Analyze of the MPEG-4 Compressed Streams

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Abstract: - In this paper, an analysis of video quality of compressed MPEG-4 stream is performed. The video quality is performed using a test system composed by two metering devices: TEKTRONIX PQA500 Picture Quality Analyzer and TEKTRONIX MTS4EA Elementary Stream Analyzer. The measured parameters of compressed MPEG-4 signal are: macro block measurements and PSNR.

Key-Words: - video quality signal, macro block measurements, MPEG-4, PSNR, DMOS

1 Introduction

In [1], a measurement system is proposed for the test of the DVB(Digital Video Broadcasting) receivers. In [2], an analysis of baseband transmission channel parameters in DVB Video signal is performed. The simulation model proposed take in account the evaluation of subjective picture quality.
In [3], the authors propose a proxy caching system using MPEG-4 codec for video compression and offering streaming services with a better quality.
Another approach is proposed by Chaari R. et. al. in [4]. The authors propose an adaptive BCH scheme to improve the quality of image transmission.
Because the available bandwidth in a wireless networks is limited, Liu Y.-P. et. al. propose in [5] a method based on H.264/AVC standard to reduce the necessary bandwidth and improve the quality of video transmission.
Currently, for evaluating the image quality by measurements, two measurement methods are used using:

- Objectives methodologies – which measures at the MPEG compressed video stream level;
- Measurement methodologies based on subjective criteria related to human images perception – which measures at the uncompressed video signal level.

Modern methods for assessing the quality of video signals based on human perception modeling leads to very good results compared with classical methods of subjective evaluation using human observers [3].
These measurements provide precise and repeatable data of DMOS and PQR values and a detailed analysis of artifacts which inevitably appear in the MPEG encoding process. The measurements allow the optimization of video processing block for images quality improvement based on the generating of Attention Model (AM) as is in the TEKTRONIX PQA 500 device based on this measurement methodology.
In this case, the question is if do we need equipment that measure using objective evaluation methods or it is just a rhetorical question?
This paper tries to give a response to this issue in case of a TEKTRONIX PQA 500 and MTS4EA (MPEG analyzer software version) now widely used for such as measurements.

2 Test measurement scheme

In order to make a correct comparison regarding measurement results that were made with the two equipments we picture a measurement scheme that includes a unique reference signal source, a MPEG coding – decoding chain and the equipments.
To carry out the measurement a video processing structure made by a coding-decoding assembly, delivered by the same corporation, was used.
The YUV decoded signal of MTS4EA output wasn't used because of ignoring for some errors types to a certain level.
The main signal source is a video file in YUV format which is MPEG – 4 coded and decoded.
The measurement system schema is shown below in Fig 1:

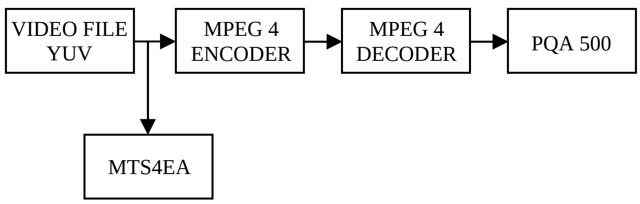


Fig. 1 Test measurement scheme

This way the signal quality will be measured with both equipments on the same signal type. Measurements made with PQA 500 were accomplished with a same schema from Fig. 1 and they were automatically assumed for the present test where the PQA 500 measurements were completed by the MTS 4EA measurements.

2.1 Measurements Performing

TEKTRONIX MTS4EA is a software version of stream analyzer in order to detail measure MPEG – 2, MPEG – 4 and H264.AVC streams [6].
Using the compressed file at the output of MPEG–4 encoder the next measurements types were made with this equipment:
- Compliance measurements – made automatically by equipment when access the test file for visualization. At the file access the following alarm was produced (Fig. 2):

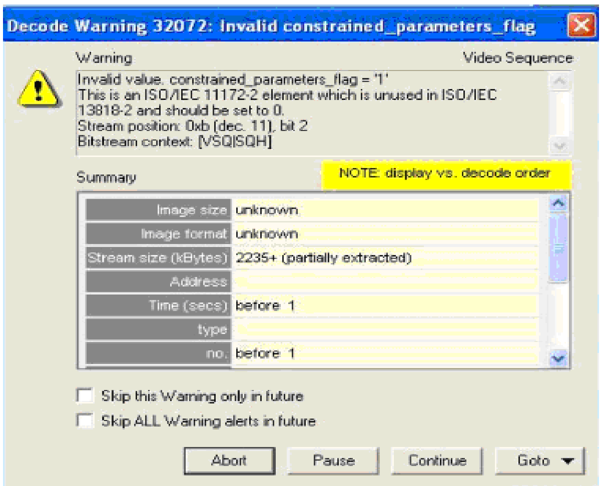


Fig. 2 The alarm produced

The alert message point to an error in the video sequence that is not registered in the Hex format and it is automatically put on O.
By ignoring this alarm the investigation may continue with the alarm visible during video clip duration.
In Fig. 3 is shown the status at 2.6 seconds after the playing started.
- Macro-block measurement – a specific measurement for MPEG analyzers which complete verify the coder and its response to different signal types. In order to perform the measurement MB (Macro Block) distribution was catch for different clip frames to visualize the coder functionality and its response varying witch applied signal type. The logged data are presented below for the 73 to 76 frames in Fig. 4, Fig. 5, Fig. 6 and Fig. 7.

Fig.4 The logged data. Frame number 73.

