A brief introduction to the

Video Quality Experts Group

January 2023

VQEG—A Brief History

- Formed in 1997 to advance the field of video quality assessment
- Closely related to ITU-T and ITU-R study groups
  - ITU-T SG9 (Broadband cable & TV)
  - ITU-T SG12 (Performance, QoS and QoE)
  - ITU-R WP6C (Programme production and quality assessment)
- Historically, a primary focus on:
  - Creation of test plans to develop and validate objective quality metrics
  - Particular focus on defining the scope and subjective test methodology
  - Statistical techniques for assessing model performance
  - →recommending approaches/models to be standardized by ITU-R/ITU-T

INSA Rennes, 2022

Wuhan Univ., Tencent, Shenzhen, 2019

Google, USA, 2019

Netflix, Los Gatos, 2017

How is it organized?

- VQEG board
  - Kjell Brunnström (RISE Research Institute of Sweden AB)
  - Margaret Pinson (NTIA/ITS, USA)
- Working groups
  - Individual co-chairs per group
- Bi-annual meetings
  - Historically in-person, worldwide
  - Now mostly online (due to COVID health and traveling restrictions)
- Next meeting: May/June 2023 (tba)

Current Chairs & Co-Chairs

General chairs	Kjell Brunnström, Margaret Pinson
5G Key Performance Indicators (5GKPI)	Pablo Perez, Kjell Brunnström
Audiovisual HD (AVHD)	Shahid Satti, Silvio Borer, Ioannis Katsavounidis
Computer Graphics Imagery (CGI)	Saman Zadtootaghaj, Nabajeet Barman
Emerging Technologies Group (ETG)	Nabajeet Barman, Saman Zadtootaghaj
Human Factors for Visual Experiences (HFVE)	Maria Martini, (vacant)
Immersive Media Group	Jesus Gutierrez, Zhenzhong Chen, Pablo Perez
Implementers Guide for Video Quality Metrics (IGVQM)	Ioannis Katsavounidis, (vacant)
JEG Hybrid	Marcus Barkowsky, Glenn Van Wallendael, Enrico Masala
No Reference Metrics (NORM)	Ioannis Katsavounidis, Margaret Pinson, Werner Robitza, Cosmin Stejerean
Quality Assessment for Computer Vision Applications (QACoViA)	Mikolaj Leszczuk, Patrick Le Callet, Lu Zhang
Quality Assessment for Heath applications (QAH)	Lu Zhang, Lucie Lévêque, Meriem Outtas
Statistical Analysis Methods	Lucjan Janowski, Ioannis Katsavounidis, Zhi Li, Patrick Le Callet
Tools and Subjective Labs Setup Co-Chair	Glenn Van Wallendael, Werner Robitza
Video Archives Support	Femi Adeyemi-Ejeye

What's nice about VQEG?

- Free to join —no membership fees
- No strict or complicated rules
  - Consensus is often reached without lengthy voting procedures
- Simple organization and hierarchy
  - Chairs &co-chairs for different projects
  - Anyone can propose or contribute a new project
- Highly interactive meetings
  - Anyone can present their ideas
  - Focus on discussion time
- Not a commercial venue
  - No sales talks, no commercial advertising
- Mixture between academia and industry

General Topics and Resources

Main Topics

- General research on video QoE in various fields
- Video quality model development
  - Various types of models (hybrid/bitstream, no-reference, ..)
  - VQEG members may define the scope and test plan
- Input to standardization forums
  - …based on developed and validated models
- Subjective tests & collection of subjective databases
  - To develop and validate subjective test methodologies (“ILG” approach)
  - To predict the performance of objective video quality models
- Joint production of software tools
  - Helper tools for conducting subjective tests
  - Objective quality analysis
- Exploration of new application areas
  - Multimedia, 3DTV, gaming, VR/XR, …

