

译 MSU 出品的 H.264 编码器比较 (2012.5)

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莫斯科国立大学的MSU Graphics & Media Lab (Video Group)出品的H.264编码器性能测试报告《Eighth MPEG-4 AVC/H.264 Video Codecs Comparison》。这个报告每年都有，这是最近的一次。它们测试了主流的H.264编码器的性能。从测试的结果来看，开源产品x264性能已经超过了商用编码器的性能。在此简单记录其结果。

一.概述

参与测试的编码器有如下几种：

H.264

- DivX H.264
- Elecard H.264
- Intel Ivy Bridge QuickSync (GPU encoder)
- MainConcept H.264 (software)
- MainConcept H.264 (CUDA based encoder)
- MainConcept H.264 (OpenCL based encoder)
- DiscretePhoton
- x264

非H.264

- XviD (MPEG-4 ASP codec)

使用的测试序列：

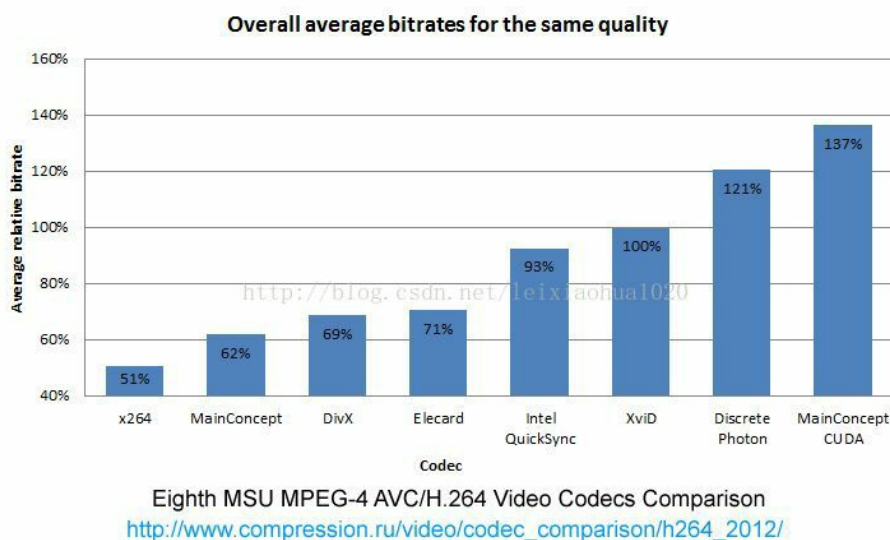
序列	帧数	帧率	分辨率
视频会议 (5 个)			
Deadline	1374	30	352x288
Developers 4CIF	3600	30	640x480
Developers 720p	1500	30	1280x720
Presentation	548	30	720x480
Business	493	30	1920x1080
电影 (10 个)			
Ice Age	2014	24	720x480
City	600	60	704x576
Crew	600	60	704x576
Indiana Jones	5000	30	704x288
Harbour	600	60	704x576
Ice Skating	480	60	704x576
Soccer	600	60	704x576
Race Horses	300	30	832x480
State Enemy	6500	24	720x304
Party Scene	500	50	832x480
HDTV (16个)			
Park Joy	500	50	1280x720
Riverbed	250	25	1920x1080
Rush Hour	500	25	1920x1080
Blue Sky	217	25	1920x1080

Station	313	25	1920x1080
Stockholm	604	50	1280x720
Sunflower	500	25	1920x1080
Tractor	690	25	1920x1080
Bunny	600	24	1920x1080
Dream	600	24	1920x1080
Troy	300	24	1920x1072
Water Drops	535	30	1920x1080
Capitol	600	30	1920x1080
Parrots	600	30	1920x1080
Citybus	600	30	1920x1080
Underwater	600	30	1920x1080

测试硬件设备配置：

Sugar Bay platform, 3rd Generation Core i7 3xxx(IVB), 4 Cores CPU @3.4 GHz, Integrated GPU: Intel HD Graphics 4000 GPU: NVIDIA GeForce GTX 580 HDD: SSD1 60G Total Physical Memory: 2x2 Gb RAM (1600 MHz)
OS Name: Microsoft Windows 7

总体结果：



编码器编码质量排序（注意：这里并没有考虑编码速度）：

1. x264
2. MainConcept
3. DivX H.264
4. Elecard
5. Intel Ivy Bridge QuickSync
6. XviD
7. DiscretePhoton
8. MainConcept CUDA

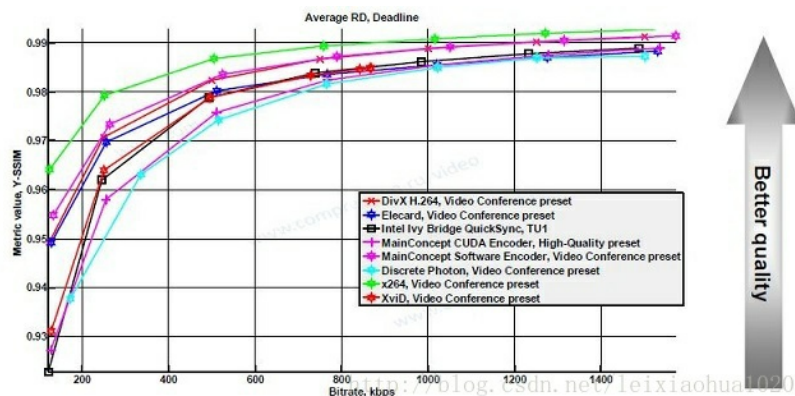
二.部分详细图表

整个测试分为三种场景：视频会议（Video Conferences），电影（Movies），高清电视（HDTV）。每种场景的每个测试视频序列都列了一张图表。总体说来图表数量非常之巨大。在此不能一一列举。仅仅举一些例子说明图表的意义。

