基于HEVC的UHD（超高清4K）视频质量评价

2013年10月19日 19:10:27　阅读数：6429

Sung-Ho Bae等人在论文《Assessments of Subjective Video Quality on HEVC-Encoded 4K-UHD Video for Beyond-HDTV Broadcasting Services》中，对基于HEVC编码的4K超高清视频序列进行了主观质量评价和客观质量评价。这在目前来说还是比较超前的。在此记录一下其实验过程以及实验结论。

选择序列的过程

选择序列的过程如下图所示。一共对36个测试序列进行筛选。计算Ct（时间复杂度）以及Cs（空间复杂度）。以Cs为横坐标，Ct为纵坐标，散点图如下图所示。

空心的点代表没有被选中的序列。被选中的序列标记成了红点。注意，该图被划分为9个区域，分别表示Ct和Cs的高，中，低（H，M，L），该9个区域每个区域选择一个序列。

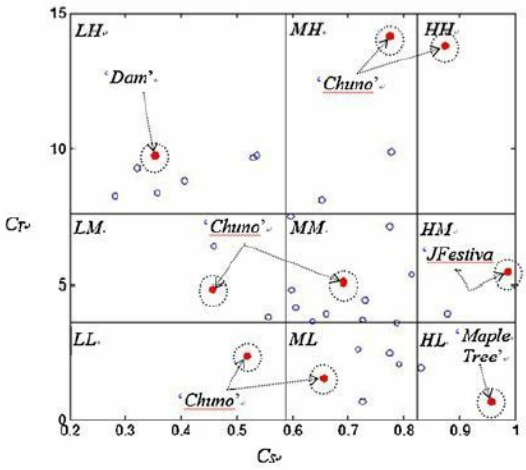

Fig. 1. 2-D scatter plot of the pairs of spatial and temporal variances for 36 extracted candidate test sequences. All the unselected empty circles indicate the candidate sequences from the *Chuno* video.

选择的序列的Cs（空间复杂度）以及Ct（时间复杂度）如图所示。

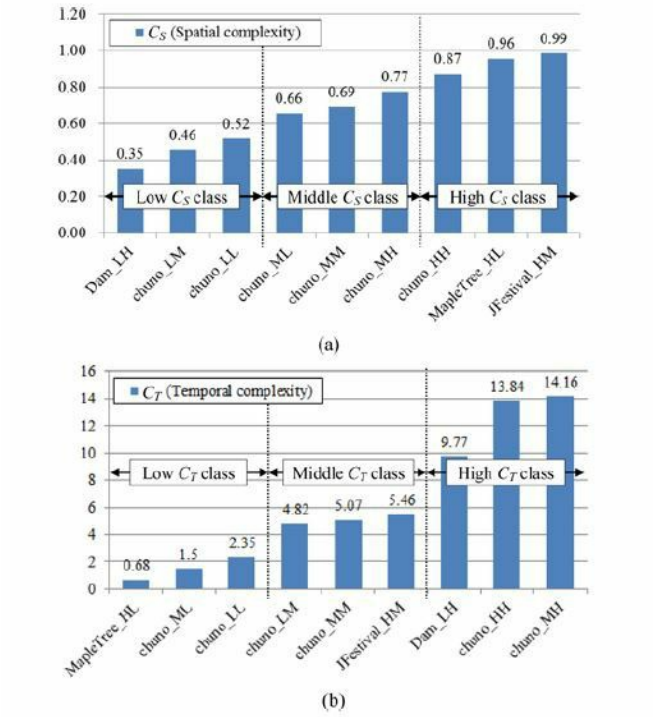

Fig. 2. Categorization of nine selected 4K-UHD test sequences. (a) C_S-based categorization. (b) C_T-based categorization.

