RESEARCH ON H.265/HEVC INTRA PREDICTION MODES SELECTION FREQUENCIES

Sharabayko M.P.

Scientific Adviser: Markov N.G., Doctor of Sc., Professor

National Research Tomsk Polytechnic University, 634050, Russian Federation, Tomsk, Lenin Avenue, 30

e-mail: sme_box@tpu.ru

Introduction

H.265/HEVC video compression standard provides higher compression efficiency compared to current industrial standard H.264/AVC. One of the advantages in HEVC intra-coding is the increase of intra-prediction directions. AVC has a total of 10 intra-prediction modes, while HEVC has 35 possible prediction modes.

In this paper we carry out a research on HEVC intra-prediction modes usage frequencies for the purposes of video compression. The analysis could be useful for development of intra-prediction search speed-up techniques [1].

HEVC Intra Prediction

HEVC intra prediction is performed on a prediction unit (PU) – a region of a video frame. PU pixels values should be predicted as close to original pixels values as possible to improve compression efficiency. There is a total of 35 intra-prediction modes in HEVC [2]: Planar (mode 0), DC (mode 1) and 33 angular modes (modes 2-34 on Fig.1).
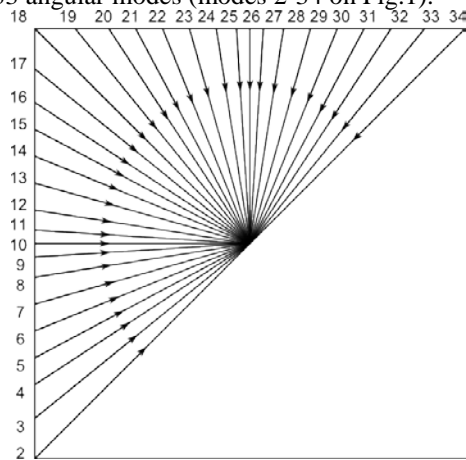

Fig. 1. H.265 angular intra prediction modes

DC intra-prediction is the most simple mode in HEVC. All PU pixels are set equal to the mean value of available neighboring pixels. Planar intra-prediction is a two-dimensional linear interpolation of neighboring pixels values. Finally, angular intra-prediction modes 2-34 are linear interpolations of pixel values in the corresponding directions (arrows on Fig. 1).

A detailed review of HEVC intra-prediction process can be found in [3].

Modes Selection Frequencies

For HEVC compression purposes we use the HM reference encoder v.12.1 [4]. It implements quasi-full RDO model providing the best relation between distortion and compression ratio. The findings are valid for JCT-VC test sequences [5]. In this paper we expose results for several test sequences, listed in Table 1.

Table 1. Test video sequence set

Sequence	Resolution	Frame-rate, Hz	Frames
BasketballDrill	832×480	50	500
Cactus	1920×1080	50	500
PeopleOnStreet	2560×1600	30	150

Fig.2–4 illustrate intra-prediction modes selection frequencies in the HM-coded test video sequences with several quantization parameters (QP). The most frequently used modes are Planar (mode 0) and DC (mode 1). Planar prediction is performed for 20% of PUs, while about 10% are predicted by DC. Each video sequence has several angular prediction usage peaks. These peaks characterize video sequence features in horizontal (modes 2-17) and vertical (modes 18-34) directions.
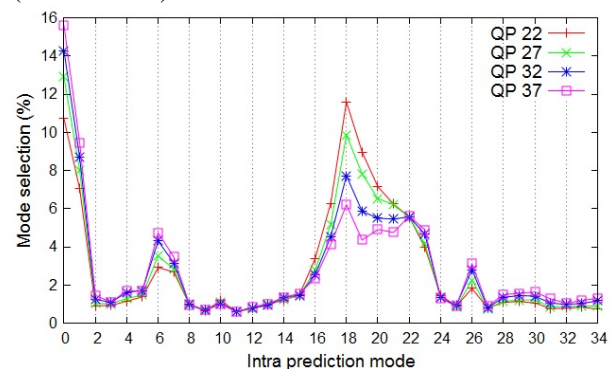

Fig. 2. Intra prediction modes selection frequencies for BasketballDrill sequence