2.1.视频会议（Video Conferences）

2.1.1.RD曲线 (RD Curves)

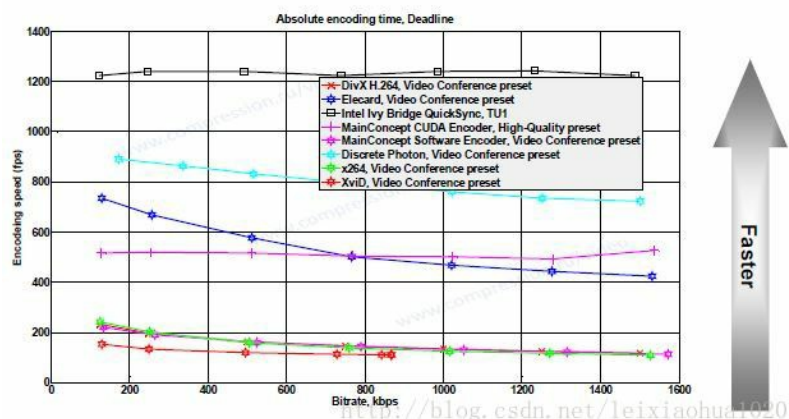
RD曲线是视频质量评价中最常见的一种曲线，中文名是率失真曲线。横坐标是码率，纵坐标是视频客观算法的结果（例如PSNR或者SSIM）。下面可以看一下第一个测试视频序列的RD曲线：



这张图的视频分辨率是QCIF (176×144)。曲线横坐标是视频的码率，纵坐标是计算出来的SSIM。SSIM取值0-1之间，值越大，代表视频质量越好。从曲线中可以看出，在码率相同的情况下，x264编码的视频质量要高于其他编码器（绿色的线）。第二名是MainConcept。

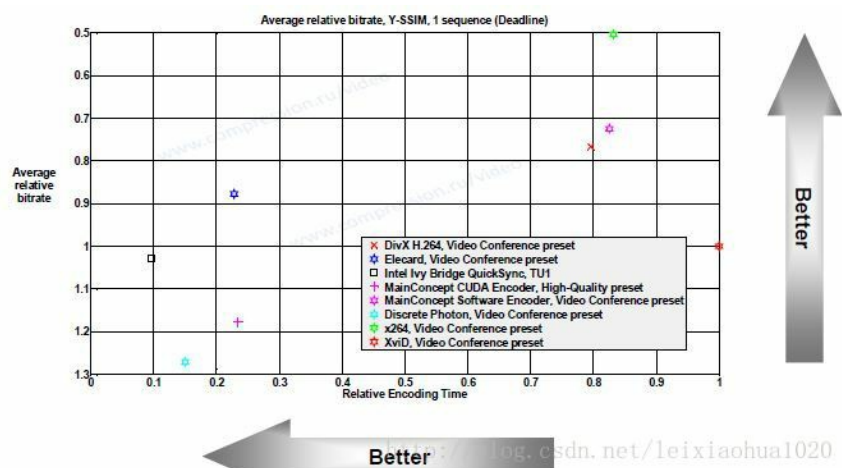
2.1.2.编码速度 (Encoding Speed)

编码速度的图表如图所示。横坐标是编码视频的码率，纵坐标是编码速度（在这里是每秒编码的帧数）。总体来说，随着编码的码率的增长，所有编码器的编码速度都有所下降。Intel Ivy Bridge QuickSync编码的速度非常之快，远超其他编码器。Discrete Photon, MainConcept CUDA和 Elecard在第二集团。X264编码速度算是比较慢的了。



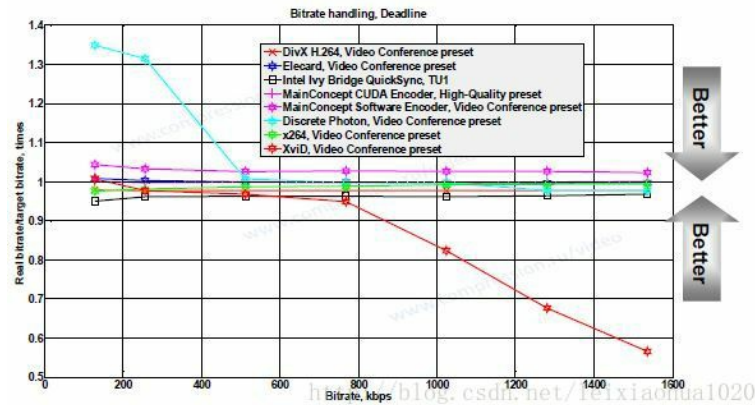
2.1.3.速度/质量权衡 (Speed/Quality Trade-Off)

一般情况下，编码速度越快，编码的质量就会差一些；编码对质量的要求较高，那么编码的速度就会慢很多。这就是所谓的“鱼和熊掌不可兼得”了。于是就有了速度/质量权衡的图表。在这张图表中，横坐标代表相对的编码时间，取值越小越好。纵坐标代表相同视频质量的时候编码器使用的相对码率。在这里MSU使用XviD作为参考编码器。即XviD在这张表的横坐标和纵坐标都是1，即位于 (1,1) 点。可以看出，X264是编码慢，质量最好。Intel Ivy Bridge QuickSync是编码最快，质量稍差。