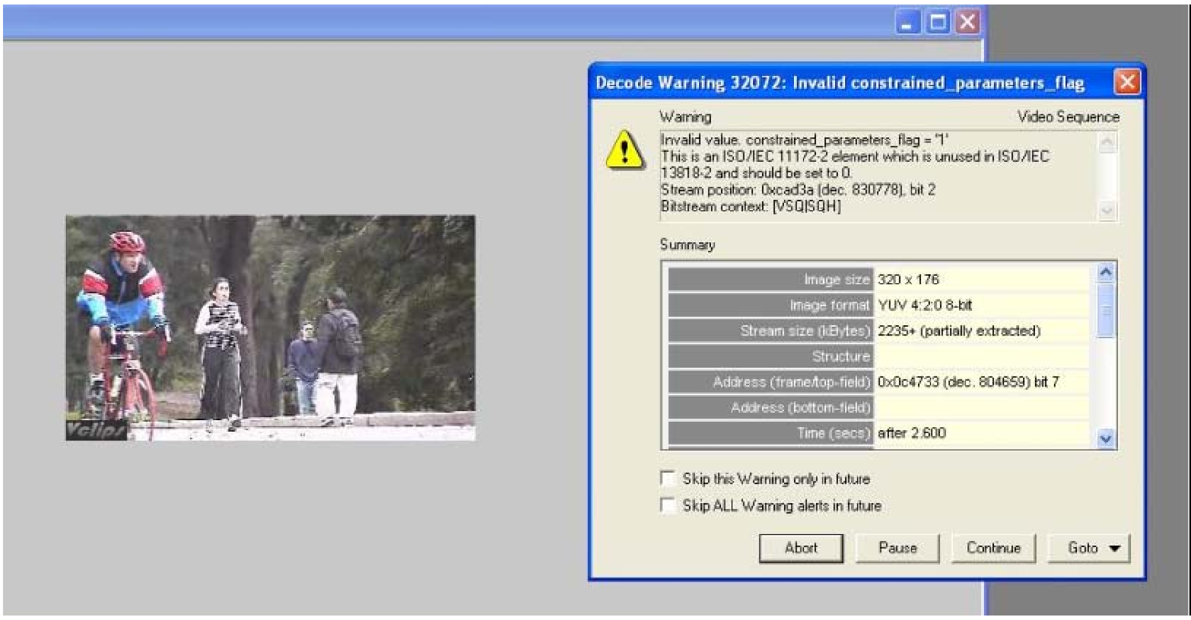


Fig. 3 The status after 2.6 seconds

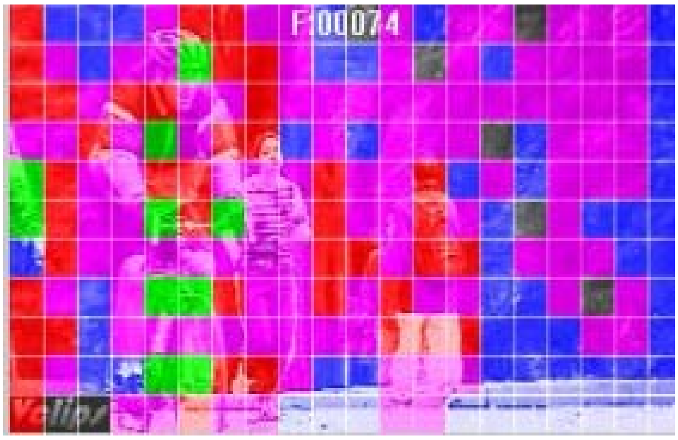


Fig.5 The logged data. Frame number 74.

Fig.6 The logged data. Frame number 75.

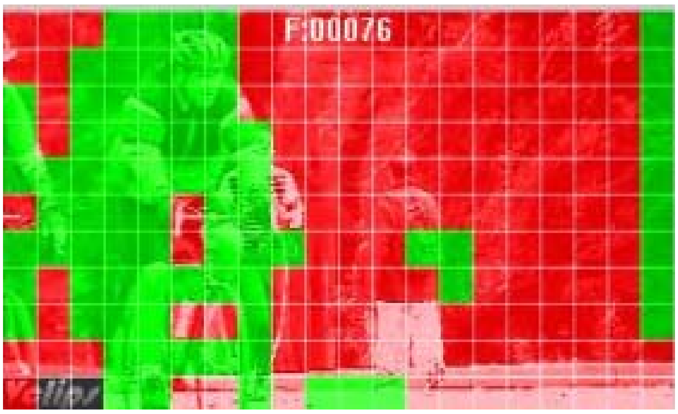


Fig.7 The logged data. Frame number 76.

The MB structure is reloaded after 12 frames and indicates a correct functionality of the coder which is coding or a predictive structure with low bits number.
The structure of a MB and MB types key are shown in Fig. 9 and Fig. 10.
The graphics for spatial bits per MB coded and MB coded frequency are shown in Fig. 11 and Fig. 12