选择的序列的内容如图所示。

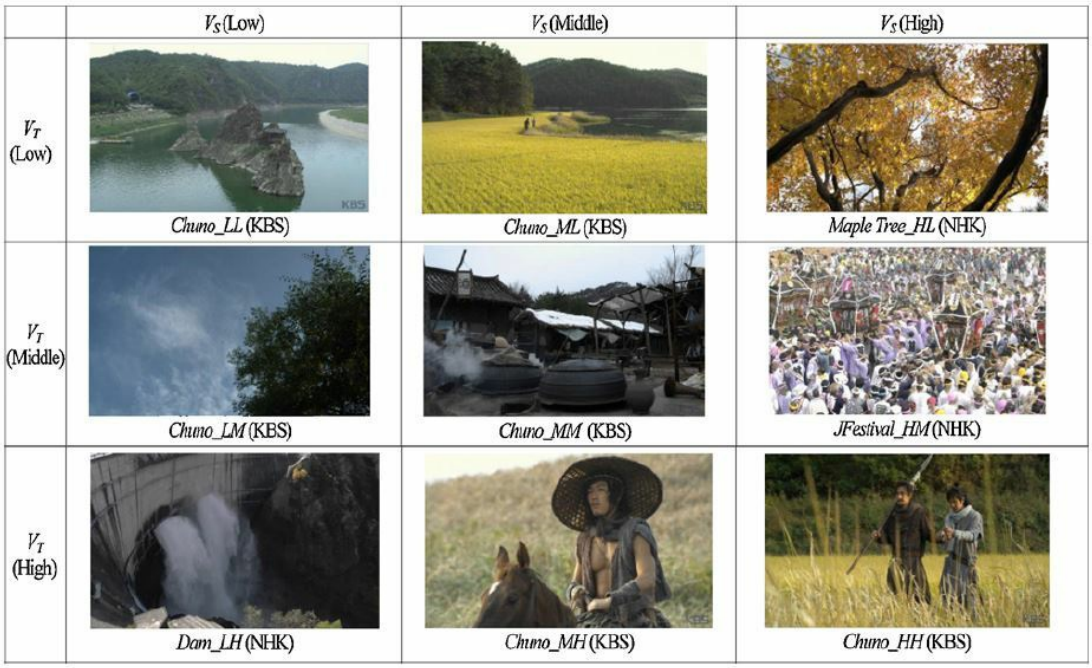

Fig. 3. Snapshots of nine selected 4K-UHD test sequences: *Four seasons* and *Chuno* provided by NHK and KBS, respectively.

CU和TU的四叉树结构如下图所示。

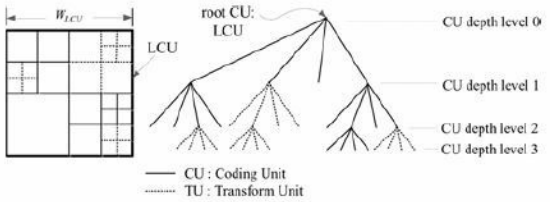

Fig. 5. CU and TU with quadtree structures in HEVC.

编码器配置如下表所示。

TABLE I
CONFIGURATION SETTING OF HM 5.0 (PROFILE: HIGH EFFICIENCY – RANDOM ACCESS)

Configuration	Parameters
Max CU size	64×64
Max TU size	32×32
Intra Period	16
Motion search algorithm	Enhanced Predictive Zonal Search
GOP size	8
GOP structure	IbBbPbBb
Motion search range	64
Deblock filter	Yes
Sample adaptive offset	Yes
Adaptive loop filter	Yes
LM chroma	Yes
Non-square transform	Yes

预期设定的比特率和实际比特率之间的比较如下表所示。每个序列期望达到18，23，36Mbps三个比特率。通过设定不同的QP，以达到相应的目标比特率。需要注意的是，根据序列内容的不同，设定的QP是不一样的。

TABLE II

COMPARISON OF THE TARGET BITRATES AND THE ACTUAL BITRATES ENCODED BY HM 5.0 WITH SELECTED QP VALUES SEQUENCES FOR YUV420 TEST SEQUENCES WITH THREE TARGET BITRATES