2.1.4.码率控制 (Bitrate Handling)

这张图表用于测试编码器的码率控制性能。码率控制性能好的编码器，编码后输出的视频码率和编码前设定的码率相同。码率控制性能差的编码器，编码后输出的视频码率和编码前设定的码率差别会很大。图表中纵坐标是实际码率与设定码率的比值。这个值为1，代表码率控制准确。横坐标是码率。从图中可以看出XviD在码率大于800kbps之后，出现码率控制不准的情况。Discrete Photon在码率小于500kbps的时候也出现不准的情况。其他编码器码率控制都很准确。



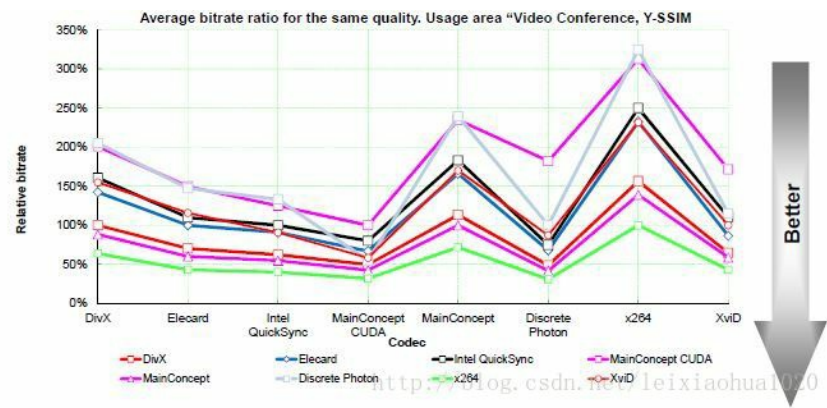
2.1.5.相对质量分析 (Relative Quality Analysis)

下列这张表列出了在相同的视频质量的前提下，不同的编码器需要使用的码率。可以看出，X264确实是最强悍的。

Table 3. Average bitrate ratio for the same quality. Usage area "Video Conference". Y-SSIM.

	DivX	Elecard	Intel QuickSync	MainConcept CUDA	MainConcept	Discrete Photon	x264	XviD
DivX	100%	142%	161%	201%	88%	205%	64%	155%
Elecard	70%	100%	110%	150%	60%	147%	43%	116%
Intel QuickSync	62%	91%	100%	125%	55%	133%	40%	91%
MainConcept CUDA	50%	67%	80%	100%	43%	55%	32%	58%
MainConcept	113%	166%	183%	235%	100%	240%	72%	170%
Discrete Photon	49%	68%	75%	182%	42%	100%	31%	87%
x264	156%	233%	250%	313%	139%	324%	100%	232%
XviD	65%	86%	110%	171%	59%	115%	43%	100%

下图以图形化的方式显示了上面那张表。不同颜色的线代表不同的编码器。纵坐标代表达到和横坐标编码器相同的视频质量需要的相对码率。



2.2.电影 (Movies)

电影 (Movies) 场景的实验方式和上文中的视频会议 (Video Conferences) 类似。在此不再详述，列出图表以作备忘。需要注意的是电影 (Movies) 场景每个编码器使用了3种preset：High Speed Preset，Normal Preset，High Quality Preset。其中High Speed Preset更注重编码的速度，视频的质量其次考虑。High Quality Preset更注重编码的质量，速度相对会慢一些。

2.2.1.1.RD曲线 (RD Curves)

(1) High Speed Preset

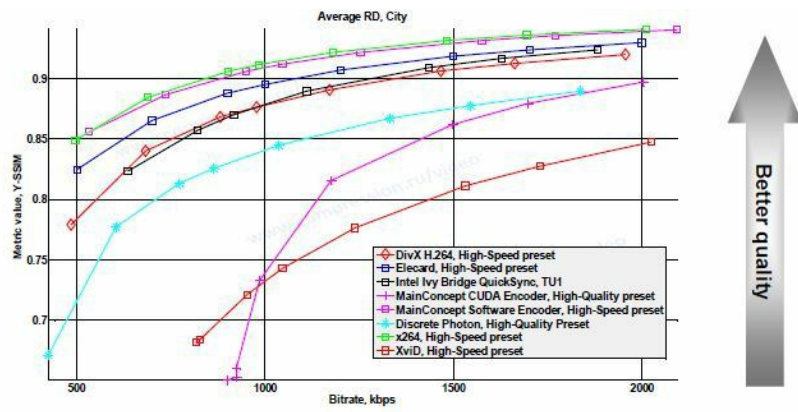


Figure 23. Bitrate/quality—usage area “Movies,” “City” sequence, High Speed preset, Y-SSIM metric

(2) Normal Preset

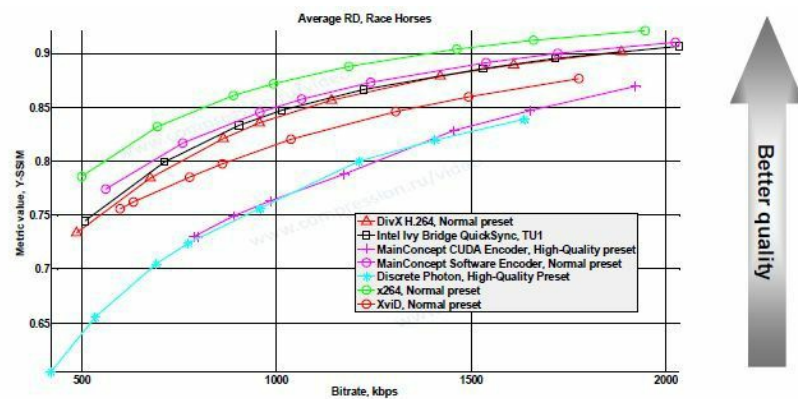


Figure 26. Bitrate/quality—usage area “Movies,” “Race Horses” sequence, Normal preset, Y-SSIM metric

