



# CREATING THE LIVING NETWORK™

JVET-F0042

AHG8: On cross-format S-PSNR-NN

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# Introduction

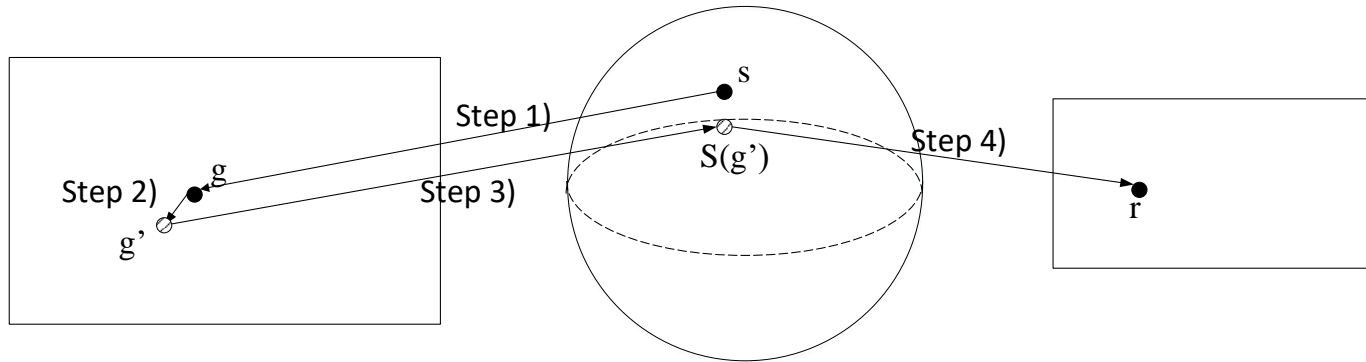
- The cross-format spherical metrics in 360 common test conditions will measure the quality difference between the original video and the reconstructed video at codec output
  - The reconstructed video is not converted back to the same projection format and resolution as the original video
- Cross-format S-PSNR-NN may have the problem of sample misalignment
  - Denote  $S$  as the point on the unit sphere
  - Denote  $g$  as the point with fractional precision in the original video project plane that corresponds to  $S$
  - Denote  $r$  as the point with fractional precision in the reconstructed video projection plane that corresponds to the same point  $S$
  - Denote  $g'$  and  $r'$  as the nearest neighbor integer sampling point of  $g$  and  $r$ , respectively
  - Due to the fact that the original projection plane and the reconstructed projection plane are in different formats and/or resolutions,  $g'$  and  $r'$  do not always correspond to the same point on the sphere

# Proposed cross-format S-PSNR-NN (1)

- It will allow fractional sample position in the reconstruction video, and apply interpolation to derive the sample value at the fractional sample position
- **There is no interpolation applied to the original video**
  - The characteristics of the original video are not changed during the metric calculation

# Proposed cross-format S-PSNR-NN (2)

1. Map point  $S$  to point  $g$  in the original video projection plane
2. Round point  $g$  to nearest integer sampling point  $g'$  in the original video projection plane
3. Perform inverse coordinate mapping of the point  $g'$  back onto the sphere at  $S(g')$
4. Perform coordinate mapping from the spherical coordinate  $S(g')$  to the reconstructed video projection plane at the position  $r$
5. Apply interpolation to derive the sample value at point  $r$  if  $r$  is not located at integer sampling position; otherwise, use the sample value without any interpolation
6. Calculate error between the sample value at point  $g'$  in the original video and the interpolated sample value at point  $r$  in the reconstructed video



# Proposed cross-format S-PSNR-NN (3)

- Steps (1) to (4) are pre-calculated at the sequence level, only steps (5) and (6) need to be performed on-the-fly for metric calculation
- No interpolation applied to original video
  - Avoid changing the original video characteristics and avoid the impact on distortion calculation due to interpolation
- If the original video and the reconstructed video have the same projection format and the same resolution, the proposed cross-format S-PSNR-NN will achieve the same result as that calculated with the end-to-end S-PSNR-NN

# Simulation results

- The same interpolation filters as those used for other cross-format spherical metrics are used in the proposed cross-format S-PSNR-NN calculation
- We compared the coding performance among different projection formats using HM-16.15 based 360Lib-2.1 with the proposed cross-format S-PSNR-NN calculation method