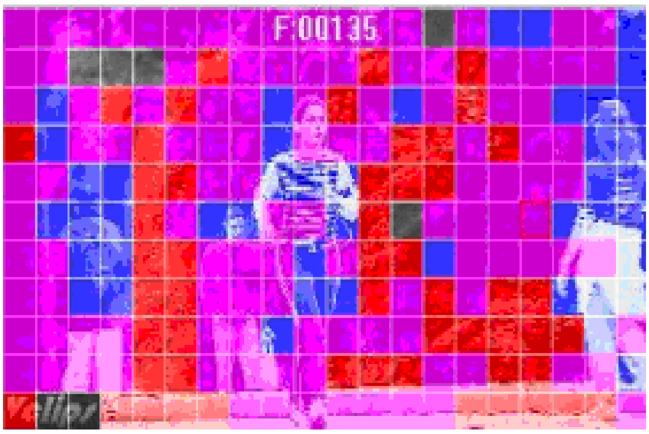
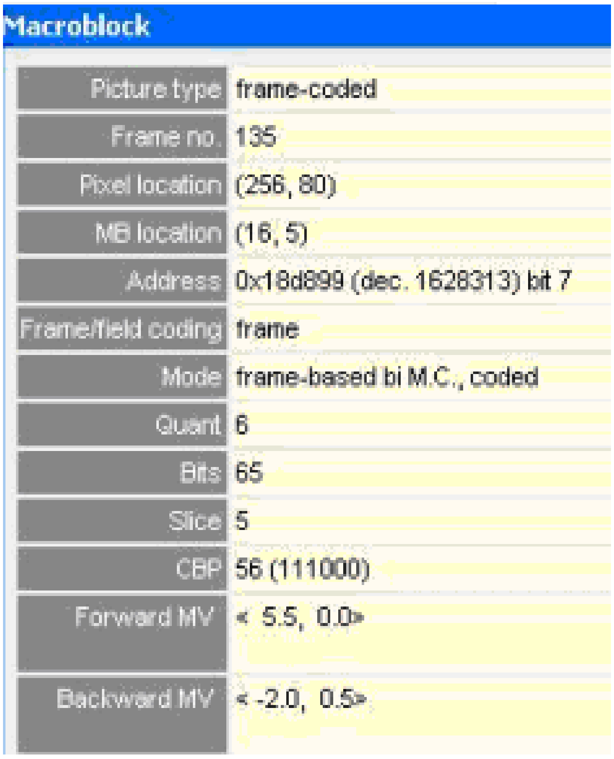


Fig. 8 The structure of MB for the frame number 135.



Macroblock

Picture type	frame-coded
Frame no.	135
Pixel location	(256, 80)
MB location	(16, 5)
Address	0x18d899 (dec. 1628313) bit 7
Frame/field coding	frame
Mode	frame-based bi M.C., coded
Quant	6
Bits	65
Slice	5
CBP	56 (111000)
Forward MV	< 5.5, 0.0>
Backward MV	< -2.0, 0.5>