Video Quality Model Development — Typical Approach

Test Plan	Training Databases	Model Training	Validation Databases	Data Analysis
Creation of scope and terms of reference	Joint development of subjective test databases	Development of the models by proponents based on training data	Development of new databases with previously unknown content	Validation of model performance according to predetermined statistical criteria
Definition of inputs/outputs	Conduction of tests by proponents or independent labs ("Independent Laboratory Group", ILG)	Collaborative or in form of a competition — various advantages of either method	Conduction of tests by different labs	Suggestion of which models may be standardized →ITU-T contributions
Rules for model submission and validation	Sharing of training data	Submission of model candidates	Collection of validation data; merging with training data to form complete dataset	
Open call for participation to industry/academia				

→historical approach — model development may now be iterative/collaborative or done within ITU-T itself

Model Development — Previous Projects

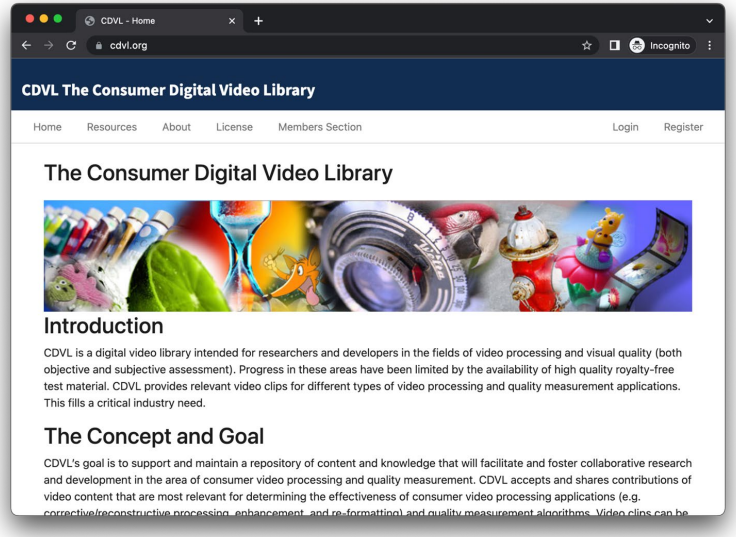
- FRTV Phase 1:
  - ITU-T Rec. J.144 (2003) – collection of full-reference models
- Multimedia Phase 1:
  - ITU-T Rec. J.246 and J.247 (2008) – Reduced- and full-reference models
- HDTV Phase 1:
  - Led to ITU-T Rec. J.341 and J.342 (2011) – Full- and reduced-reference models
  - Five video datasets available
- AVHD-AS:
  - Joint project with ITU-T Study Group 12 P.NATS Phase 2
  - UHD/4K, 60p, H.264, H.265, VP9
  - Led to ITU-T P.1204 series (2021) – No-reference bitstream-based, pixel-based, no-reference hybrid
  - IEEE Access Paper summarizing the effort

Input to Standardization Forums

- Historically, VQEG has recommended model algorithms to become standardized
- Based on performance against subjective data
- Sometimes no models could be standardized due to low performance or unreliability (e.g., mostly the case with no-reference pixel-based models)
- Newer VQEG projects have a more collaborative and iterative approach to developing algorithms
- Contributions for subjective evaluation techniques