# CMP vs ERP coding results

CMP vs. ERP	WS-PSNR (End to End) in 360Lib-2.1			S-PSNR-NN (Cross Format) in 360Lib-2.1			Proposed S-PSNR-NN (Cross Format)			S-PSNR-I (Cross Format) in 360Lib-2.1		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	-2.2%	4.8%	-0.4%	-48.3%	7.1%	1.5%	-2.3%	4.7%	-0.3%	-2.3%	4.8%	-0.3%
GasLamp	2.4%	5.4%	10.7%	-44.7%	8.1%	13.4%	2.1%	5.5%	10.8%	2.1%	5.4%	10.8%
Sb_in_lot	-8.5%	-9.6%	-10.8%	-38.2%	-6.5%	-7.8%	-8.8%	-9.8%	-11.0%	-8.8%	-9.8%	-11.0%
Chairlift	-18.2%	-13.3%	-14.1%	-44.0%	-11.5%	-12.0%	-18.1%	-13.1%	-13.9%	-18.1%	-13.1%	-14.0%
KiteFlite	-4.9%	-1.5%	-3.8%	-48.8%	0.7%	-2.2%	-5.2%	-1.5%	-3.8%	-5.1%	-1.5%	-3.8%
Harbor	1.1%	-3.0%	-2.1%	-51.9%	-0.4%	0.3%	1.0%	-3.1%	-2.2%	0.9%	-3.1%	-2.2%
PoleVault	-2.4%	-5.8%	-4.9%	9.3%	-3.6%	-3.5%	-2.2%	-5.7%	-4.8%	-1.3%	-5.0%	-4.4%
AerialCity	4.2%	3.7%	3.6%	7.8%	3.6%	2.9%	4.2%	3.8%	3.8%	4.3%	3.8%	3.8%
DrivingInCity	4.8%	7.2%	9.2%	9.5%	6.3%	7.2%	4.6%	7.1%	9.0%	5.5%	7.1%	9.0%
DrivingInCountry	-14.6%	-14.3%	-13.6%	-10.3%	-14.7%	-14.3%	-14.5%	-14.2%	-13.5%	-13.5%	-14.1%	-13.5%
Overall	-3.8%	-2.7%	-2.6%	-25.9%	-1.1%	-1.5%	-3.9%	-2.6%	-2.6%	-3.6%	-2.5%	-2.6%

More consistent with WS-PSNR

# OHP vs ERP coding results

OHP vs. ERP	WS-PSNR (End to End) in 360Lib-2.1			S-PSNR-NN (Cross Format) in 360Lib-2.1			Proposed S-PSNR-NN (Cross Format)			S-PSNR-I (Cross Format) in 360Lib-2.1		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	-2.5%	8.1%	3.5%	-47.8%	10.3%	5.1%	-2.2%	8.1%	3.4%	-2.3%	8.1%	3.3%
GasLamp	1.6%	6.4%	10.7%	-43.9%	9.0%	12.9%	1.7%	6.4%	10.9%	1.9%	6.4%	10.8%
Sb_in_lot	-4.0%	-4.2%	-5.2%	-34.8%	-0.9%	-1.9%	-4.2%	-4.7%	-5.6%	-4.3%	-4.7%	-5.6%
Chairlift	-13.6%	-4.7%	-7.2%	-39.1%	-2.6%	-4.8%	-13.4%	-4.6%	-7.0%	-13.4%	-4.6%	-7.2%
KiteFlite	-4.6%	2.3%	0.4%	-47.5%	4.9%	2.3%	-4.6%	2.5%	0.5%	-4.6%	2.4%	0.2%
Harbor	0.6%	2.8%	3.9%	-51.7%	5.7%	6.6%	0.9%	2.7%	3.8%	0.8%	2.6%	3.8%
PoleVault	-3.4%	-5.8%	-5.7%	5.0%	-3.3%	-3.6%	-3.5%	-5.7%	-5.6%	-2.6%	-4.9%	-5.1%
AerialCity	5.0%	7.8%	7.2%	6.6%	8.1%	6.8%	5.0%	7.7%	7.2%	5.3%	7.8%	7.2%
DrivingInCity	14.5%	25.4%	22.3%	20.2%	24.6%	21.3%	14.3%	25.2%	22.1%	15.4%	25.1%	22.2%
DrivingInCountry	-7.5%	-5.0%	-7.0%	-4.3%	-5.2%	-7.4%	-7.3%	-4.9%	-7.1%	-6.5%	-4.9%	-7.0%
Overall	-1.4%	3.3%	2.3%	-23.7%	5.1%	3.7%	-1.3%	3.3%	2.3%	-1.0%	3.3%	2.3%