Test Sequences	Target Bitrates (Mb/s)	QP	Actual Bitrates (Mb/s)	$PSNR_{YUV}$ (dB)
Chuno_HH	36	22	37.81	41.78
	23	25	21.77	41.16
	18	26	18.26	40.92
Chuno_LL	36	25	38.97	39.99
	23	28	23.52	38.82
	18	30	17.25	38.03
Chuno_LM	36	22	37.21	41.59
	23	23	24.56	41.26
	18	24	17.10	40.97
Chuno_MH	36	21	39.27	42.74
	23	22	24.58	42.52
	18	23	14.96	42.36
Chuno_ML	36	25	36.72	38.51
	23	27	21.07	37.50
	18	28	17.12	37.16
Chuno_MM	36	22	36.50	41.76
	23	23	23.54	41.50
	18	24	16.41	41.28
Dam_LH	36	21	37.14	45.88
	23	23	21.22	45.22
	18	24	16.08	44.94
JFestival_HM	36	35	33.70	32.51
	23	36	22.53	31.75
	18	38	16.45	31.04
MapleTree_HL	36	31	38.47	34.45
	23	34	23.80	32.22
	18	36	17.56	31.67

$$PSNR_{YUV} = (6 \times PSNR_Y + PSNR_U + PSNR_V)/8.$$

下图（a）反映了不同码率的情况下，视频平均PSNR的大小。

（b）反映了不同码率下，同时又是不同Cs（空间复杂度），视频平均PSNR的大小。

（c）反映了不同码率下，同时又是不同Ct（时间复杂度），视频平均PSNR的大小。

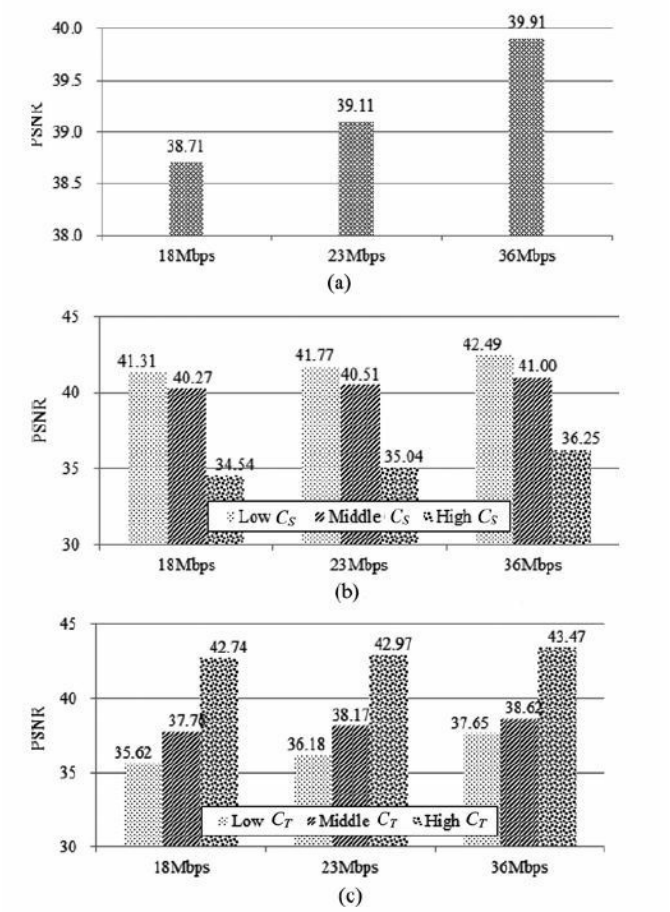

Fig. 6. Average PSNR values for C_S and C_T classes at different target bitrates. (a) Average PSNR values for all test sequences at different target bit rates. (b) Average PSNR values of test sequences in each *CS* class for different target bit rates. (c) Average PSNR values of test sequences in each C_T class for different target bit rates.