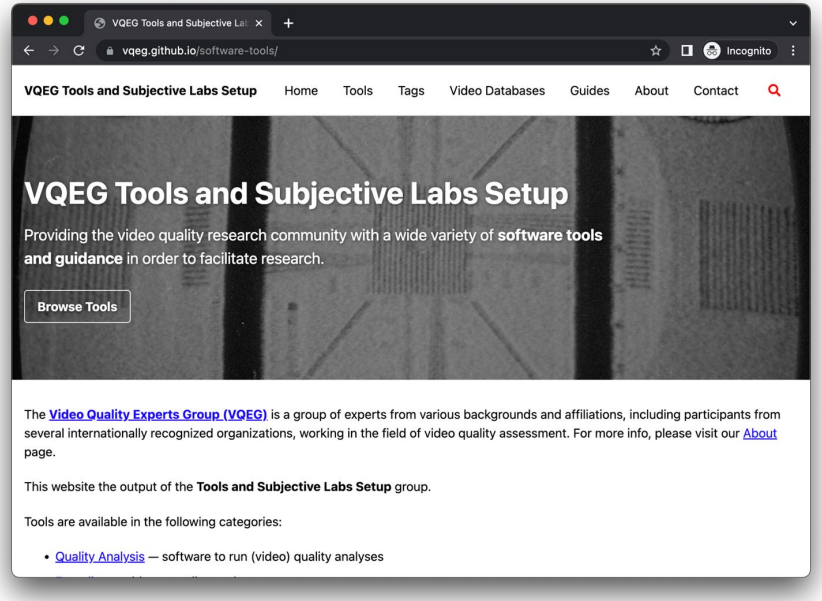
Video Datasets & CDVL

- Consumer Digital Video Library
- High-quality, royalty-free test material, mostly from previous VQEG projects
- Another list of datasets on VQEG website



Software Tools

- Public [software tools repository]
- Various software packages developed over the years
- Grouped by topic and searchable
  - Quality Analysis
  - Encoding
  - Streaming
  - Subjective Test Software
  - Helper Tools



Please submit your tools! →
https://github.com/VQEG/software-tools/

Dissemination

- Extensive reports of previous subjective test and model development activities
  - Can be found on VQEG website
  - …even for historical activities
- VQEG has contributed columns to SIGMM Records (ACM SIG Multimedia's quarterly newsletter) with recent updates
  - Latest issue: https://records.sigmm.org/2023/01/31/vqeg-column-vqeg-meeting-dec-2022/
  - Detailed Summary of the December meeting

VQEG Column: VQEG Meeting December 2022

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Introduction

This column provides an overview of the last Video Quality Experts Group (VQEG) plenary meeting, which took place from 12 to 16 December 2022. Around 100 participants from 21 different countries around the world registered for the meeting that was organized online by Brightcove (United Kingdom). During the five days, there were more than 40 presentations and discussions among researchers working on topics related to the projects ongoing within VQEG. All the related information, minutes, and files from the meeting are available online on the VQEG meeting website, and video recordings of the meeting are available on Youtube.

Many of the works presented in this meeting can be relevant for the SIGMM community working on quality assessment. Particularly interesting can be the proposals to update and merge ITU-T recommendations P.913, P.911, and P.910, the kick-off of the test plan to evaluate the QoE of immersive interactive communication systems, and the creation of a new group on emerging technologies that will start working on AI-based technologies and greening of streaming and related trends.

We encourage readers interested in any of the activities going on in the working groups to check their websites and subscribe to the corresponding reflectors, to follow them and get involved.

Group picture of the VQEG Meeting 12-16 December 2022 (online).

Current Activities

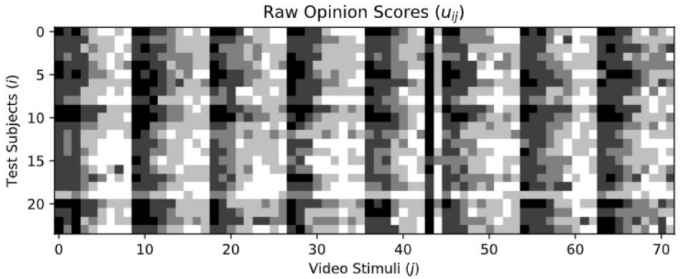
Details:

https://vqeg.org/projects-home/
https://vqeg.org/meetings-home/

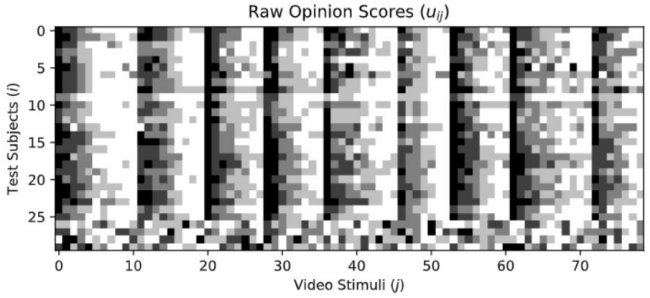
Statistical Analysis Methods (SAM)