More consistent with WS-PSNR



# ISP vs ERP coding results

ISP vs. ERP	WS-PSNR (End to End) in 360Lib-2.1			S-PSNR-NN (Cross Format) in 360Lib-2.1			Proposed S-PSNR-NN (Cross Format)			S-PSNR-I (Cross Format) in 360Lib-2.1		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	-5.1%	5.5%	0.9%	-48.6%	7.9%	2.7%	-5.1%	5.4%	0.9%	-5.1%	5.5%	0.9%
GasLamp	-2.4%	2.3%	7.7%	-45.5%	4.7%	10.0%	-2.4%	2.3%	7.7%	-2.4%	2.3%	7.6%
Sb_in_lot	-8.1%	-7.3%	-10.3%	-36.8%	-3.9%	-6.9%	-8.1%	-7.3%	-10.3%	-8.2%	-7.3%	-10.3%
Chairlift	-13.8%	-6.4%	-8.3%	-39.2%	-4.6%	-6.0%	-13.6%	-6.3%	-8.1%	-13.6%	-6.3%	-8.1%
KiteFlite	-7.0%	-0.7%	-2.3%	-48.3%	1.7%	-0.6%	-6.9%	-0.6%	-2.2%	-7.0%	-0.6%	-2.3%
Harbor	-6.5%	-0.5%	-1.4%	-53.1%	2.1%	1.0%	-6.0%	-0.5%	-1.5%	-6.2%	-0.4%	-1.4%
PoleVault	-5.8%	-6.7%	-6.8%	0.8%	-3.3%	-4.0%	-5.7%	-6.5%	-6.6%	-4.9%	-6.0%	-6.3%
AerialCity	3.3%	3.9%	3.9%	-0.9%	4.2%	3.5%	3.4%	4.0%	4.0%	3.8%	4.0%	4.1%
DrivingInCity	3.4%	13.4%	12.7%	0.9%	12.5%	11.7%	3.4%	13.4%	12.7%	4.6%	13.5%	12.9%
DrivingInCountry	-9.4%	-8.8%	-9.1%	-4.7%	-9.2%	-9.7%	-9.3%	-8.7%	-9.0%	-8.2%	-8.6%	-8.9%
Overall	-5.2%	-0.5%	-1.3%	-27.5%	1.2%	0.2%	-5.0%	-0.5%	-1.2%	-4.7%	-0.4%	-1.2%

More consistent with WS-PSNR

# SSP vs ERP coding results

SSP(vert) vs. ERP	WS-PSNR (End to End) in 360Lib-2.1			S-PSNR-NN (Cross Format) in 360Lib-2.1			Proposed S-PSNR-NN (Cross Format)			S-PSNR-I (Cross Format) in 360Lib-2.1		
	Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	-8.7%	2.9%	-2.9%	-50.6%	5.2%	-1.1%	-8.6%	2.9%	-2.8%	-8.7%	2.9%	-2.8%
GasLamp	-5.5%	1.3%	6.7%	-47.0%	4.4%	9.5%	-5.3%	1.4%	6.9%	-5.2%	1.4%	6.8%
Sb_in_lot	-16.1%	-14.1%	-14.3%	-41.8%	-10.5%	-10.5%	-16.1%	-14.0%	-14.2%	-16.2%	-14.0%	-14.1%
Chairlift	-20.3%	-12.6%	-13.6%	-43.7%	-10.3%	-11.3%	-20.2%	-12.5%	-13.4%	-20.3%	-12.6%	-13.5%
KiteFlite	-9.8%	-2.7%	-3.1%	-49.8%	-0.5%	-1.5%	-9.7%	-2.6%	-2.9%	-9.8%	-2.6%	-3.0%
Harbor	-8.1%	0.8%	1.3%	-52.6%	4.1%	4.2%	-7.6%	0.9%	1.3%	-7.7%	1.1%	1.4%
PoleVault	-8.9%	-9.9%	-9.8%	3.9%	-4.8%	-5.8%	-8.9%	-9.9%	-9.7%	-8.2%	-9.3%	-9.4%
AerialCity	-2.4%	0.5%	-0.5%	4.6%	2.5%	0.2%	-2.4%	0.6%	-0.4%	-2.1%	0.9%	-0.2%
DrivingInCity	-2.6%	8.7%	6.0%	6.5%	10.6%	6.3%	-2.7%	8.8%	6.0%	-1.4%	9.3%	6.1%
DrivingInCountry	-20.3%	-14.9%	-15.9%	-14.2%	-14.4%	-15.8%	-20.3%	-14.8%	-15.8%	-19.1%	-14.8%	-15.7%
Overall	-10.3%	-4.0%	-4.6%	-28.5%	-1.4%	-2.6%	-10.2%	-3.9%	-4.5%	-9.9%	-3.8%	-4.4%

More consistent with WS-PSNR

# Conclusion

- From the results, the BD gain reported by the proposed cross-format S-PSNR-NN calculation is consistent with end-to-end WS-PSNR
  - Avoids performing unnecessary interpolation to the original video
- Compared to the existing cross format S-PSNR-NN implementation in 360Lib-2.1, the proposed modification significantly improves consistency with other metrics
- Suggest to replace the existing cross-format S-SPSNR-NN with the proposed cross-format S-PSNR-NN calculation in the next release of 360Lib

Thank MediaTek for cross-checking the results (JVET-F0090)

THANK YOU!