估算编码23Mbps的视频序列需要的QP值是通过下图所示的方法。如图所示，横坐标为QP，纵坐标为码率。已知QP为21的时候，码率大概为38Mbps，QP为24的时候，码率大概为17Mbps。则大致可以估计出，如果想要码率达到23Mbps，QP值应该取23（这两个数竟然一样，实在是一个巧合）

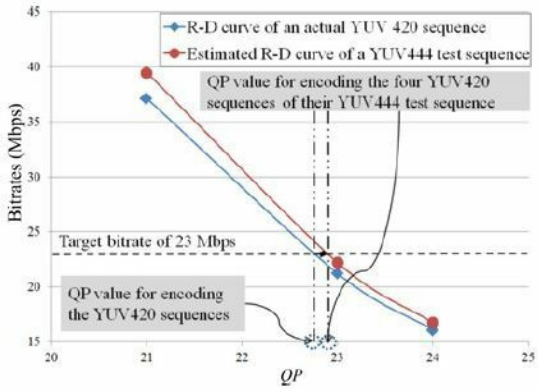

Fig. 8. QP estimation to encode four YUV420 *Dam_LH* sequences using HM 5.0 for the given target bitrate of 23 Mb/s.

DSIS（ 双刺激 损伤评价法(Double Stimulus Impairment Scale) :看原始图像,再看编码后图像,比较之打分,循环。 ）如下图所示。

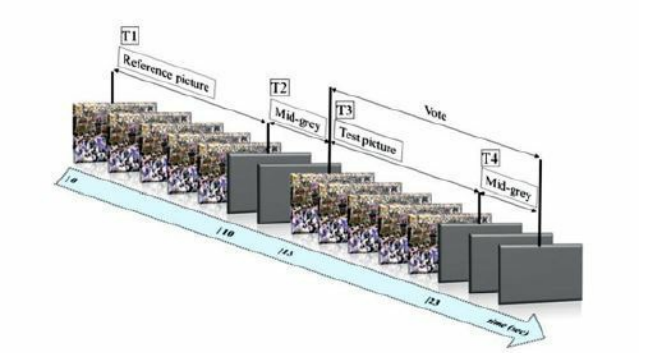

Fig. 9. Presentation of reference and impaired sequences in DSIS for subjective quality assessment [9], [15].

4组主观评价实验的测试序列参数如下表所示。

TABLE V
SESSION CONFIGURATIONS FOR SUBJECTIVE QUALITY ASSESSMENT ON 4K-UHD TEST SEQUENCES

Sessions	# of Test Sequences	Target Bitrates (Mbps)	Color Formats/Frame Rates of Original Seq. (T1)	Color Formats/Frame Rates of Reconstructed (Impaired) Seq. (T3)	Viewing Distances
Session I	9	18, 23, 36	YUV420/30 f/s	YUV420/30 f/s	0.75H
Session II	9	18, 23, 36	YUV420/30 f/s	YUV420/30 f/s	1.5H
Session III	9	18, 23, 36	YUV444/30 f/s	YUV420/30 f/s	1.5H
Session IV	9	18, 23, 36	YUV444/30 f/s	YUV444/30 f/s	1.5H

(*); Screen height, 0.7 m (UHD monitor).

4组实验的数据量太大了，这里不一一说明，只列出几张结果图。

第一组实验实验结果如图所示。注意第一组实验观察距离是0.75H。（a）图是各种序列的平均值。（b）图分为三种：低Cs，中Cs，高Cs。（c）图分为三种：低Ct，中Ct，高Ct。

