

# Performance Comparison of AV1, HEVC, and VP9 based on the Subjective and Objective analysis for Panoramic Videos.

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## Abstract

The panoramic video contents are recently adopted for a wide application providing a 360-degree spherical space field of views. This paper provides a detailed subjective and objective analysis for the 4K panoramic contents using different encoders under different quantization parameters to examine the impact of compression on user visual quality. A detailed full-reference objective video quality model is implemented followed by a statistical model evaluation to find the correlation between the subjective and objective models. Furthermore, for a better reflection of the performance of the objective model, metrics such as spherical peak-signal-to-noise ratio (SPSNR) and video multi-method assessment fusion (VMAF) is implemented. The results are bench-marked with state-of-the-art encoders such as HEVC/H.265 and VP9.

## I. Introduction

Recent advancement in multimedia technology and computer graphics has led considerable attention for virtual reality (VR) technology, where better user experience and effective human-computer interaction can be seen [1]. Panoramic videos that provide a 360-degree is a recent multimedia content providing a complete spherical space field of view (FoV) [2]. Unlike a two-dimensional (2D) planar video, the panoramic video recording process can be divided into three major steps: capturing, stitching, and projection.

Furthermore, HD and UHD contents are produced by broadcasting groups requiring high data rates spanning to good encoding methods [3]. Recent advancement in video codecs such as VP9 i.e. Google Developed open-source under WebM project and HEVC/H.265 Part 2, jointly developed by Video Coding Experts Group (VCEG) have been reported. Principally, these codecs have the goal of decreasing bit rates by approximately 50% presenting the equivalent quality [4]. In 2018 the Alliance of Open Media (AO Media) developed a royalty-free AV1, a successor to VP9 resulting 34% higher data compression [5].

The performance comparison of HEVC, VP9 is reported showing the encoding and compression efficiency considering ultra-high-definition (UHD) contents [3]. An extended study for the performance comparison can be seen in [6], where HEVC, VP9, and AV1 encoders opt for HD contents. Moreover, detailed analysis with subjective analysis of HEVC and VP9 for high frame rates considering full HD contents are reported [7, 8].

The presented work provides a detailed subjective and objective analysis for the panoramic video contents. A detailed subjective analysis based on ITU recommendation (ITU-R BT.1769) is done to generated MOS values to record human opinion [9]. A

detailed objective analysis is conducted which is followed by a statistical evaluation for the validation of both analyses.

## II. Data Set and Encoder Settings

From our previous work [1], a dataset comprising of 16 reference panoramic having 4k resolution is used for the implementation. Before the encoder settings, five different QP levels, i.e., QP= 27,32,37,42, and 47 are chosen to quantize or compress the panoramic videos. Based on spatial information (SI) and temporal information (TI), five panoramic videos are selected for the analysis [2].

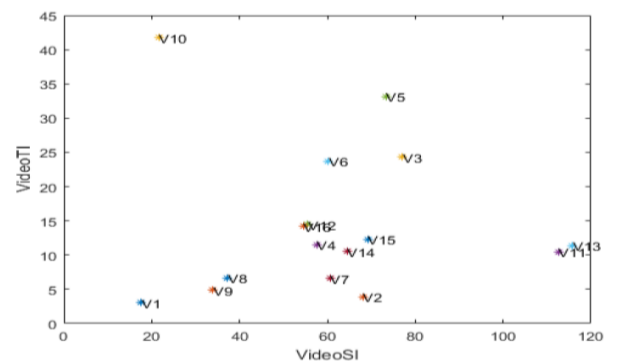


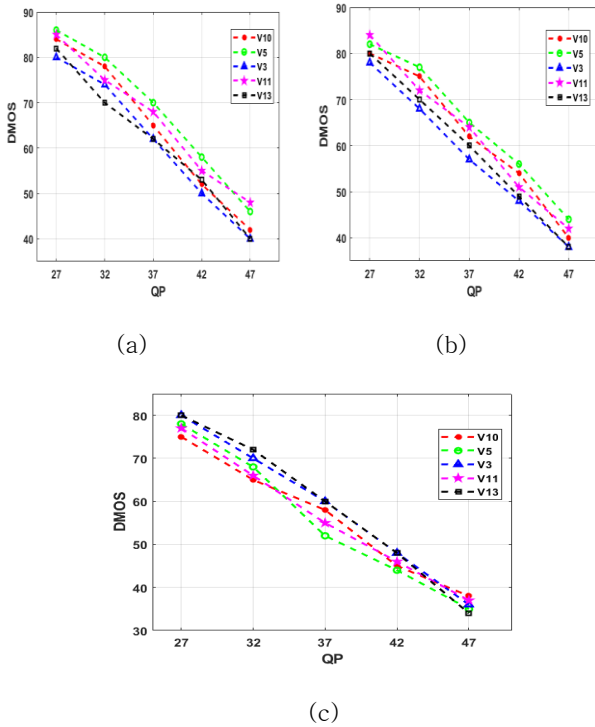
Figure 1. SI and TI of the panoramic video dataset [1]

We have use FFmpeg [2] an open-source library to encoder and fix the parameters. To achieve the same encoding configuration, we have set *preset "slow"*. A total of 275 encoded video sequences were achieved, each encoder output generating 125 encoded video sequence.

## III. Subjective Evaluation and Objective Evaluation

Figure. 2 shows the differential mean opinion score (DMOS) as a subjective evaluation against different QP

levels using Double Stimulus Continuous Quality Scale Type II (DSCQS-II) using MSU tool [2].



**Figure. 2** Subjective analysis at five different QP levels in terms of DMOS values, where (a) represent AV1, (b) represent HEVC/H.265, and (c) represent VP9 encoders.

For the statistical evaluation that can find the correlation coefficient in terms of Pearson's Linear Correlation Coefficient (PLCC) and the Spearman's Rank Order Correlation Coefficient (SROCC) [1–3], Table. 1 provides the results. Clearly it can be seen that performance of AV1 outperforms both HEVC and VP9 at high QP levels as shown in Figure. 2 and Table 1.

**Table. 1** Correlation coefficient between DMOS and FR-VAQ metrics.

Encoders	Correlation Coefficient	FR-VQA metrics		
		PSNR	SPSNR	VMAF
AV1	PLCC	<b>0.9212</b>	<b>0.9131</b>	<b>0.9165</b>
	SROCC	<b>0.9104</b>	0.8581	<b>0.9124</b>
HEVC	PLCC	0.8973	0.8877	0.8606
	SROCC	<b>0.8911</b>	0.9021	<b>0.9001</b>
VP9	PLCC	<b>0.8826</b>	0.8622	0.8977
	SROCC	<b>0.9022</b>	<b>0.9114</b>	0.8511

## Conclusion

A detailed full-reference objective video quality model is implemented followed by a statistical model evaluation to find the correlation between the subjective and objective models. Furthermore, for a better reflection of the performance of the objective model, metrics such as spherical peak-signal-to-

noise ratio (SPSNR) and video multi-method assessment fusion (VMAF) is implemented.

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