- Overview: Statistical Analysis Methods
- Minutes: VQEG SAM Monthly
- Developed a new ratings recovery method based on SUREAL
  - How can you better recover "real" ratings from noisy subjective data?
- Further additions to ITU-R BT.500-14 and ITU-T Rec. P.910/913
- Revisions and merging of ITU-T Rec. P.913 and P.910

Li et al., 2020



(a) VQEG HD3 dataset



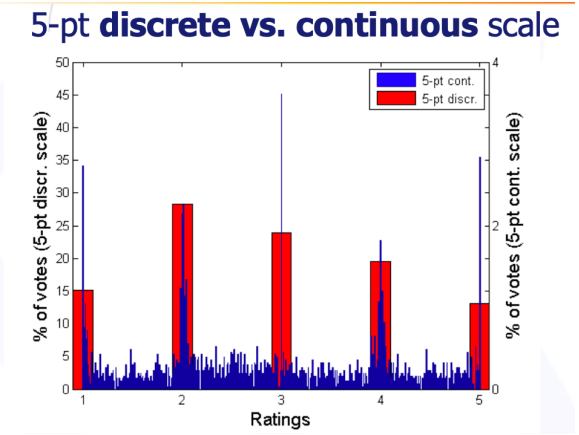
(b) NFLX Public dataset

Statistical Analysis Methods (SAM) ctd.

- Various historical activities related to designing and evaluating test methods
- How to obtain the most valid and reliable ratings?
- Examples:
  - Comparison of different rating scales (2011 paper)
  - Impact of the test environment on MOS (2012 paper)
  - Experiments with unrepeated scenes (2019 paper)

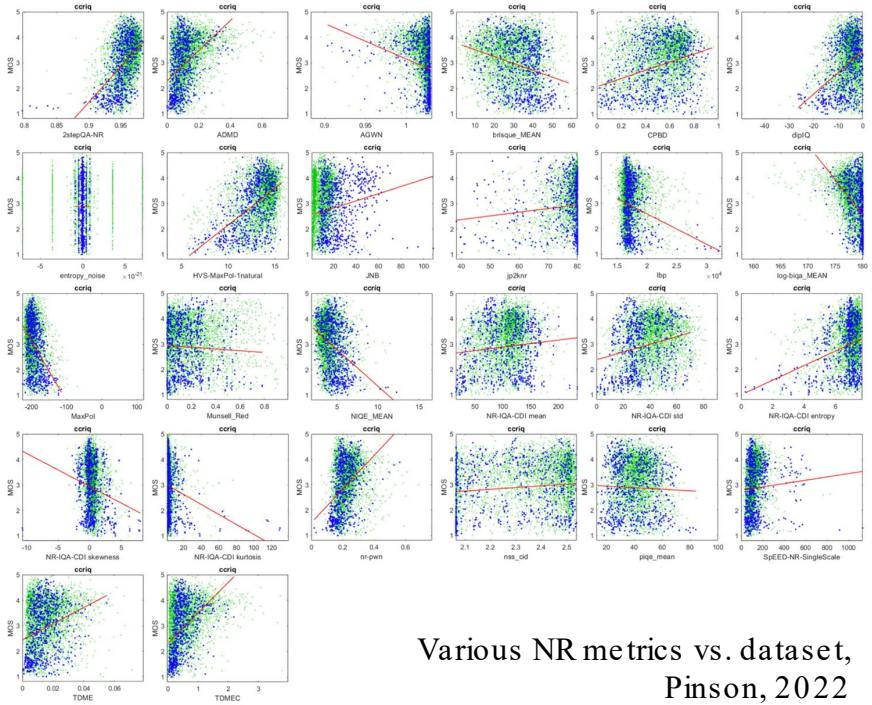
Janowski et al. 2019

Huynh-Thu et al., 2011



No-Reference Metrics (NORM)

- Design of a no-reference pixel-based metric
- Various resources for NR metrics
- Collection of video datasets with new scope (e.g. security applications, user-generated content)
- Open framework for collaborative development of no-reference quality indicators
- Journal paper (2022) showing why NR metrics lack accuracy and reproducibility

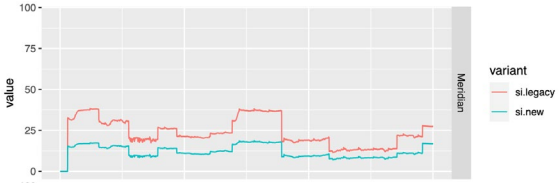


Various NR metrics vs. dataset, Pinson, 2022

No-Reference Metrics (NORM) ctd.

