Video Quality Assessment Methods Performance Comparison for 3DoF+

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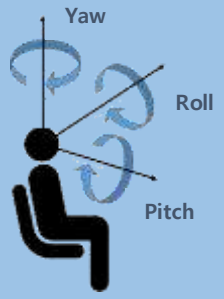
Virtual Reality in MPEG-I

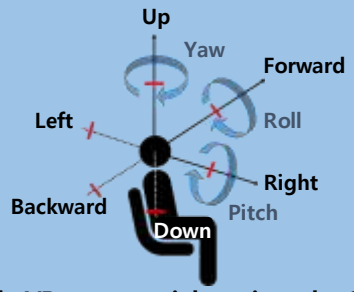
- Three phases of ISO/IEC MPEG-Immersive VR standardization
  - To support the entire movement in VR, 6DoF is required
  - 6DoF media support will be completed by 2022
  - 3DoF+ standard will be established by 2020 to support the limited 6DoF

Step 1



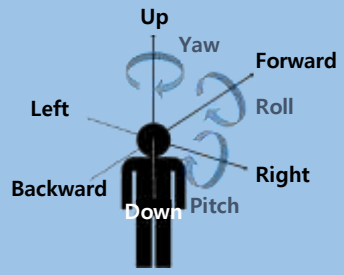
- Complete 3DoF standard by 2017
- Rotate head in a fixed state
- 360 video full streaming by default
- Tiled streaming if possible

Step 2



- Enable VR commercial servicers by 2020
- Allow head rotation and movement within a restricted area
- User-to-user conversations and projection optimization

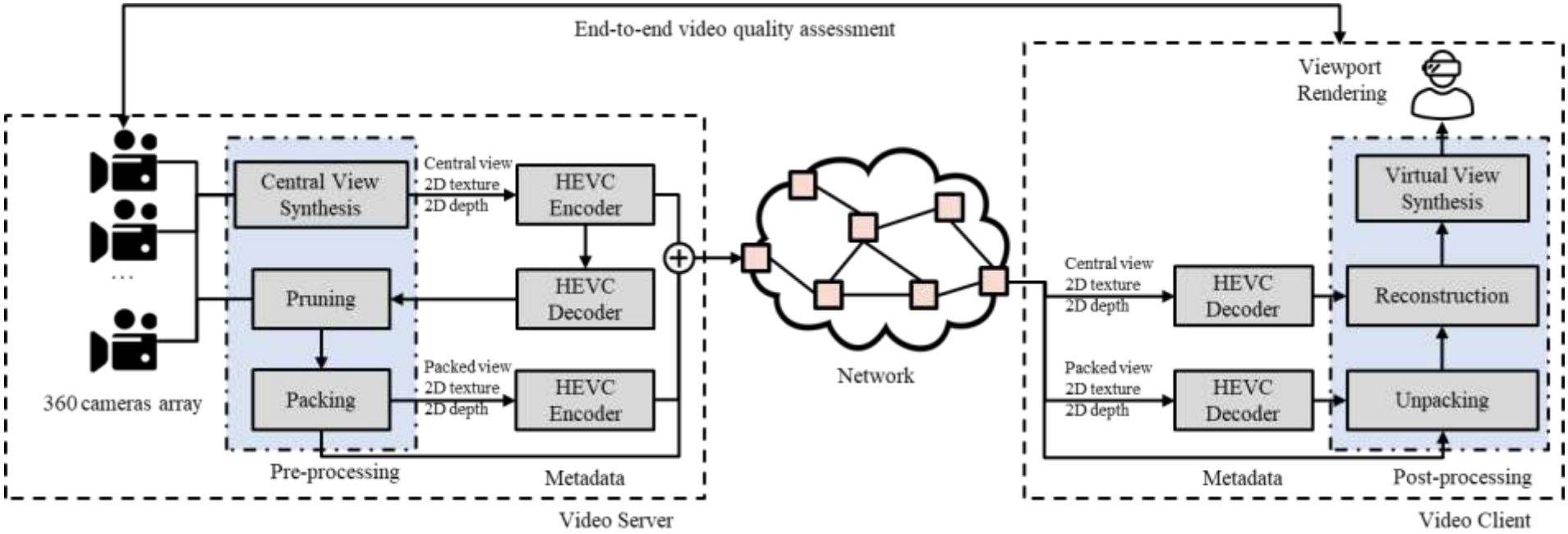
Step 3



- Support 6DoF by 2022
- 6DoF video will reflect user's walking motion
- Support interaction with virtual environments

Virtual Reality in MPEG-I (Cont'd)

- Background
  - General framework for 3DoF+ S/W
  - Uses HEVC (not MV-HEVC) and additional metadata
  - End-to-end video quality assessment is conducted



Block diagram for 3DoF+ S/W platform

Source: Jong-Beom Jeong, Soonbin Lee, Dongmin Jang, Eun-Seok Ryu. "Towards 3DoF+ 360 Video Streaming System for Immersive Media" IEEE Access, vol.7, pp.136399-136408, 2019

Virtual Reality in MPEG-I (Cont'd)