(3) High Quality Preset

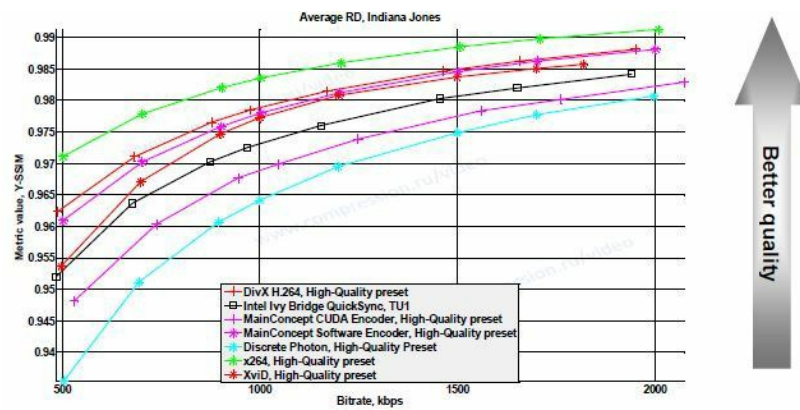


Figure 29. Bitrate/quality—usage area “Movies,” “Indiana Jones” sequence, High Quality preset, Y-SSIM metric

2.1.2.编码速度 (Encoding Speed)

(1) High Speed Preset

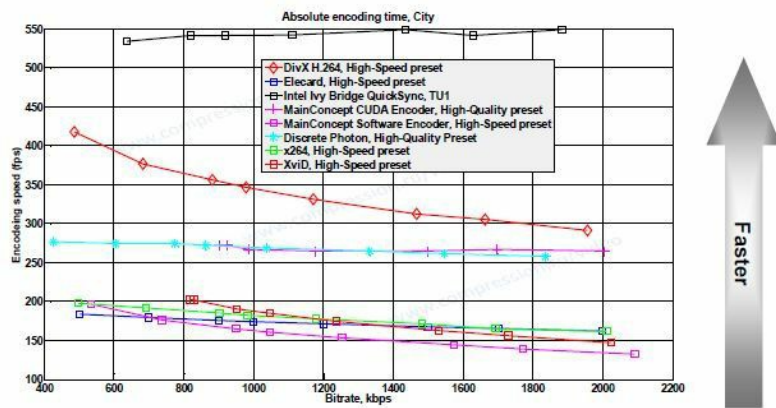


Figure 33. Encoding speed—usage area “Movie”
“City” sequence, “High Speed” preset

(2) Normal Preset

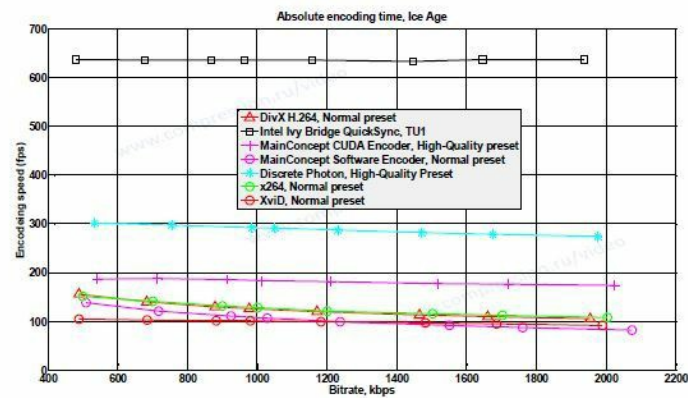


Figure 35. Encoding speed—usage area “Movies”
“Ice Age” sequence, Normal preset

(3) High Quality Preset

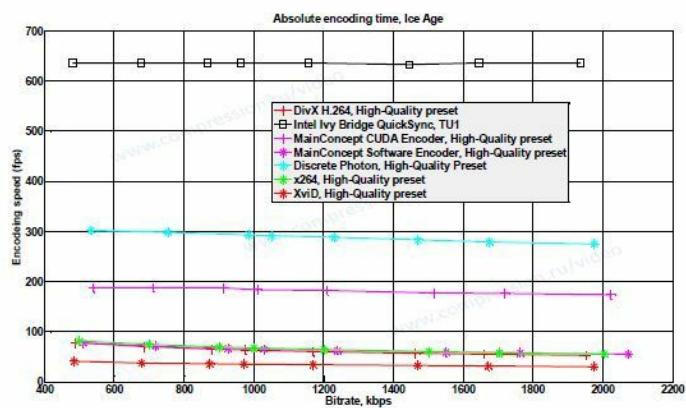


Figure 38. Encoding speed—usage area “Movies”
“Ice Age” sequence, High Quality preset

2.1.3.速度/质量权衡 (Speed/Quality Trade-Off)