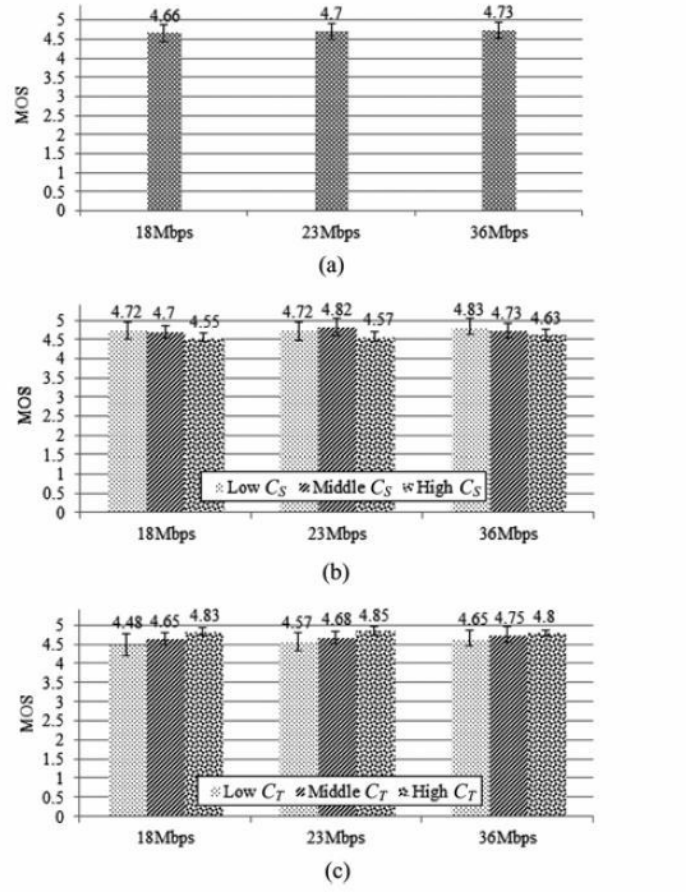

Fig. 10. MOS values of test sequences obtained in Session I. (a) MOS values of all test sequences at different target bitrates. (b) MOS values of the test sequences in the same categories of spatial complexity at different target bitrates. (c) MOS values of the test sequences in the same categories of temporal complexity at different target bitrates.