- Background
  - 3DoF+ video has multiple views, including texture + depth
  - Based on the views, viewport of an user is generated

ClassroomVideo

TechnicolorMuseum

TechnicolorHijack

TechnicolorPainter

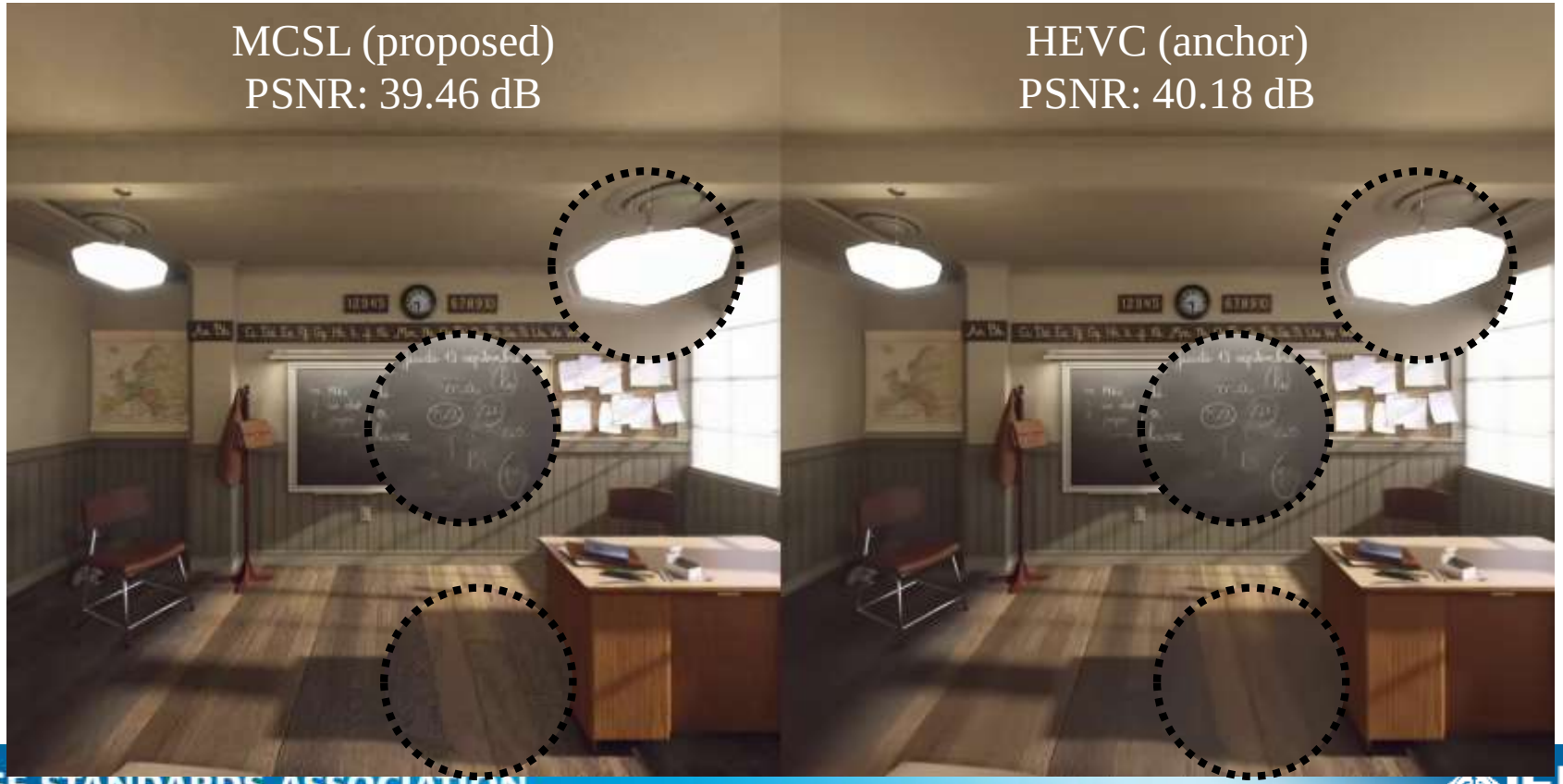
IntelKermit

Sequence	Class	Resolution	No. of views	Frame count	Frame rate	Source FoV
ClassroomVideo	A	4096x2048	15	120	30	360º x 180º
TechnicolorMuseum	B	2048x2048	24	300	30	180º x 180º
TechnicolorHijack	C	4096x4096	10	300	30	180º x 180º
TechnicolorPainter	D	2048x1088	16	300	30	46º x 25º
IntelKermit	E	1920x1080	13	300	30	77.8º x 77.8º

Virtual Reality in MPEG-I (Cont'd)

- Limitation
  - In some cases, PSNR (traditional quality metric) does not reflect the user's QoE
  - Unlike traditional codec, 3DoF+ shows different types of artifacts

    -> Need to find a better quality metric



Difference between objective and subjective quality in 3DoF+ 360 video viewport rendering