Fig. 9 The structure of MB

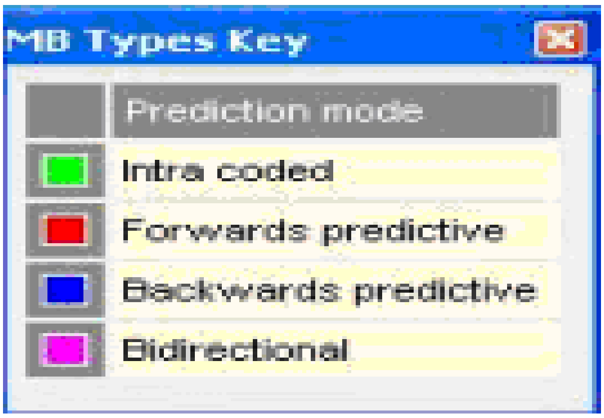


Fig. 10 The structure of MB Types key

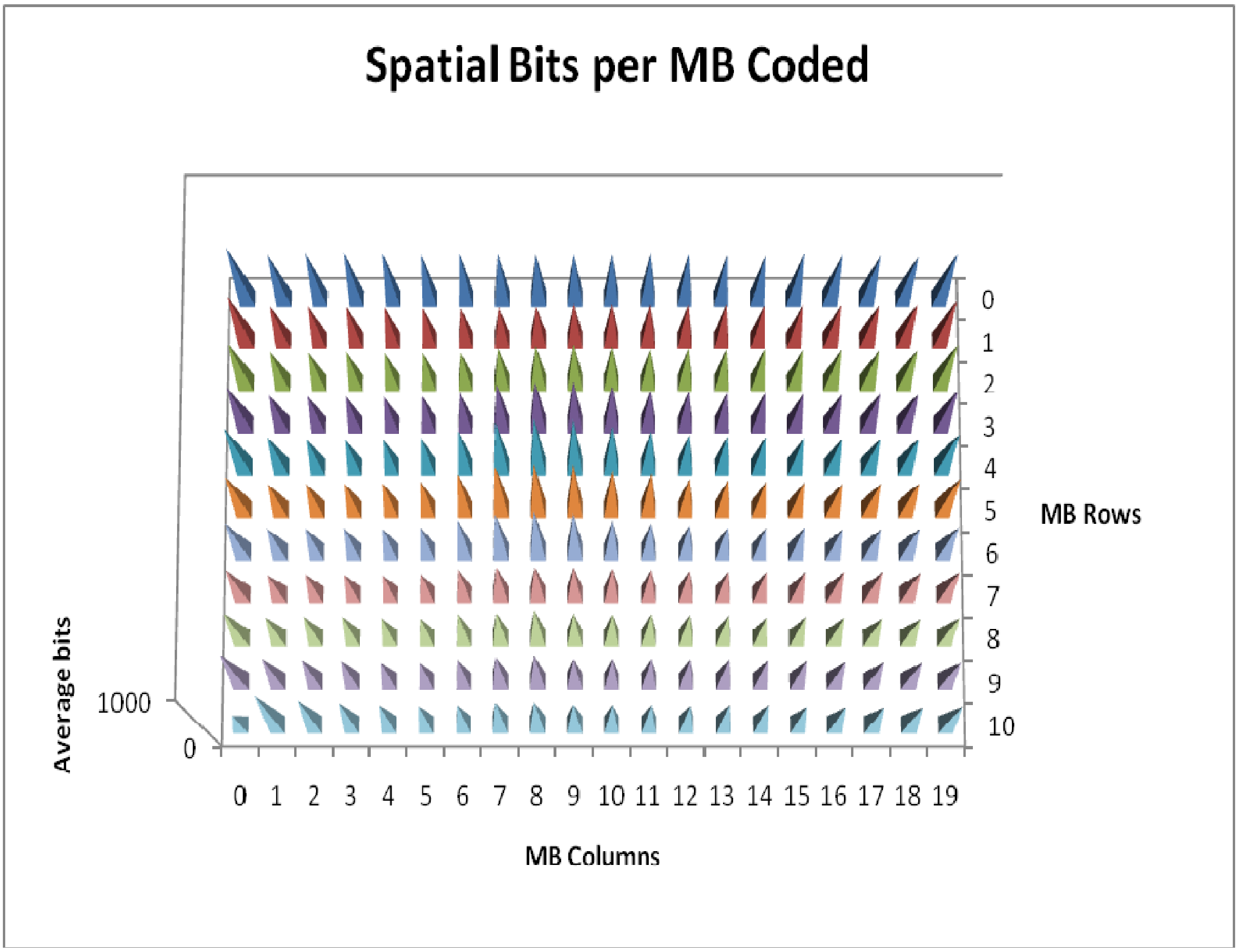


Fig. 11 Spatial Bits per MB coded

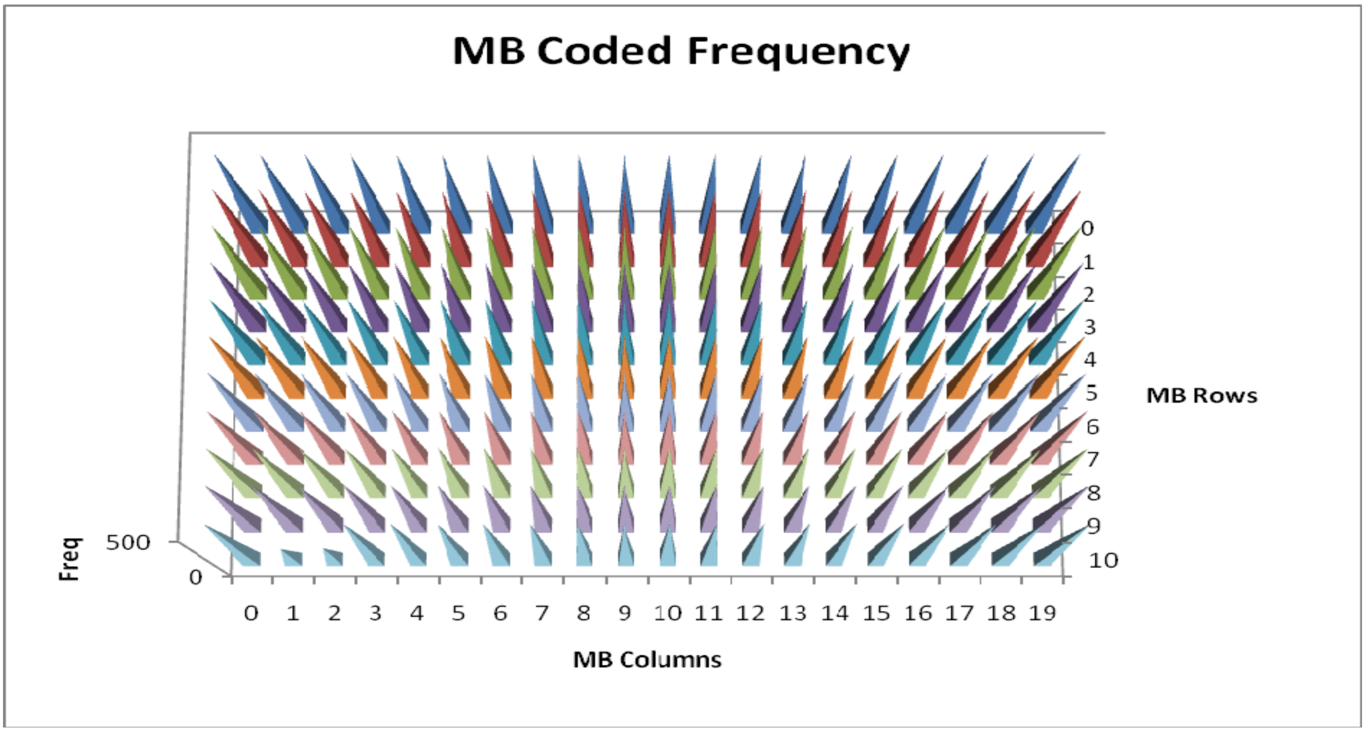


Fig. 12 MB coded frequency

- Motion vectors measurements – made on the entire image and that verify the correct functioning of the encoder [9].

The logged data are presented below for the frame number 118, 120, 121, 122, 123 and 124 in Fig. 13, Fig. 14, Fig. 15,Fig. 16, Fig. 17, Fig. 18 and Fig. 19. The motion vectors are stable and were the appropriate orientation:

- video buffer measurements – which attend the correct functionality of the buffer meaning correct dimensioning and avoiding of the overflow or sub-flow state.

