error between **objective model prediction** and **DMOS**

Prediction model	Variance
PSNR	0.1590
WS-PSNR	0.1416
S-PSNR-NN	0.1421
CPP-PSNR	0.1396
E2E-WSPSNR	0.1451
PSNR-VP0	0.1048
PSNR-VP1	**0.2482**
Number of samples	*40*
Threshold F-ratio	*1.7045*

Conclusion

- A subjective quality database for panoramic videos is established through a compact subjective rating test.
- The performance of existing objective assessment models are evaluated with the database.
- The database can be promising in:
  1) Figuring out the observers’ psychophysical response to the VR contents.
  2) Providing reliable reference for evaluating and improving the performance of the objective assessment methods.
  3) Showing insight for further subjective test design.

Special Issue on Visual Information Processing for Virtual Reality

Journal of Visual Communication and Image Representation (JVCI)

This Special Issue invites researchers in all related fields (including but not limited to image and video signal processing, computer vision and pattern recognition, multimedia communications, human-computer interaction) to join us to share their latest innovations and experiences on all aspects of recently-developed techniques and new methods for VR and its related areas such as augmented reality (AR), mixed reality (MR), and 3D user interfaces. ALL submissions must highlight their approaches and discuss how their solutions deal with solution of Virtual Reality. The topics of interest of this Special Issue include but are not limited to:

Topics of Interest

- VR video compression, and streaming
- Video content analysis and mining
- Vision Analysis: Sync, tracking, detection
- Client-Cloud computing for immersive media
- Immersive media systems
- Multi-sensor data fusion
- Object modeling for VR/AR/MR
- Quality of Experience/Service for VR/AR/MR
- Security and privacy in VR/AR/MR
- 3D interaction for VR/AR/MR

Contact: Prof. Zhenzhong Chen, zzchen@whu.edu.cn

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- 1st. Round of Reviews Dec. 31, 2017
- Authors Revised Versions Feb. 28, 2018
- 2nd Round of Reviews April. 30, 2018
- Authors Revised Versions June 30, 2018
- Expected Publication Winter 2018

Guest Editors

- Prof. Zhenzhong Chen, Wuhan Univ., China
- Prof. Alexander Luoi, Kodak/Univ. Toronto, USA/Canada
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Thanks!
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