UNIVERSITÉ DE NANTES

NOKIA Bell Labs

UNIVERSITY OF SURREY

VQEG

Methodologies for subjective quality evaluation of short and long 360-degree videos

Jesús Gutiérrez, Pablo Pérez, Femi Adeyemi-Ejeye

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Outline

- Introduction / motivation
- Subjective evaluation of video quality: from 2D to immersive media
- What is short and long?
- Related work for short 360-degree videos
- Related work for long 360-degree videos

Introduction / Motivation

- Need of recommendations/standards for subjective quality assessment of 360-degree videos.
  - Work on defining test plan within VQEG-IMG
  - Contributions to ITU-T SG12/13 G.360-VR
- Some works have been already published using typical methodologies for 2D video.
- Importance of the duration of test content:
  - 10 seconds (e.g., MPEG) → too short?
  - Different factors to evaluate depending on duration? Immersion, sickness, etc.
  - Different methodologies for short and long sequences?
  - What is short and long?

Subjective evaluation of 2-Dimensional video quality

Standard	Full meaning	Stimuli Presentation	Questions / scales	Voting method
ACR	Absolute Category Rating	Single Stimulus	5-grade quality scale ("Bad – Excellent")	Absolute Values
ACR-HR	Absolute Category Rating with Hidden Reference		5-grade quality scale ("Bad – Excellent")	Absolute Values. Differential scores between reference and Impaired versions (DMOS)
SSCQE	Single Stimulus Continuous Quality Rating		Continuouse Scale over time, at certain intervals	Slider/Fader
DSCQS	Double Stimulus Continuous Quality Scale	Double Stimulus	Continuouse Scale over time, at certain intervals	Slider/Fader
DSIS	Double Stimulus Impairment Scale		5-grade scale ("Very Annoying – Imperceptible")	Absolute Values
PC	Pair Comparison		5-grade scale ("Very Annoying – Imperceptible") Preference	Absolute Values. Preference (transformation of values with e.g. BT-model)

Subjective evaluation of video quality

Immersive media adds more dimensions

2D

- Content Type
- Encoding
  - Target bitrate
  - Target resolution
  - Video Codec and Implementation
  - Encoding Parameters
- Display Resolution
- Network Impairments

VS

Immersive Media

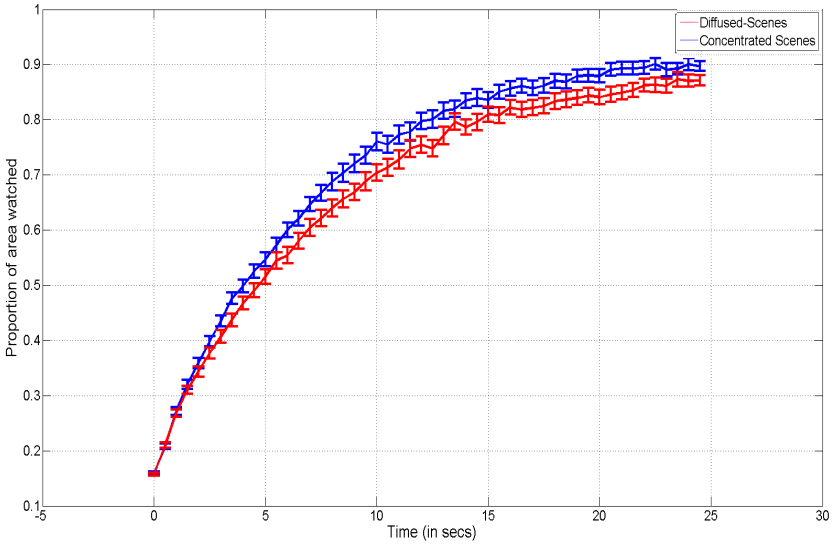
- Content Type
- Encoding
  - Target bitrate
  - Target resolution
  - Video Codec and Implementation
  - Encoding Parameters
- Display Resolution
- Network Impairments
- Immersion
- Presence
- Cyber sickness
- Exploration Behaviour
- Physiological responses
- Audio-Visual quality

What is short and long?
Stimuli duration

- No standard definition
- For 2D videos
  - In 2009, Interactive Advertising Bureau prescribed long sequences as those longer than 10 mins in length.
  - On Youtube, long sequences are those defined to be longer than 20 mins in length, while short sequences are less than 4 mins
  - SoA subjective tests: long sequences from 1 minute.
- For Immersive media
  - Makers of VR headsets recommend you take a break of 10-15mins after every 30 mins
  - What are the acceptable durations for Long and Short Sequences?

What is short and long?
How much time do observers need to explore 360º content?

- At least 20 seconds to explore images.



Rai et al. MMSys2017

- M. Huang *et al*. TIP2018: Testing different exploration times with images:
  - 10s: Too short
  - 20s: Time “to acclimate to a fixed virtual world”.
  - 40s: Too long for their setup. No improvement over 20s.
- Exploration of videos:
  - “Driven by contents” (F. Duanmu *et al.* ICME2018) → From “diffused scenes” (exploration like images) to “concentrated scenes” (limited exploration).
  - Limited movements (Singla et al. AhG82017).
  - Repeating the clips “does not necessarily lead to more unique fixation points” (Ozcinar et al. QoMEX2018)

Related work for **short** 360-degree videos
Introduction

- Some works published on quality evaluation of 360-degree short videos:
  - Short videos: typically used to develop and evaluate the performance of coding techniques.
    - Videos currently used in MPEG: 10 seconds
  - Mainly only evaluation of audiovisual quality
  - Use of typical methodologies for 2D video: ACR, DSIS, etc.

