SD AND HD COEXISTING IN CURRENT DVB-T BROADCASTING

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ABSTRACT

Digital video broadcasting – terrestrial (DVB-T) is important occasion in these days. But HDTV broadcasting is not widely used in Europe in DVB-T nets due high bandwidth requirements. Several solutions of this problem are discussed in this paper. Scalable video coding is the first choice but not very useful. MPEG-4 AVC coding algorithm brings a lot of new features and better compression efficiency also. But differential frame coding is going further. Proposed method can handle a problem with migration from Standard Definition (SD) to High Definition (HD) resolution and saving of the bandwidth in DVB-T nets.

1 INTRODUCTION

Standard analog television format (SDTV) is interlaced PAL 720x576 pixels and 25 frames in Czech republic. Nowadays digital video broadcasting market is expanding while more and more families buy set-top boxes for DVB-T receiving with PAL resolution of the video. Some TV broadcasters are testing interlaced HDTV format 1920x1080 pixels and 25 frames per second in Europe. There will be a need of HDTV broadcasting after massive expansion of DVB, but many people will still have set-top boxes unable to receive and decode HDTV signal. And, probably, a first expansion of HDTV broadcasting will be with conditional access (PayPerView,..).

2 SD TO HD MIGRATION PROBLEM

DVB-T broadcasting uses PAL resolution and MPEG-2 compression. TV programs are multiplexed with audio streams and additional data like Electronic Program Guide (EPG) and Multimedia Home Platform (MHP) applications together in one multiplexed stream, which occupies one channel for analog TV broadcasting. The usual bit rate of one multiplex is about 20-24 MBits/s [1]. The video of one TV channel occupies approximately 4 MBits/s in the

multiplex when using 4 video streams. For HDTV resolution and MPEG-2 video compression algorithm we need a huge amount of data bit rate for one channel. This is the reason why only one or max. two HDTV channels can be placed in one multiplex. Therefore HD resolution videos are mostly broadcasted only in cable and satellite DVB nets (DVB-C and DVB-S). The solution of this problem is in better compression technique like MPEG-4 AVC which can save about 50% of target bit rate in comparison with MPEG-2 compression. This solution looks quite nice but one problem is that customers will need to buy new set-top boxes which can decode MPEG-4 AVC video [2].

				Compression algorithm					
				MPEG-2		MPEG-4 AVC		Proposed method	
TV	Resolution	Interlaced/	Frame rate	Bit rate	Quality	Bit rate	Quality	Bit rate	Quality
	[pixel]	progressive	[Hz]	[Mbits/s]	Y [dB]	[Mbits/s]	Y [dB]	[Mbits/s]	Y [dB]
SDTV	720x576	I	25	3,7	34	1,6	36	NA	-
HDTV	1920x1080	I	25	12	35	6,5	36	4	33

Tab. 1: *Video quality and corresponding bit rates for SDTV and HDTV.*

3 SOLUTION

Solution of problems discussed in previous chapter is in spatial scalability or in data partitioning combined with MPEG-4 AVC compression.

3.1 SPATIAL SCALABILITY

Spatial scalability involves generating two spatial resolution video streams from a single video source such that the base layer provides the basic spatial resolution (720x576) and the enhancement layer employs the difference between spatially interpolated base layer and original high resolution video stream. Although MPEG-2 standard supports spatial scalability the need of replacing set-top boxes is still present and moreover this feature is not widely used nor implemented. Except this the bandwidth requirement is quite high yet. Furthermore the scalability feature consumes higher bit rate than single-layer encoding with comparable video quality [3].

3.2 SEPARATE VIDEO STREAMS WITH DIFFERENT RESOLUTIONS

It can be broadcasted both SDTV and HDTV video streams in MPEG-2. But from Tab.1 it can be seen that this solution is wasting of the available bandwidth where corresponding quality of the luminance component (Y) of the compressed video is compared equally to target bit rate. Broadcasters present the need of evolution from MPEG-2 to MPEG-4 AVC because the bandwidth saving is about 50% while employing MPEG-4 AVC compression. Therefore there is possibility to broadcast SDTV in MPEG-2 format but HDTV stream in MPEG-4 AVC. Then consumers will need to upgrade their current set-top boxes which will be capable to decode MPEG-4 AVC. The bit rates are about 4 MBits/s for SDTV in MPEG-2 and about 6,5 MBits/s for HDTV in MPEG-4 AVC.

3.3 DIFFERENTIAL FRAME CODING OF HDTV RESOLUTION

The SDTV is encoded in MPEG-2 and this stream can be understood as base layer in spatial scalable encoder because the idea is similar to scalable video coding and data

partitioning.