第二组实验实验结果如图所示。注意第二组实验观察距离是1.5H。依然是三个图。（a）图是各种序列的平均值。（b）图分为三种：低Cs，中Cs

，高Cs。（c）图分为三种：低Ct，中Ct，高Ct。

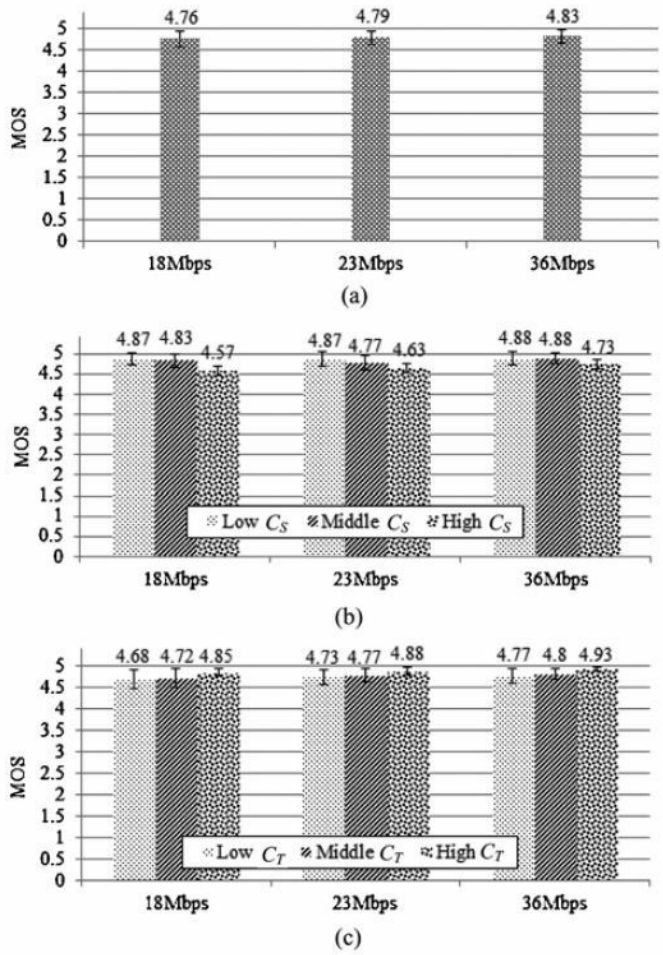

Fig. 11. MOS values of test sequences in Session II. (a) MOS values for all test sequences at different target bitrates. (b) MOS values versus spatial complexity categories at different target bitrates. (c) MOS values versus temporal complexity categories at different target bitrates.

第一组实验数据和第二组实验数据之间的比较。测试序列数量还是很多的。注意第一组实验观察距离是0.75H，第二组实验观察距离是1.5H。

整体来说差别不是很大，但是离近些的话，会更容易感受到视频质量的下降。画红色圈的序列表现比较明显。

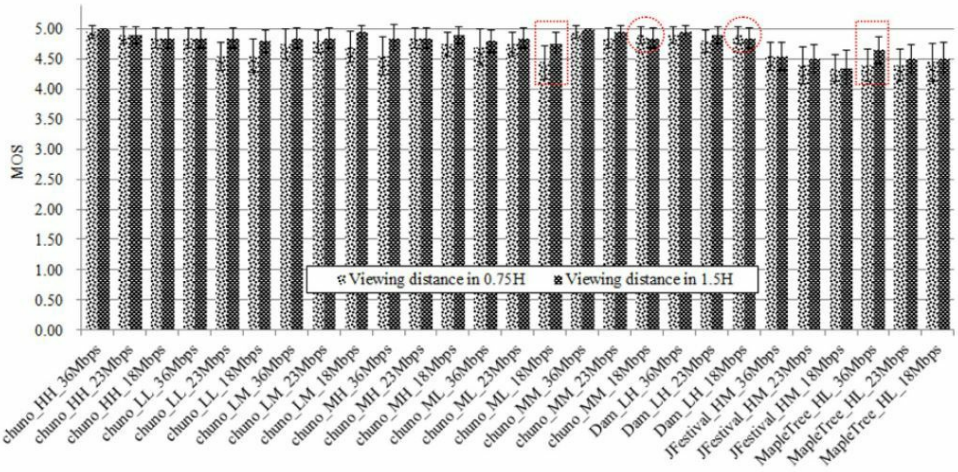

Fig. 12. MOS values for the subjective quality assessment under 0.75H and 1.5H viewing distances for the impaired YUV420 sequences in Sessions I and II.

第三组实验数据和第四组实验数据之间的比较。受损YUV420序列与受损YUV444序列之间的比较。第三组实验和第四组实验都是使用YUV444序列进行编码的。第三组实验解码后的受损序列是YUV420格式的。第四组实验解码后的受损序列是YUV444格式的。

使用YUV444格式编码的话，编码UV数据需要相对比较大的数据量。因而在码率相同的情况下，使用YUV420格式编码的时候Y的数据量会比YUV444大一些。从实验结果来看，YUV420序列的质量要好于YUV444。尤其在序列“Chuno−LM 18，23Mbps”，以及“MapleTree−HL 18,23,36Mbps”序列上表现明显。

