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Title	**Pruning in picture reference list in HEVC**
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Introduction

Possibility of selection of a particular reference picture from many previously encoded frames is one of the reasons of significant extension of time necessary for encoding of a video sequence with HEVC. Search of motion vectors within all available reference pictures for every PU (allowed by the HEVC standard) and selecting the best one, significantly enhances coding effectiveness but requires big computational effort leading to long encoding time. A fast method for selection of the best reference picture would be a source of shortening of the encoding time. This documents reports and verifies a method for fast reference picture selection in which reference picture list is pruned basing on the size of the PU under consideration. This way the number of reference picture necessary to look at the during motion vector search is reduced. Foundations of the reported method are the results of statistical analysis of the actual selected reference picture (considered by the encoder as the best in terms of RD) during encoding of the particular PU size.

Although results presented in this document are original authors contributions, very similar analysis and experimental results can be found in [1]. So the aim of this document is to bring attention of MPEG experts to this novel approach which allows for speeding-up motion estimation search.

Proposed Solution

For every CU (of a permitted size from 8x8 up to 64x64) HM encoder checks all available divisions onto PUs, and for every PU motion estimation is performed. As was already said, motion estimation search is repeated for/in all available reference picture, and the best motion vector and best reference picture are selected independently for every PU. Our analysis reveals that in every CU there is a strong correlation of number of reference picture selected. Similar results was reported in [1] where authors asses that in over 80% cases encoder select the same reference picture for 2Nx2N partitions and the smaller PU-s in the same CU unit. This observation is the key to fast reference picture selection method reported in this document.

In the reported method, during RD optimization encoder first check PU of a size 2Nx2N, and then goes to smaller partitions. During 2Nx2N check, motion estimation process is not altered it means that motion search is performed for all available reference pictures and the best one is selected. Following the check 2Nx2N is check of division of given CU onto a smaller PU sizes. For smaller PU sizes than 2Nx2N only reference picture that was selected as the best one for 2Nx2N PU is considered during a motion search.

In the example presented in Fig 1, there are 4 reference pictures on L0 list and 4 on L1 list. Let’s say that the encoder, after checking all reference pictures, pick picture 0 form L0 and picture 1 from L1 as the best one for uni-prediction. Similarly, during the search for bi-prediction pictures 0 form L0 and L1 have been selected.

Next, the encoder starts assessing smaller PUs. During a motion search only reference pictures that have been selected for 2Nx2N are considers. So, motion vectors will be sought only within a picture 0 from L0 and 0 and 1 from L1.

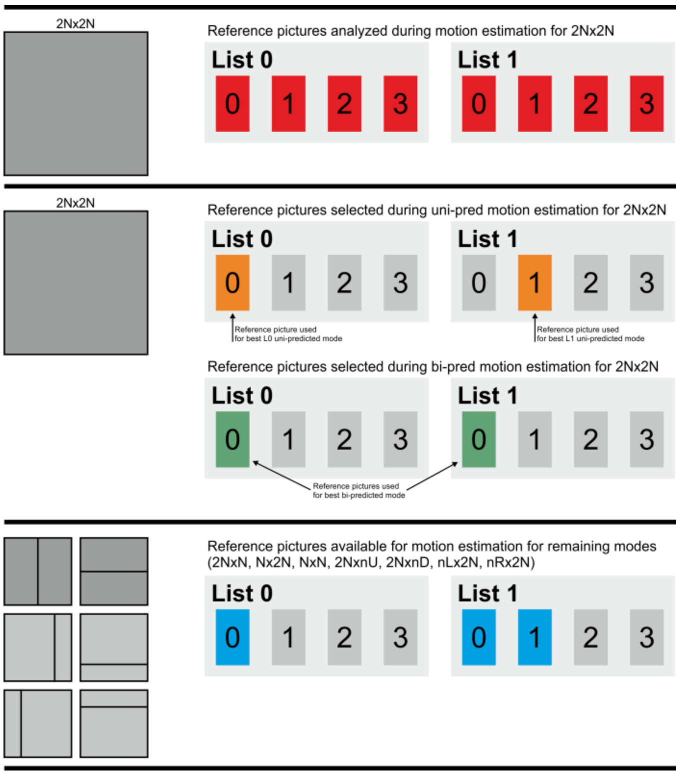

Fig. 1. Idea of reported method for fast reference picture selection. PUs of smaller size that 2Nx2N considers only reference pictures that was considered the best for 2Nx2N PU.

Methodology of the Experiments

For the experiments we have implemented the reported method in HM software version 16.9. With use of created software we have performed a series experiments. The goal of the experiments was to assess the computational complexity and the efficiency of the resultant codec. All of the experiment have been performed under “common test condition” – “random access” scenario [2]. All standard test sequences have been encoded with four QP values (22,27,32,37) with help of the prepared software and with the reference codec - unaltered HM version 16.9. In each case encoding times have been collected, as well as bitrate and quality of the reconstructed images (in terms of luminance PSNR)

The results have been compared with help of Bjøntegaard metric [3] and reduction of complexity was expressed as relative encoding times.

Efficiency of the method – experimental results

As can be seen from Table 1, reported method leads to nearly twenty percent reduction of the encoding time, while quality degradation is negligible - in most cases less that 0.5 percent. In work [1] one can find additional results, similar to ours presented here.

Table 1. Results of the presented method. The presented YUV values are Bjøntegaard deltas (positive values are bitrate increases and thus quality reductions).

Tier 2 (22-37)				
Random Access Main				
	Y	U	V	Enc Time
Class A	0,51%	0,64%	0,33%	85,96%
Class B	0,27%	0,27%	0,25%	87,25%
Class C	0,49%	0,43%	0,46%	84,61%
Class D	0,51%	0,60%	0,48%	85,73%
Class E	0,06%	0,04%	0,09%	82,94%
Overall A-E	**0,37%**	**0,40%**	**0,32%**	**85,30%**
Class F	0,43%	0,48%	0,46%	84,00%
Overall A-F	**0,38%**	**0,41%**	**0,34%**	**85,08%**

3. Conclusion

The document proposed reference picture list pruning to the MPEG. Presented method leads to 15% complexity reduction in random-access scenario, with negligible quality loses. It is propose to include presented method in HM software.

Acknowledgement

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5. References

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[2] Bossen F.. 2012. „Common test conditions and software reference configurations". Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Doc. JCTVC-J1100.

[3] [3] Bjøntegaard G.. 2001. „Calculation of average PSNR differences between RD curves". ITU-T SG16/Q6, Doc. VCEG-M33.