(1) High Speed Preset

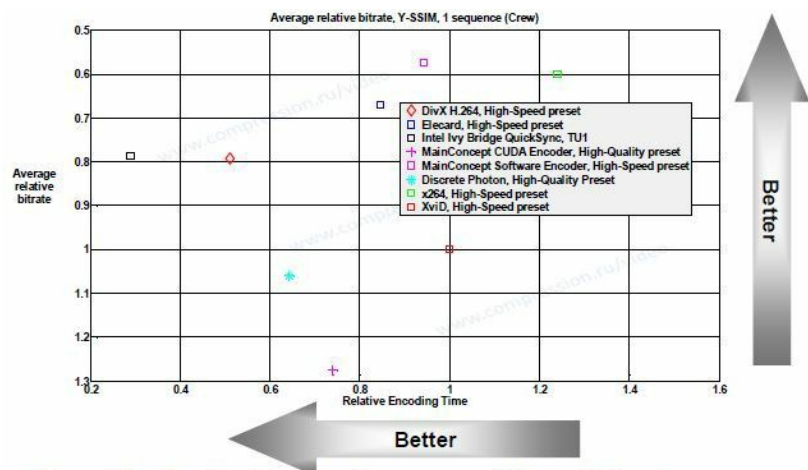


Figure 40. Speed/quality trade-off—usage area “Movies,” “Crew” sequence, High Speed preset, Y-SSIM metric

(2) Normal Preset

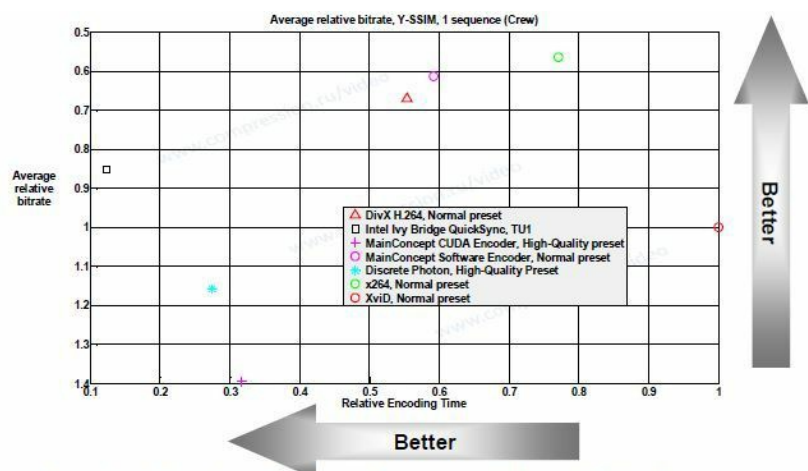


Figure 44. Speed/quality trade-off—usage area “Movies,” “Crew” sequence, Normal preset, Y-SSIM metric

(3) High Quality Preset

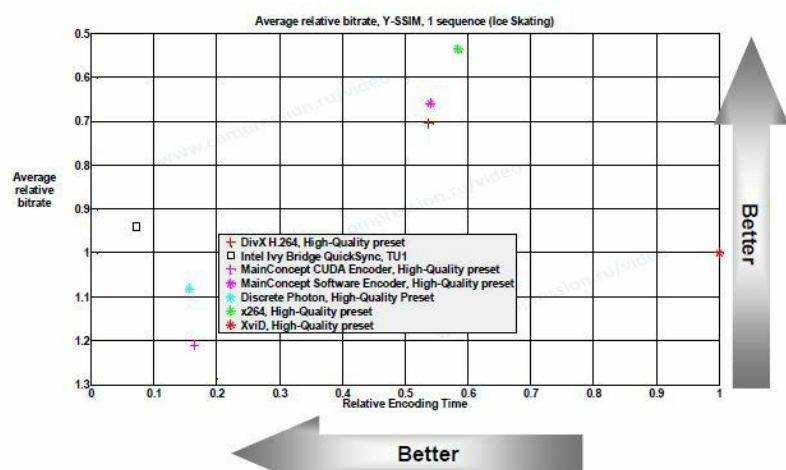


Figure 48. Speed/quality trade-off—usage area “Movies,” “Ice Skating” sequence, High Quality preset, Y-SSIM metric

2.1.1.1.码率控制 (Bitrate Handling)

(1) High Speed Preset

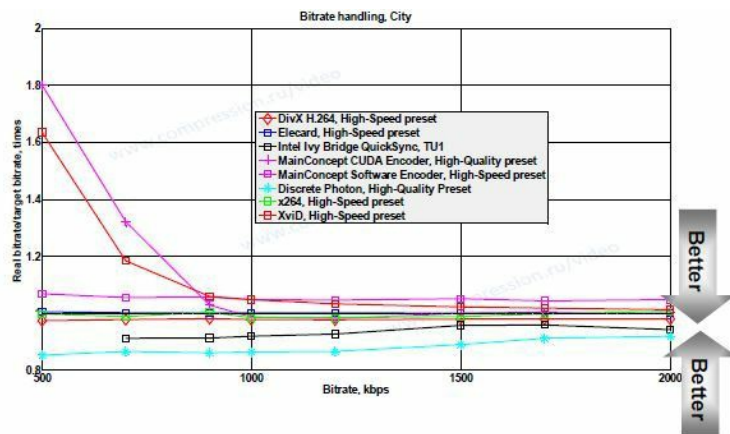


Figure 52. Bitrate handling—usage area “Movies,” “City” sequence, High Speed preset