Objective Quality Metrics for Immersive Video

IEEE 3079

- Background
  - Immersive video shows different types of artifacts
  - For evaluation, common test conditions for immersive video defines the quality metrics
- Purpose
  - Evaluate the 3DoF+ system SW (test model for immersive video (TMIV)) to:

    Provide the viewport which satisfies the user's quality of experience (QoE)

Metric name	Document No.	Location	Tag/branch
WS-PSNR	w18069	https://gitlab.com/mpeg-i-visual/wspsnr	v2.0.1
VMAF	-	https://github.com/Netflix/vmaf	v1.3.14
MS-SSIM	-	https://github.com/Netflix/vmaf	v1.3.14
VIF	-	https://github.com/Netflix/vmaf	v1.3.14
IV-PSNR	w18709	https://gitlab.com/mpeg-i-visual/ivpsnr	v1.0

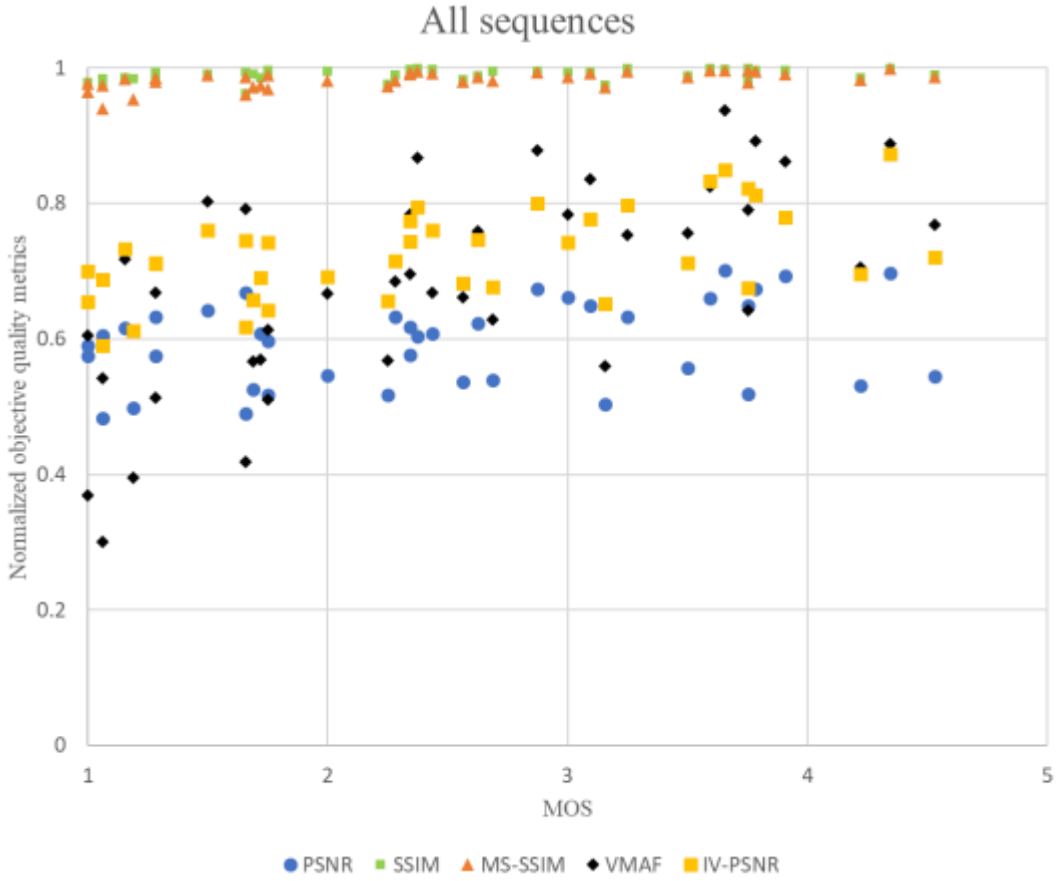
Objective quality metrics for immersive video

Test Conditions

- Test Materials
  - Followed common test conditions (CTC) of MPEG-I
  - 5 test sequences(class A, B, C, D, E) were encoded
  - For subjective data, used 3DoF+ CfR results including mean opinion score (MOS)
- Environment
  - Versions of softwares meet the requirements of 3DoF+ CfP
  - OpenCV 3.4.2 was used to build reference view synthesizer (RVS) v3.1

Experimental Results

- VMAF showed the best correlation coefficient with MOS
- PSNR showed the worst results among the metrics



Correlation between MOS and objective quality metrics

Metric name	Correlation coefficient with MOS
PSNR	0.3012
SSIM	0.3932
MS-SSIM	0.5694
VMAF	0.6601
IV-PSNR	0.5539

Correlation coefficient between MOS and objective quality metrics

Conclusion

- Problem
  - For state-of-the-art virtual reality system, quality metric is really important
  - Subjective quality and traditional metric (e.g. PSNR) shows low correlation
- Proposed Methods and Insights
  - Quality metrics of MPEG-I were analyzed with 3DoF+ subjective quality data
  - Traditional metric (e.g. PSNR) is not appropriate for 3DoF+
- Future Work
  - Human-familiar quality metric should be developed