Fig. 13 Motion vectors measurements. Frame number 118

Fig. 14 Motion vectors measurements. Frame number 119

Fig. 15 Motion vectors measurements. Frame number 120

Fig. 16 Motion vectors measurements. Frame number 121

Fig. 17 Motion vectors measurements. Frame number 122

Fig. 18 Motion vectors measurements. Frame number 123

Fig. 19 Motion vectors measurements. Frame number 124

Video buffer capture is presented in the following picture (Fig. 20):

Fig. 20 Video buffer capture

The measurement point to a correct functionality of the buffer, avoid the limit states (Fig. 21 and Fig. 22).

- PSNR Measurement – it is the only measurement for which the equipment made a comparison between the reference sequence and the test ones.

The capture was made in the interval of 1 and 3.3 seconds, evaluate on YUV components.

The measurements indicate PSNR values over 30dB for V component when that it is not an issue, the measurement could be compared with the PQA 500 one (Fig.23 and Fig. 24).

2.2. Measurements performed with PQA 500

The goal of this paper is to make a comparison between the two types of measurement therefore from the PQA measurements will be selected only representative types and those who could be used for PSNR measurements on Attention Model, DMOS and PSNR on Perceptual Difference Map and artifact detection [8]. Table 1, Table 2 contains the values measured for the attention mode using PQA500 (the tables contains the values for the first 22 frames) .

Table 1 Measured parameters using PQA500 for the first 22 frames: Min,Max, Mean Abs.

Frame <Ref Test>	Min	Max	Mean Abs.
#1.0<1.0 1.0>	0	0.156	0.000
#1.5<1.5 1.5>	-0.37285	0.484	0.010
#2.0<2.0 2.0>	-0.83472	0.672436	0.008
#2.5<2.5 2.5>	-143.165	1.953.293	0.012
#3.0<3.0 3.0>	-205.161	8.405.715	0.020
#3.5<3.5 3.5>	-258.272	3.965.699	0.033
#4.0<4.0 4.0>	-479.795	8.918.234	0.051
#4.5<4.5 4.5>	-168.374	1.177.587	0.081
#5.0<5.0 5.0>	-710.493	1.419.402	0.117
#5.5<5.5 5.5>	-752.289	1.634.959	0.164
#6.0<6.0 6.0>	-114.178	2.634.846	0.184
#6.5<6.5 6.5>	-142.395	164.996	0.212
#7.0<7.0 7.0>	-195.706	3.943.591	0.202
#7.5<7.5 7.5>	-15.001	2.309.217	0.216
#8.0<8.0 8.0>	-879.782	2.448.107	0.199
#8.5<8.5 8.5>	-837.184	3.986.105	0.192
#9.0<9.0 9.0>	-547.816	1.780.485	0.185
#9.5<9.5 9.5>	-815.093	1.695.904	0.213
#10.0<10.0 10.0>	-114.422	2.004.411	0.226
#10.5<10.5 10.5>	-141.081	1.962.373	0.222
#11.0<11.0 11.0>	-149.623	2.445.609	0.202

Table 2. Measured parameters using PQA500 for the first 22 frames:DMOS, PQR and PSNR

Frame <Ref Test>	DMOS	PQR	PSNR
#1.0<1.0 1.0>	0.011235	0.14872	969.863
#1.5<1.5 1.5>	0.268062	0.731946	7.935.299
#2.0<2.0 2.0>	0.513148	1.019.899	77.292
#2.5<2.5 2.5>	1.444.257	1.756.132	7.284.757
#3.0<3.0 3.0>	5.124.211	3.340.509	6.774.145
#3.5<3.5 3.5>	6.492.383	3.757.437	6.494.441
#4.0<4.0 4.0>	1.638.819	5.657.555	6.104.097
#4.5<4.5 4.5>	3.046.607	7.775.987	5.756.867
#5.0<5.0 5.0>	4.282.088	9.448.662	5.478.807
#5.5<5.5 5.5>	5.558.443	1.143.857	5.237.961
#6.0<6.0 6.0>	5.991.089	1.245.035	5.144.975
#6.5<6.5 6.5>	6.335.132	1.323.442	5.055.821
#7.0<7.0 7.0>	6.642.521	1.423.582	5.030.958
#7.5<7.5 7.5>	6.568.303	1.390.824	5.011.593
#8.0<8.0 8.0>	6.386.197	1.334.939	5.073.065
#8.5<8.5 8.5>	6.522.751	1.370.584	5.075.205
#9.0<9.0 9.0>	6.037.605	1.255.737	5.131.623
#9.5<9.5 9.5>	6.447.656	1.348.729	5.034.935
#10.0<10.0 10.0>	6.665.733	1.433.774	497.002
#10.5<10.5 10.5>	6.706.972	1.451.818	4.966.204
#11.0<11.0 11.0>	653.434	1.375.743	5.036.372

The details about video sequence used in tests as reference video for comparations are in Table 3:

Table 3. Reference video sequence details

Name	V031051_Stripy_jogger_320x180p.yuv
Width	320
Height	180
Format	Progressibe

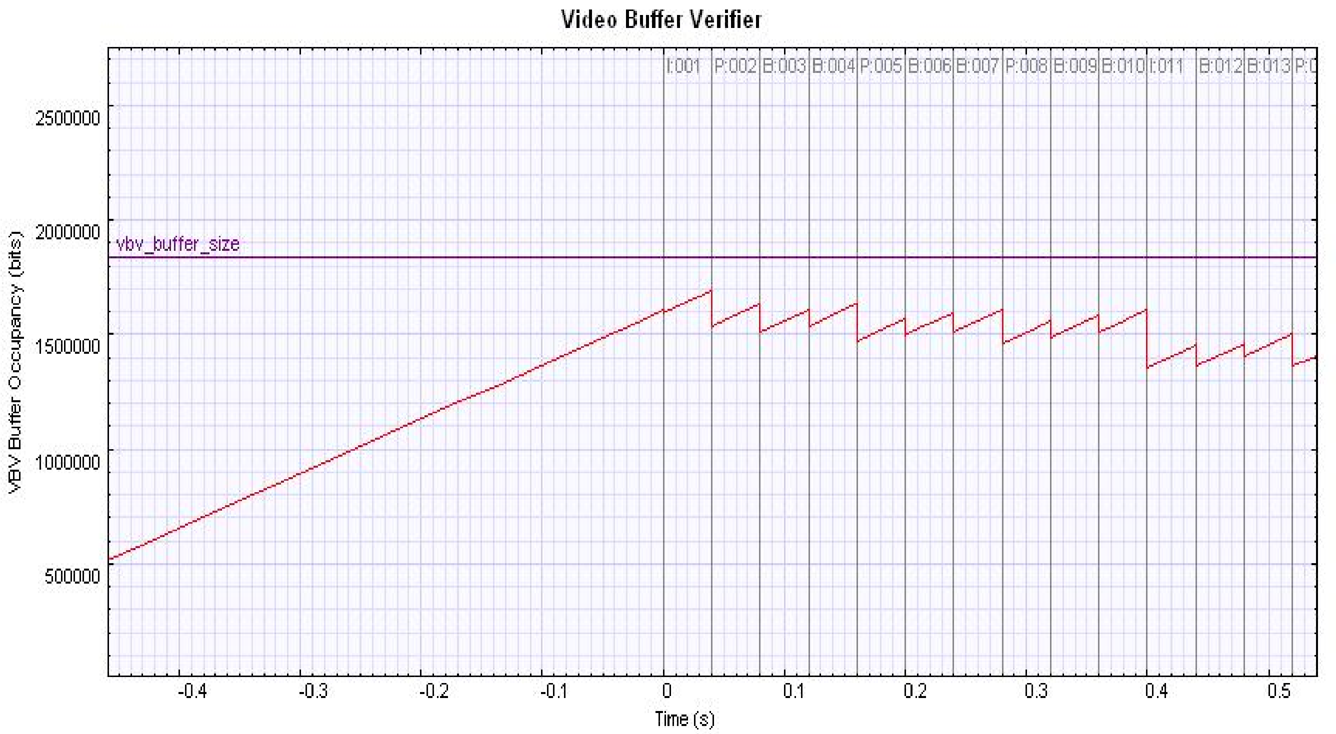


Fig. 21 Video Buffer occupancy measurement