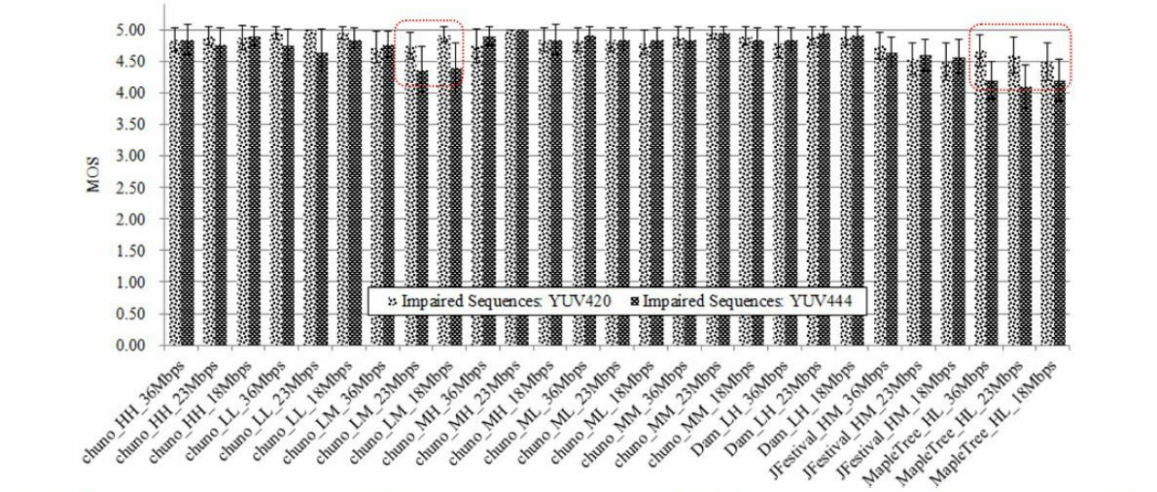

Fig. 13. MOS comparisons between the impaired YUV420 sequences against the original YUV444 test sequences (Session III) and the impaired YUV444 sequences against the original YUV444 test sequences (Session IV).

第二组实验数据和第四组实验数据之间的比较。第二组实验数据是YUV420编码后解码得到YUV420数据。第四组实验数据是YUV444编码后解码得到YUV444数据。

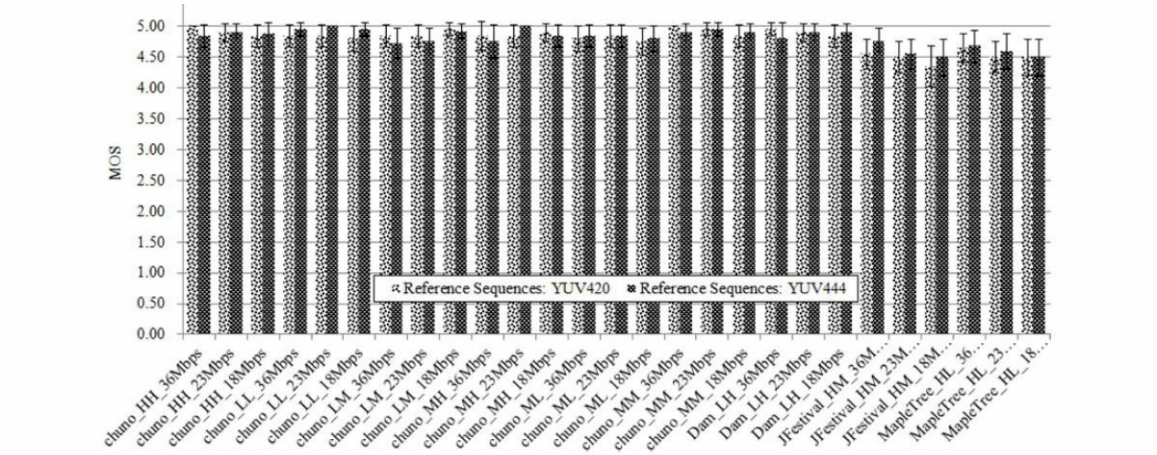

Fig. 14. MOS comparisons between the impaired YUV420 sequences against the original YUV420 test sequences (Session II) and the impaired YUV420 sequences against the original YUV444 test sequences (Session III).

论文地址： http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=6480797

文章标签： HEVC UHD 视频 质量评价 超高清

个人分类： 视频质量评价 视频编码 超高清/4K

所属专栏： 视频质量评价