- How can we determine the complexity of a video before encoding it?
  - Clarifying the use of Spatial and Temporal Information (SI, TI) → ITU-T P.910 was updated
  - Siti-tools code released as open-source
  - Taking into account motion using a motion search framework
  - Integrating approaches like Video Complexity Analyzer

Comparison of SI/TI scores

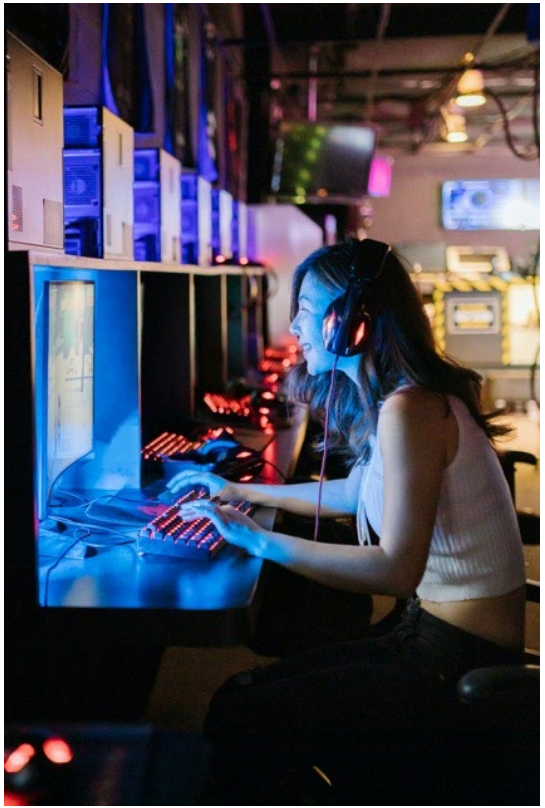


VCA metric output

- Video quality metadata standard
  - How to embed metadata on source/encoded video quality directly in containers or bitstreams
  - Payload definition and liaison with MPEG and AOM (Alliance for Open Media)

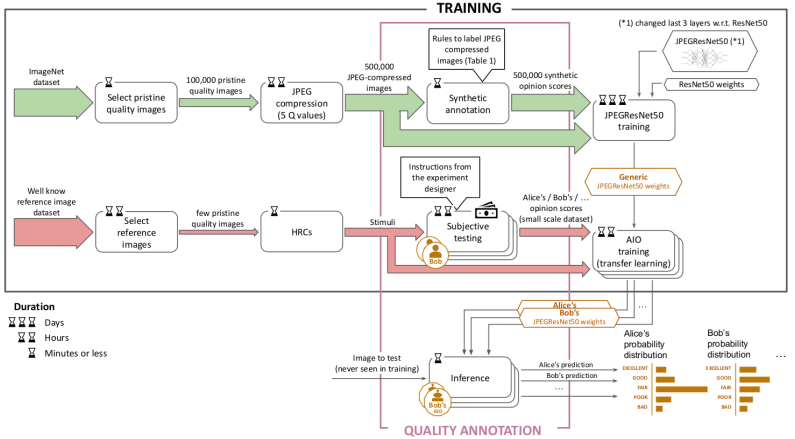
Computer Generated Imagery (CGI)

- Analyzing and evaluating of computer-generated content
  - Creation of open source datasets
  - Machine learning/deep learning based quality enhancement of gaming content
  - Development of models and metrics for assessing gaming QoE
- Aligned with ITU-T Study Group 12 work item “P.BBQCG”
  - Developing a gaming QoE model that uses the bitstream metadata for video quality
  - Interactive and passive subjective tests planned
- Previous activities:
  - Creation of various ITU-T recommendations
  - ITU-T Rec. G.1032: Influence factors on gaming QoE
  - ITU-T Rec. P.809: Subjective evaluation methods for gaming quality
  - ITU-T Rec. G.1072: Opinion model for gaming applications