(2) Normal Preset

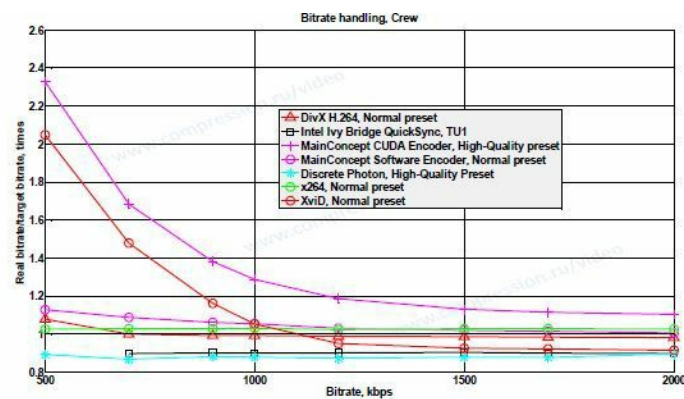


Figure 56. Bitrate handling—usage area “Movies,” “Crew” sequence, Normal preset

(3) High Quality Preset

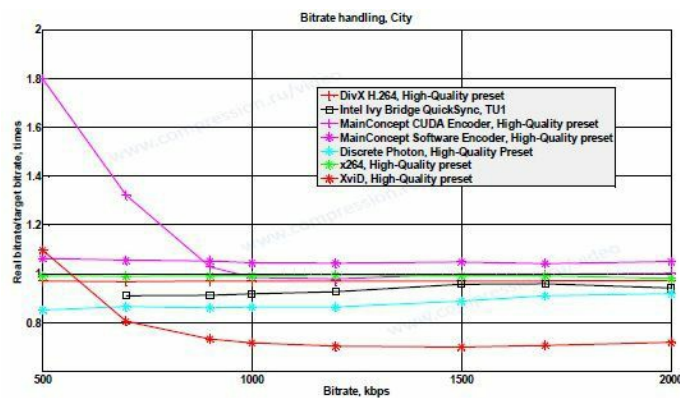


Figure 60. Bitrate handling—usage area “Movies,” “City” sequence, High Quality preset

2.1.1.相对质量分析 (Relative Quality Analysis)

(1) High Speed Preset

Table 5. Average bitrate ratio for the same quality. Usage area "Movie".
"High Speed" preset, Y-SSIM.

	DivX	Elecard	Intel QuickSync	MainConcept CUDA	MainConcept	Discrete Photon	x264	XviD
DivX	100%	80%	97%	155%	74%	140%	65%	140%
Elecard	126%	100%	115%	190%	91%	178%	82%	179%
Intel QuickSync	104%	87%	100%	183%	77%	147%	67%	145%
MainConcept CUDA	65%	53%	55%	100%	48%	77%	45%	92%
MainConcept	135%	110%	130%	208%	100%	194%	88%	174%
Discrete Photon	72%	56%	68%	130%	52%	100%	46%	101%
x264	154%	122%	148%	224%	114%	217%	100%	197%
XviD	72%	56%	69%	108%	58%	99%	51%	100%

(2) Normal Preset

Table 7. Average bitrate ratio for the same quality. Usage area "Movie".
"Normal" preset, Y-SSIM.

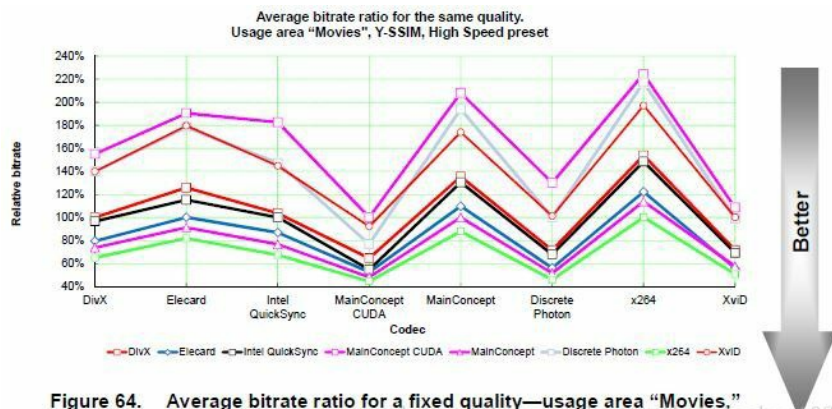
	DivX	Intel QuickSync	MainConcept CUDA	MainConcept	Discrete Photon	x264	XviD
DivX	100%	124%	195%	94%	180%	78%	148%
Intel QuickSync	81%	100%	183%	76%	147%	63%	121%
MainConcept CUDA	51%	55%	100%	48%	77%	41%	77%
MainConcept	106%	132%	210%	100%	197%	83%	160%
Discrete Photon	56%	68%	130%	51%	100%	42%	84%
x264	128%	160%	243%	121%	236%	100%	192%
XviD	68%	83%	130%	62%	119%	52%	100%

(3) High Quality Preset

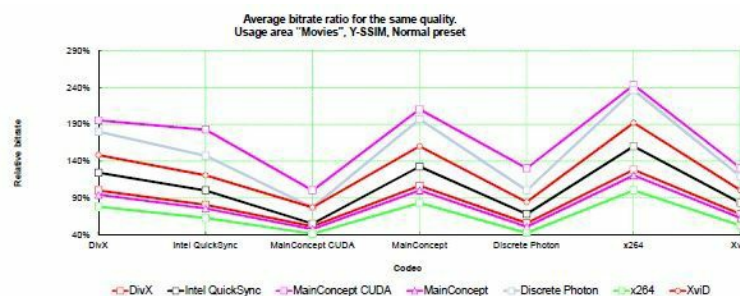
Table 9. Average bitrate ratio for the same quality. Usage area "Movie".
"High Quality" preset, Y-SSIM.