- Issues with evaluating short sequences:
  - Limited immersiveness/interest of the observer on/for the content (even in 2D videos).
  - Videos too short to be explored by the observer?
    - Need of new methodologies? → Modified ACR (Singla et al., ACMMM2017)

Related work for **short** 360-degree videos
Relevant references

Paper	Objective	Presentation Methodology	Questions / scales	Stimuli duration	Num. Observers	HMD	Voting interface
Singla et al., ACMMM2017	Coding quality	Modified-ACR	5-grade quality scale	10 s.	30	Oculus Rift	Scale shown on HMD, rating recorded verbally
Singla et al., HVEI2018	Compare M-ACR and DSIS	M-ACR DSIS	5-grade quality scale	10 s.	30 / 27		
Xu et al. arXiv2017	Coding quality	ACR	Continuous scale 0-100	12 s.	48	HTC Vive	Slider
Zhang et al., ICMEW2017	Coding quality	SSCQS SAMVIQ SAMPVIQ	0-5 quality scale	10s	10 16 23		
Upenik et al. PCS2016.	Image coding quality (JPEG)	ACR-HR	5-grade quality scale	30 s.	48	HMD "MergeVR2" and iPhone 6S	
Perrin et al. SPIE2017	HDR quality	PC toggling (switching viewports between reference and test stimuli)	5-grade scale ("worse than"… "Better than")	x	25		Displayed on the voting menu of the testbed

Related work for **long** 360-degree videos
Introduction

- Very few work on assessing audiovisual quality of long 360 videos
  - AV quality + presence, or just presence-like questions
  - Heterogeneous approach: each work uses its own questionnaires / objectives.
  - Common factors:
    - Each source shown once
    - 1-5 minute sequences
    - 5-50 diverse questions at the end (# depends on # of stimuli per subject)
- Issues with evaluating (2D) long sequences (Garcia 2014, Chen 2013):
  - **Hysteresis**: past stimulus affect present evaluation
  - **Recency**: recent events are more relevant than far away events
  - **Continuous evaluation**: people may forget to evaluate and immerse in the content
  - **Number** of test sequences per test becomes highly limited

Related work for **long** 360-degree videos
Content immersion

- For long sequences, factorial design is not possible
  - Not practical (session too long)
  - If people remember stimuli, some QoE factors cannot be assessed (MacQuarrie 2017).
- As an alternative, content-immersive methods are used (Pinson 2014)
  - Put the subject in the frame of mind of using the system for its intended application.
  - Longer and interesting stimuli to engage the subject (e.g., one minute).
  - Match the sensory experience of the target application—not the impairment modality.
  - Each source stimulus is viewed or heard only once by each subject.
- Most existing long-sequence evaluations actually follow it
  - 360 video (all references we have analyzed)
  - 2D video, e.g. P.NATS, see (Raake 2017).

Related work for **long** 360-degree videos
Within-sequence quality evaluation

- Target: finer-grain measurements, several conditions per sequence.
- We didn't found any reference for 360 video
- Approaches (2D/3D video):
  - Continuous (Staelens 2014): SSCQE, slider where user can select quality continuously.
  - Discrete (Gutierrez 2011): periodic questions to evaluate the previous X seconds of sequence (content is kept playing).
  - Interactive (Borowiak 2014): User can select desired quality by rotating a knob.
- Interaction with content immersion is unknown.

Related work for **long** 360-degree videos
Relevant references

Paper	Objective	Present. Method	Questions / scales	Stim. Dur.	Num. Obs.	HMD
Schatz et al. QoMEX2017	- Video stalling - Normal screen vs HMD.	ACR-HR	- Overall quality, stalling annoyance: 5-grade - Presence (x4): 7-grade (attention, spatial presence, awareness, realistic)	60 s.	22	Oculus Rift DK2
Singla et al., QoMEX2017	- QoE and sickness - Compare two HMDs	SS (clip + questions)	- Quality evaluation: 5-grade quality scale - SSQ	60 - 65 s.	28	HTC Vive and Oculus Rift
MacQuarrie & Steed, IEEEVR 2017	- HMD vs TV vs SurroundVideo+ - QoE factors		- Spatial Awareness (object location) - Incidental Memory: 10x open answer - Narrative Engagement (MNEQ) - Enjoyment: 2x 5p Likert - Attention - Concern about missing something; 3x 5p Likert - Fear (horror movie): 2x 5p Likert	2-5 min	63	Oculus Rift CV1, CAVE, 60" TV
Guervós et al. HVEI'19	- QoE in learning - Veterinary students, real lesson		- Video and overall quality: 5-grade (ACR) - Simulator Sickness: 5-grade (Vertigo) - Net Promoter Score: 10-grade - Temple Presence Inventory: 40 presence questions	5 min	100	Samsung Gear VR (Galaxy S8+)

Conclusion
Short sequences

What we know

- Length: 10-30 seconds
- Traditional methodologies seem valid
  - M-ACR for very short sequences (e.g., 10 seconds)
- Realistic watching setup (HMD, headphones, video+audio)
- Questions after each clip
- Factors to evaluate: mainly audiovisual quality

Open points

- Effects and need of evaluating other factors (e.g., immersion, cyber-sickness…),
- Validity of typical methodologies:
  - Cross-lab study

Conclusion
Long sequences

What we know

- Length: 1-5 minutes
- Each sequence shown once
  - Therefore Single Stimulus
- Realistic watching setup (HMD, headphones, video+audio)
- Questions after each sequence
- Several factors to evaluate (not only video quality)

Open points

- Narrow down recommended duration?
- Recommend questionnaire
  - Fixed or open?
  - Which factors to evaluate?
- Intra-sequence evaluation? Which method?
  - Focused on a single factor (audiovisual QoE)
  - SSCQE? Other?

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