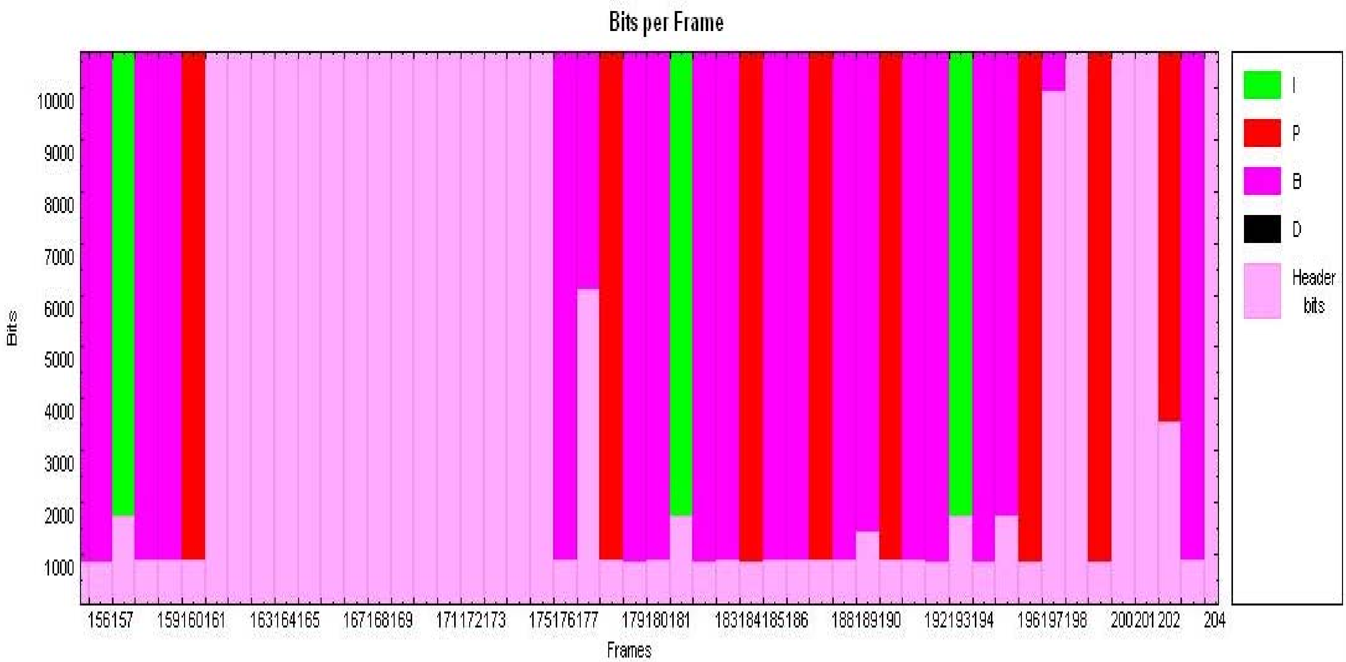


Fig. 22 Bits per Frame measurement

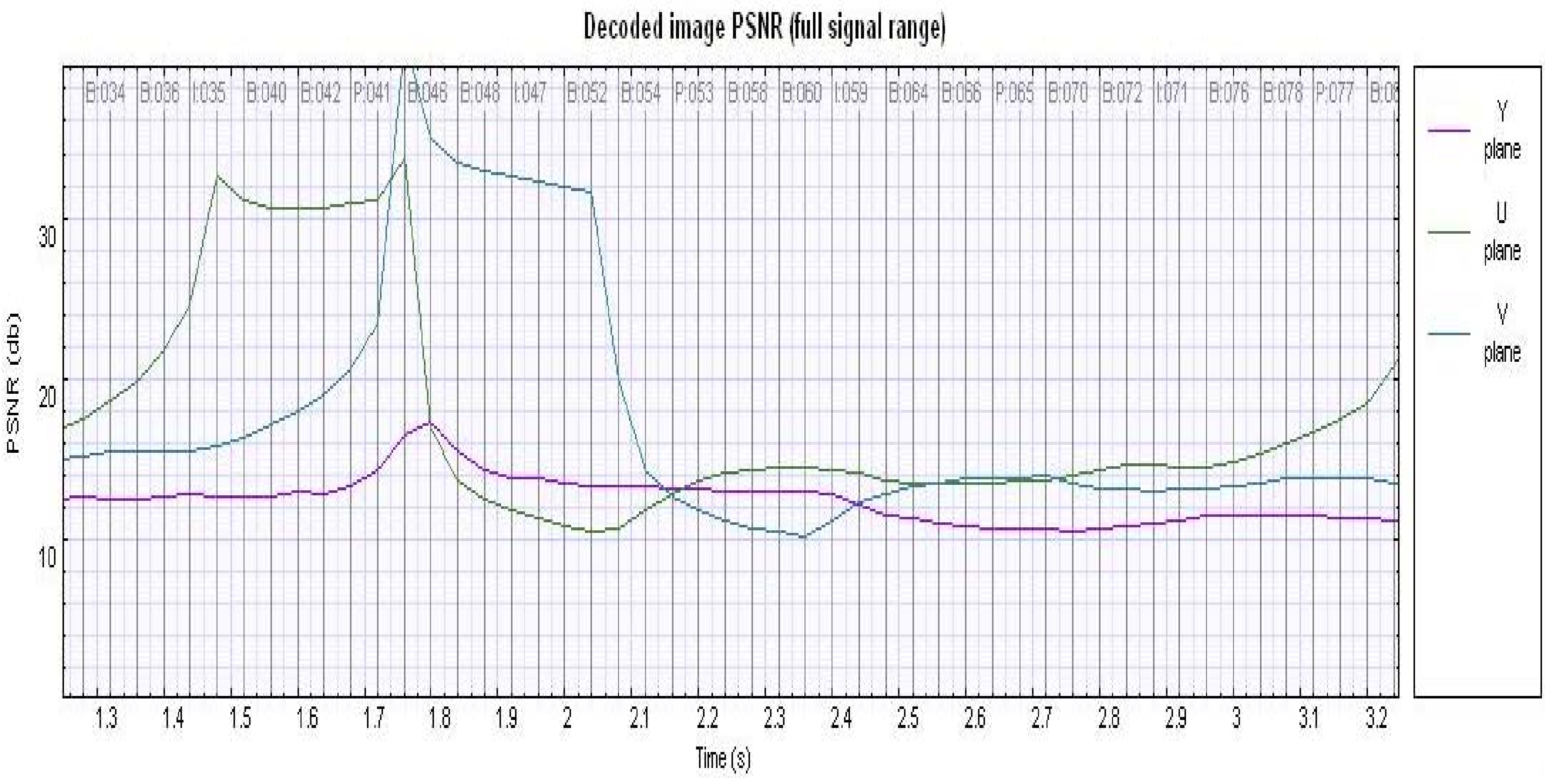


Fig. 22 PSNR of decoded image(fist 3.2 seconds)