	DivX	Intel QuickSync	MainConcept CUDA	MainConcept	Discrete Photon	x264	XviD
DivX	100%	129%	201%	96%	189%	71%	144%
Intel QuickSync	77%	100%	183%	74%	147%	54%	112%
MainConcept CUDA	50%	55%	100%	47%	77%	36%	73%
MainConcept	104%	135%	214%	100%	200%	73%	149%
Discrete Photon	53%	68%	130%	50%	100%	37%	80%
x264	142%	184%	277%	137%	272%	100%	199%
XviD	70%	89%	136%	67%	125%	50%	100%

(1) High Speed Preset



(2) Normal Preset



(3) High Quality Preset

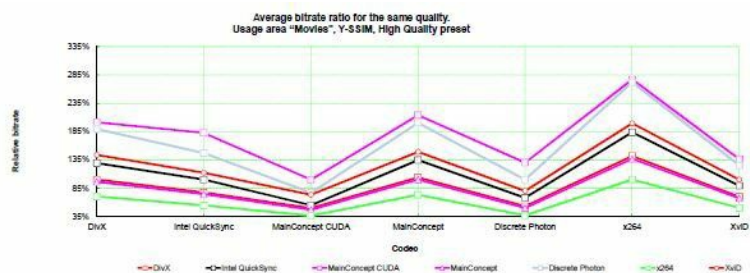


Figure 68. Average bitrate ratio for a fixed quality—usage area "Movies"
High Speed preset, Y-SSIM metric.

2.3.高清电视 (HDTV)

高清电视场景的测试方式也完全一样。图太多，不再例举。

三.附录

3.1.使用的测试视频序列

附上几张前面这些图表使用的测试视频序列的截图：

Deadline



City



Crew



Ice Age



3.2. 编码器

本次测试使用的编码器信息如下，都是控制台程序。此处不再翻译。

(1) DivX AVC/H.264 Video Encoder

- Console encoding program version 1.1.1.9
- Presets were chosen by ourselves to meet the comparison requirements

Remarks: Owing to our choice of presets, the results for the DivX H.264 encoder could be slightly diminished compared with the case where the developers provide the presets.

(2) Elecard AVC Video Encoder 8-bit edition,

- Console encoding program version 2.1.032820.120220
- Codec and presets were provided by Elecard Ltd Company specifically for this test

(3) MainConcept AVC/H.264 Video Encoder Console Application

- Console software and CUDA encoder applications and presets for them were provided by MainConcept AG Company specifically for this test

(4) x264

- Console encoding application with core:120 r2146 bcd41db was from the public repository
- Presets were provided by developers specifically for this test

Remarks: The presets provided by the developers for this comparison were specifically chosen for the SSIM metric.

(5) XviD raw mpeg4 bitstream encoder

- Console encoding program
- Codec and presets used was taken from previous comparison

(6) Discrete Photon

- Console encoding application version (1.1.0.4) and presets was provided by developers specifically for this test

(7) Intel Ivy Bridge QuickSync

- Transcoder and presets was provided by Intel specifically for this test
- Intel Ivy Bridge Platform used in hardware/software comparison was provided by Intel

3.3. 基于GPU硬件的编码器的比较

直接比较软件编码器和硬件编码器（基于GPU）在某些条件下并不是非常合适。因为基于GPU的硬件编码器可以调用更为强大的计算资源，因此有更快的计算速度。但

是基于GPU的编码器不能使用一些提高视频编码质量的算法，从而导致其质量不能达到最好。在这里单独列出基于GPU的编码器并对其性能进行性比较。如下所列：

- Intel Ivy Bridge QuickSync (GPU encoder)
- MainConcept H.264 (CUDA based encoder)
- MainConcept H.264 (OpenCL based encoder), ATI 6970 graphic card was used

在这里使用HD (1920x1080) 的测试视频序列进行比较。实际上编码HD视频是硬件编码器主要的作用。

本文中仅列几个图示。

(1) RD曲线 (RD Curves)

Intel Ivy Bridge QuickSync整体上最好，个别视频中MainConcept H.264 (OpenCL based encoder)编码器性能会更好。MainConcept H.264 (CUDA based encoder)一般情况下都排在最后。

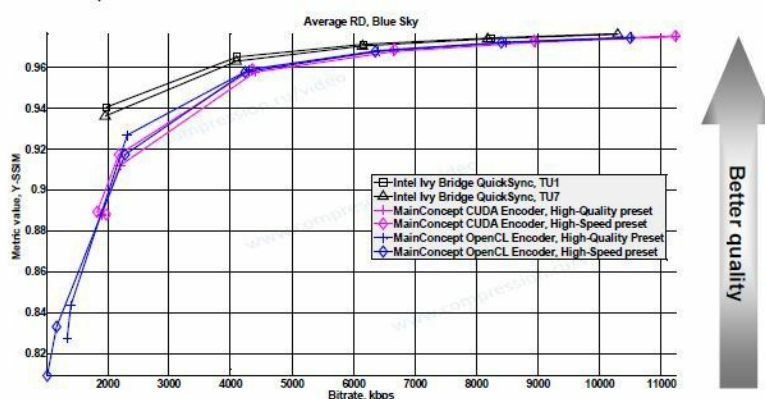


Figure 177. Bitrate/quality, GPU encoders, "Blue Sky" sequence, Y-SSIM metric

(2) 码率控制 (Bitrate Handling)

除了低码率的情况外，所有编码器的码率控制都不错。MainConcept在低码率情况下输出实际码率偏高，Intel Ivy Bridge QuickSync 不编码低码率视频。