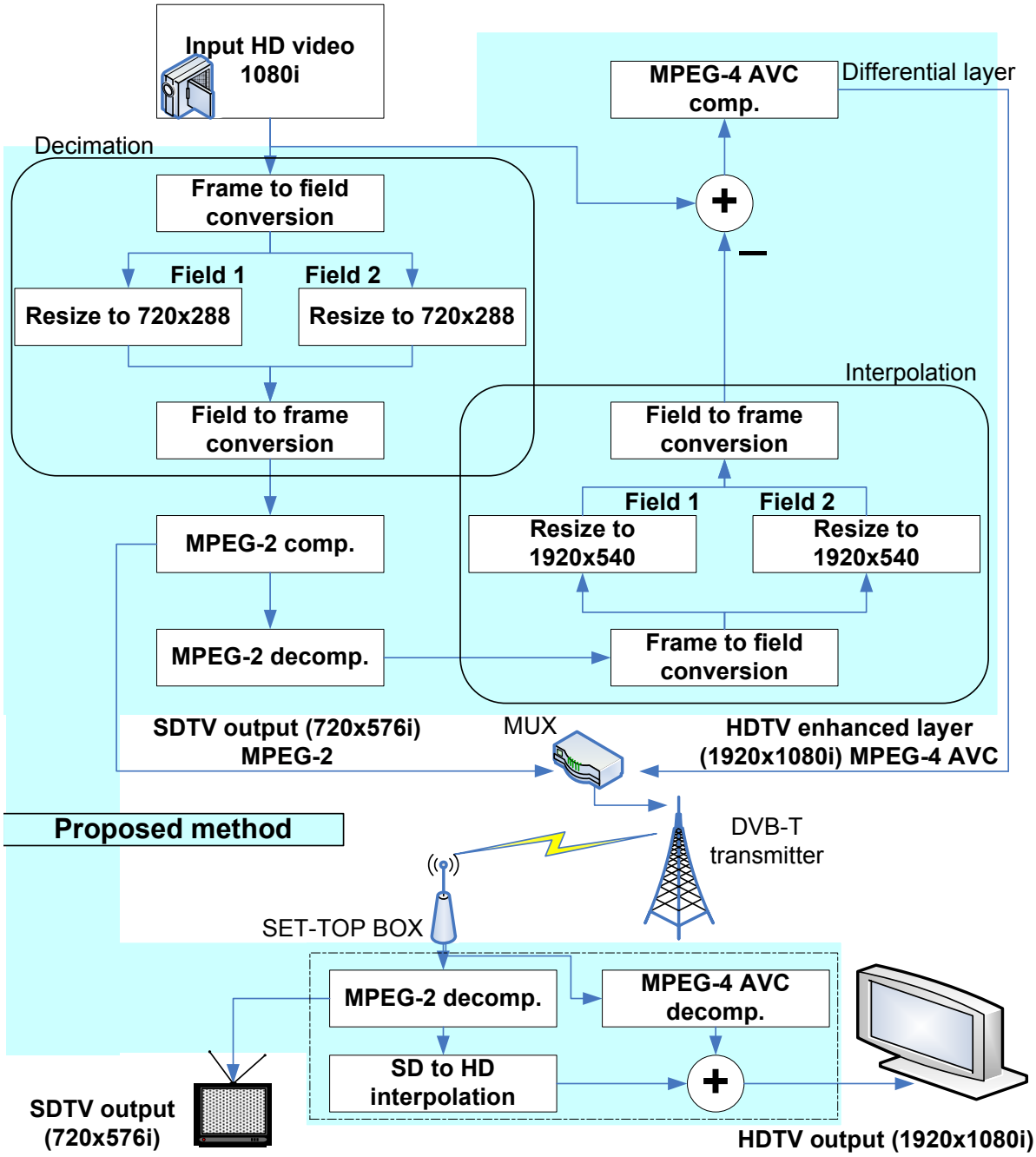

Fig. 1: *Proposed algorithm of the differential frame coding of HDTV resolution.*

The HDTV enhanced layer is not encoded by the same compression algorithm but it is carried out by MPEG-4 AVC compression standard. Proposed algorithm is depicted on Fig.1. Input HD resolution interlaced sequence is downsampled to SD resolution by employing conversion from frame into two fields. Each field is converted using bilinear decimation and then the fields are back converted to one interlaced frame. Now the SD resolution video is compressed by MPEG-2 encoder to produce DVB compatible video stream as usual. HD resolution video stream is generated by subtracting original HD video and interpolated SD

resolution compressed video to HD resolution. The differential video stream is compressed by MPEG-4 AVC encoder. SD video in MPEG-2 and this differential HD resolution video stream are transmitted together in one DVB-T multiplex. At the receiver side the low-end set-top box is capable to access and decompress SD MPEG-2 video. Advanced set-top box is able to access and decompress SD MPEG-2 video and also HD differential video stream which can process to generate high quality HD resolution video by interpolating SD resolution to HD resolution and adding differential data to obtain full HD resolution video quality.

4 CONCLUSION

HDTV video distribution in current DVB-T broadcasting is possible but employing older MPEG-2 video compression standard is not effective due the bandwidth requirements. Migration from SDTV to HDTV can be accelerated by distribution of the SD and HD resolution video content. MPEG-2 scalable video codec is not widely used and also bandwidth requirement is still too high for DVB-T nets. Therefore MPEG-4 AVC compression standard is not possibility but necessity. Backward compatibility can be guaranteed by broadcasting SD resolution video in MPEG-2 and HD resolution video broadcasting either in MPEG-4 AVC or differential frame coding also employing MPEG-4 AVC codec. Video quality and bandwidth requirements of MPEG-2, MPEG-4 AVC compression and proposed method can be compared in Tab.1. It can be seen that MPEG-4 AVC brings much better compression efficiency than MPEG-2 but proposed method is going further in bandwidth requirements with comparable video quality. Next research would be focused on investigating of better adaptive settings of the MPEG-4 AVC encoder for differential frame coding technique.

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