Joint Effort Group – Hybrid (JEG-Hybrid)

- Project homepage
- Original idea to develop a hybrid quality model, but activities evolved to become more diverse, more research-oriented
- Research questions:
  - Modeling single observer behavior in subjective experiments with neural networks
    →predicting individual quality ratings
  - Modeling disagreement in video quality metrics
  - Templates for publishing results in image/video quality assessment →reproducible research



Predicting individual quality ratings, Fotio T. et al., 2023

Implementer's Guide for Video Quality Metrics (IGVQM)

- Create a guide on how to properly use video quality metrics
- Working document available
  - Currently moving part of the activities into JEG-Hybrid
- Scope:
  - Collect full-reference metrics and open-source solutions
  - Highlight differences between metrics
  - Determine temporal aggregation methods for image-based metrics (PSNR, SSIM)
  - Mappings between nonlinear objective metrics and linear scales (e.g. 0-100)

Quality Assessment for Computer Vision Applications (QACoViA)

- Methods for determining precision of computer vision approaches
- Identifying the limits of computer vision methods with respect to the visual quality of the ingest
- Recent highlights:
  - Method for Assessing Objective Video Quality for Automatic License Plate Recognition Tasks
  - Assessing Rail 8KUHD CCTV Forward Facing Video
  - Comparing the Robustness of Humans and Deep Neural Networks on Facial Expression Recognition
  - Video Coding for Machines: Large-Scale Evaluation of Deep Neural Networks Robustness to Compression Artifacts for Semantic Segmentation

5G Key Performance Indicators (5GKPI)

- Goals:
  - Defining use cases for video in 5G
  - Studying QoE aspects for video in mobility and industrial scenarios
  - Identifying the relevant network KPIs and application-level video KPIs (e.g. picture quality, A/V sync, ..)
  - Building open datasets for algorithm testing and training
- Recent highlights:
  - ITU-T Technical Report GSTR.5GQoE (2022): Specific QoE requirements and required performance and features from the network

Immersive Media Group (IMG)

- Quality assessment of immersive media
  - 360-degree content, virtual/augmented/extended reality, light field/plenoptic content, 3D content (stereo, multiview, FVV, etc.).
- Goals: Baseline quality assessment of today's systems
  - Datasets of immersive media content
  - QoE guidelines, subjective test methods, objective metrics, etc.
- Activities:
  - Finalized test plan on quality assessment of 360-degree videos → ITU-T P.919
  - Ongoing test plan: Evaluation of immersive/interactive communication systems.
  - Light field quality assessment

Quality Assessment for Health Applications (QAH)

- Assemble databases for medical image and video quality, eye-tracking
- Define subjective experiment methodologies for diagnostic or surgery tasks, eye tracking, …
- Evaluate and develop quality metrics for medical imaging/video, visual attention prediction models, …
- Study quality requirements and QoE for telemedicine

Emerging Technologies Group (ETG)

- Newly formed group
- AI-based technologies
  - Super Resolution
  - Learning-based video compression
  - Enhancement, Denoising and other pre- and post-filter techniques
- Greening of streaming
  - Saving energy and its impact on visual quality
- Blockchain in Media and Entertainment
- Liaison with other standards activities
  - 3GPP, SVTA, CTA WAVE, UHDF, etc.
  - MPEG/JVET

Summary

Summary

- VQEG is a free-to-attend forum for video quality experts
- Both academia and industry is invited to contribute
- 25 years of history with great achievements:
  - Standardization of video quality models
  - Development and application of subjective test procedures
  - Collection of resources for video quality research (databases, software)
  - Discussion of new and emerging technology

Getting Involved

- Have a look at the projects page
- Subscribe to the mailing lists
- Join our regular working group online meetings
  - Any contribution is welcome
  - Bring your questions!
- Take part in the bi-annual VQEG general meetings