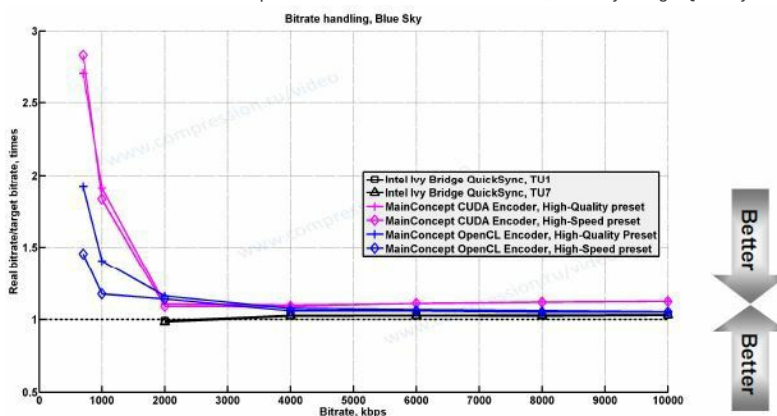


Figure 181. Bitrate handling, GPU encoders, "Blue Sky" sequence

(3) 速度/质量权衡 (Speed/Quality Trade-Off)

Intel Ivy Bridge QuickSync整体在速度和质量上都有些优势。MainConcept H.264 (OpenCL based encoder)编码器性能好于MainConcept H.264 (CUDA based encoder)

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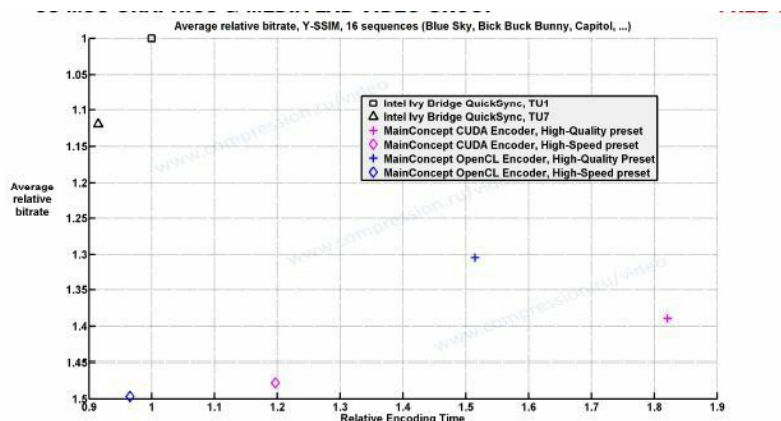


Figure 185. Speed/quality trade-off, GPU encoders, all sequences, Y-SSIM metric

(4) 结论 排序如下：

1. Intel Ivy Bridge QuickSync
2. MainConcept OpenCL
3. MainConcept CUDA

3.4.x264各个版本之间比较

此外，作为最优秀的H.264编码器x264.对比了其各个版本之间性能的区别，排序如下，可以看出其一直是出于发展状态的。1. x264 (2012)2. x264 (2011)

3. x264 (2010)
4. x264 (2009)
5. x264 (2007)
6. x264 (2006)
7. x264 (2005)

(1) RD曲线 (RD Curves)

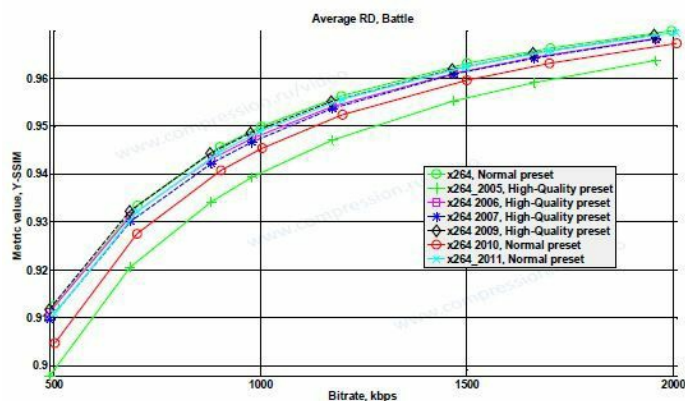


Figure 206. Bitrate/quality, x264 encoders, "Battle" sequence, Y-SSIM metric

(2) 速度/质量权衡 (Speed/Quality Trade-Off)

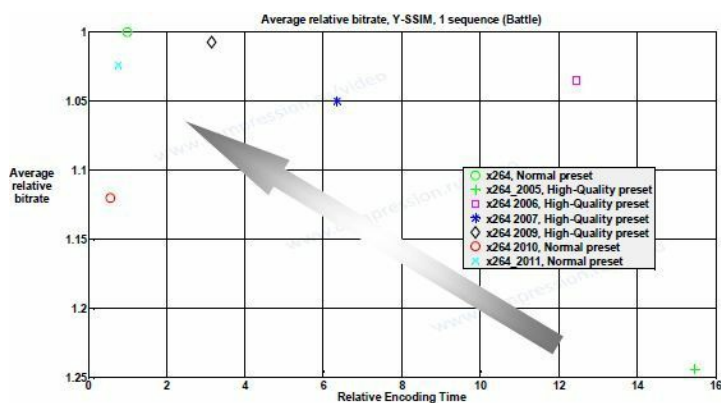


Figure 207. Speed/quality trade-off, x264 encoders, "Battle" sequence, Y-SSIM metric

完整文档地址：http://www.compression.ru/video/codec_comparison/h264_2012/mpeg4_avc_h264_video_codecs_comparison.pdf

文章标签：[H.264](#) [视频编码器](#) [速度](#) [视频质量](#) [cuda](#)

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