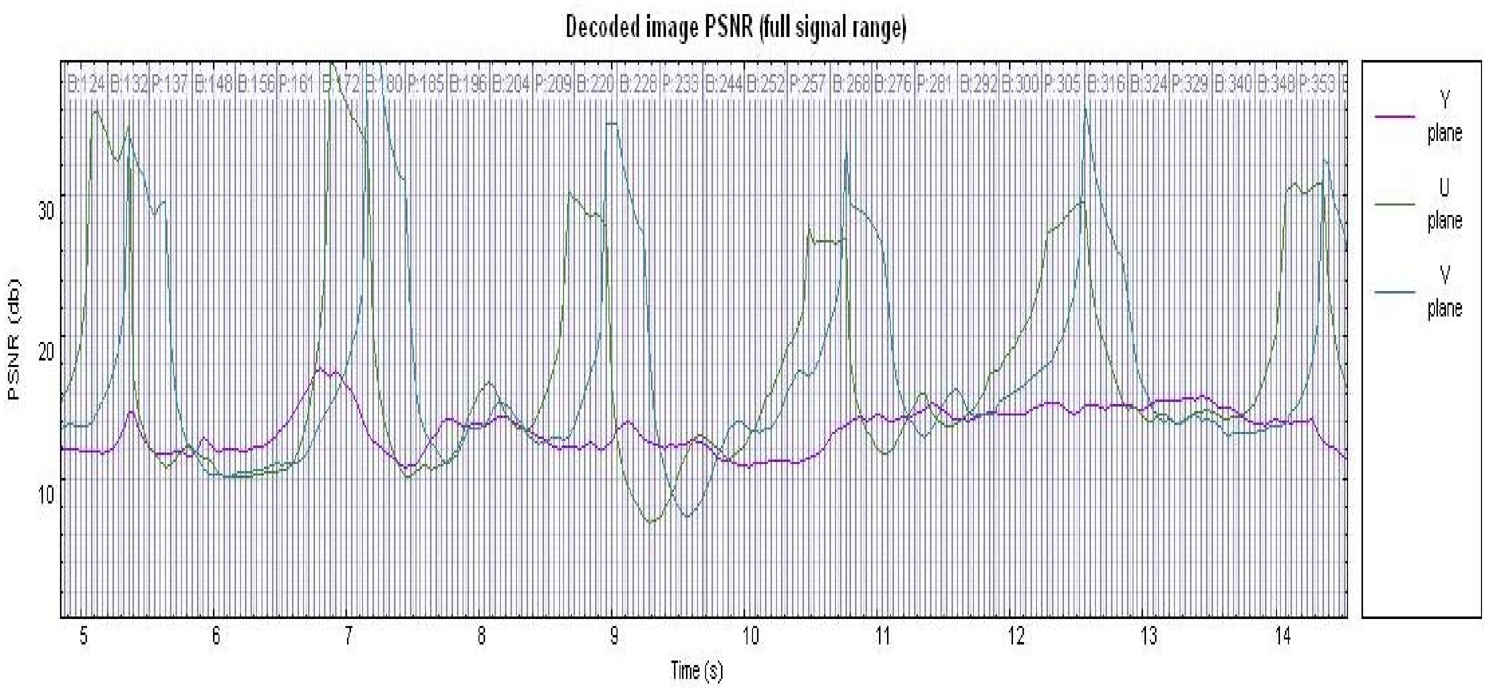


Fig. 23 PSNR of decoded image(4.8-14.5 seconds)

The results (Fig. 24, Fig. 25 and Fig. 26) are resumed as follow:
- Attention Model measurements (Fig. 27)
- Perceptual Difference Map (Fig. 28)

The measurements indicates artifacts values smaller than 1% meaning they are inside of normal values, unaffecting in a significant way the image

According to the measurements the test image it is framed in the good category as we could observe on the display capture, even if there are small imperfections regarding outline quality [6].

The measurements are widely described in [6].

Fig.24 The reference sequence

Fig.25 The test sequence

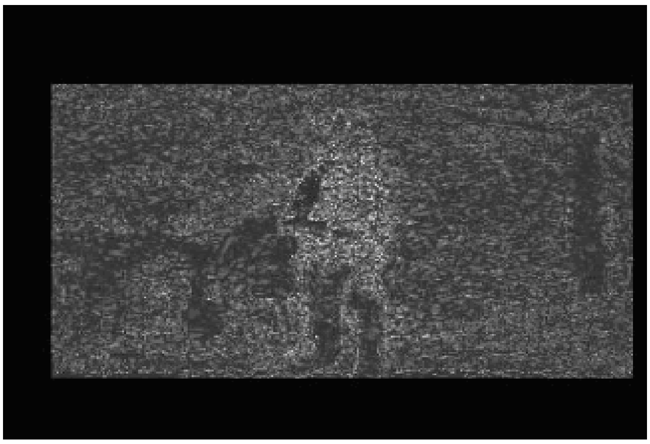


Fig. 26 The diferremce map

Fig. 27 The Attention Model

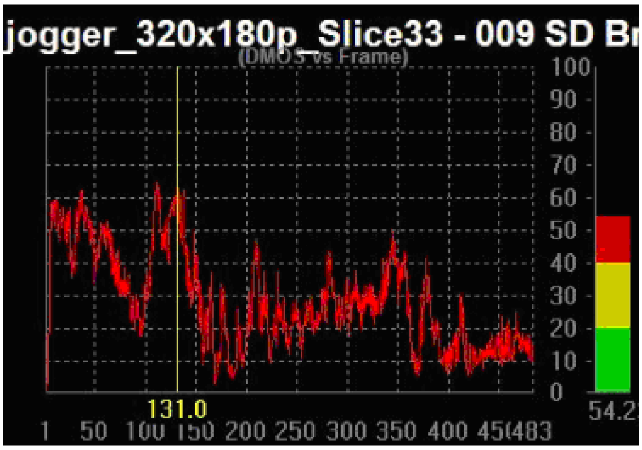


Fig. 28- Perceptual Difference Map

3 Conclusion

Both measurements fit “good quality” category of video images quality, the differences are at MTM4EA compliance measurements. This means that if a different decoder is used, it is possible to generate compatibility problems.

This fact cannot be measured with PQA 500, but PQA 500 can detect the subassembly that caused this issues.

The conclusion regarding these two types of measurements is that normally they fit the measured images on the same quality category.

This is happened because the majority of the problems came out from the coder – decoder assembly. The measurements are complementary as parameters exception of PSNR measurement which is not based on the human factor modeling.

Thus, the incompatibility situations can occur if the measurements are not complete, both objectives being based on subjective appreciation models.

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