Prediction modes 6 and 18 are the local maximums of usage frequencies for BasketballDrill sequence (Fig. 2). A total usage frequency of angular modes decreases with the QP value increase.
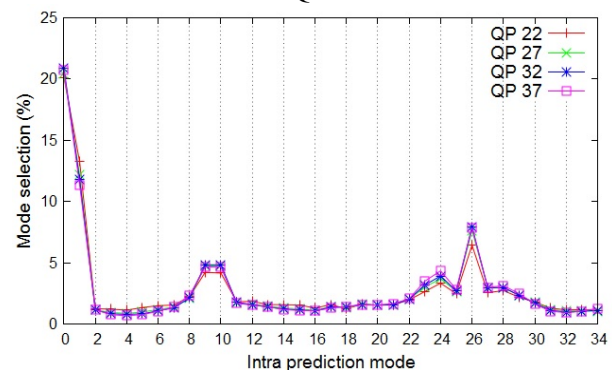

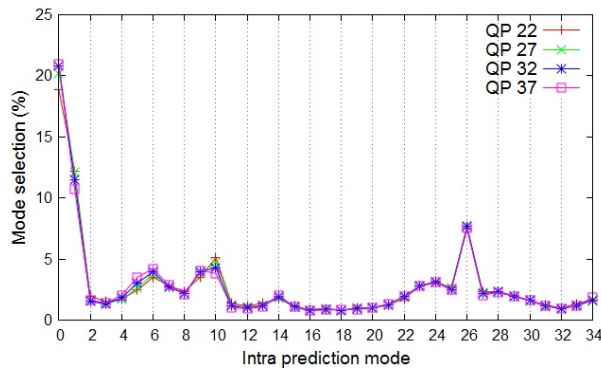*Fig. 3. Intra prediction modes selection frequencies for Cactus sequence*

Fig. 4. Intra prediction modes selection frequencies for PeopleOnStreet sequence

The HM encoder tends to use angular modes 9, 10 and 26 for unit prediction of Cactus (Fig. 3) and PeopleOnStreet (Fig. 4) video sequences.
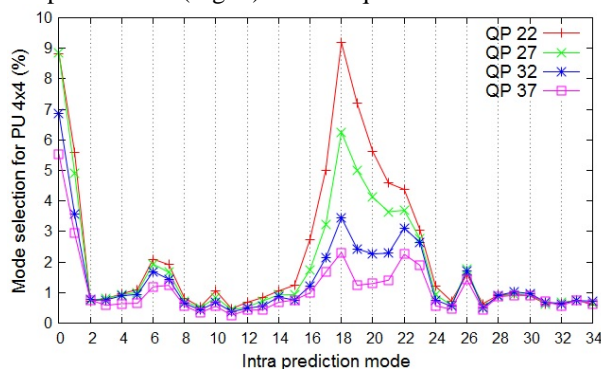

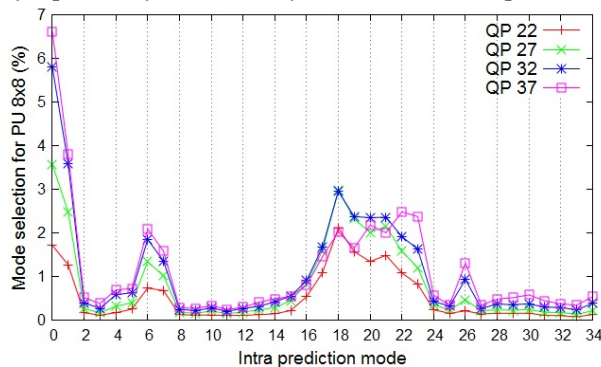*Fig. 5. Intra prediction modes selection frequencies for PU 4×4 of BasketballDrill sequence*

Fig. 6. Intra prediction modes selection frequencies for PU 8×8 of BasketballDrill sequence
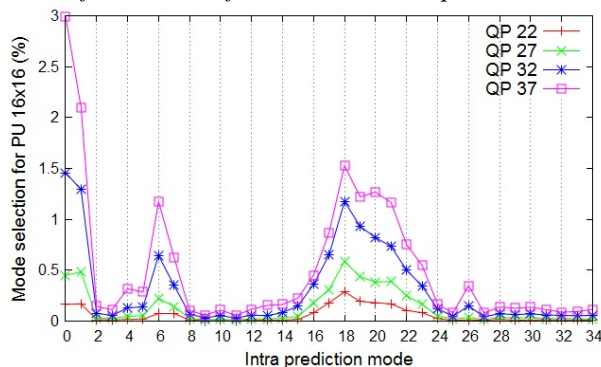

Fig. 7. Intra prediction modes selection frequencies for PU 16×16 of BasketballDrill sequence

The higher the QP is, the less details are stored in the compressed video sequence. Therefore Planar and

DC mode usage increases with the increase of QP value. Furthermore, QP also influences PU size selection. Fig. 5–8 illustrate mode usage frequencies in compressed BasketballDrill sequence with respect to PU size.
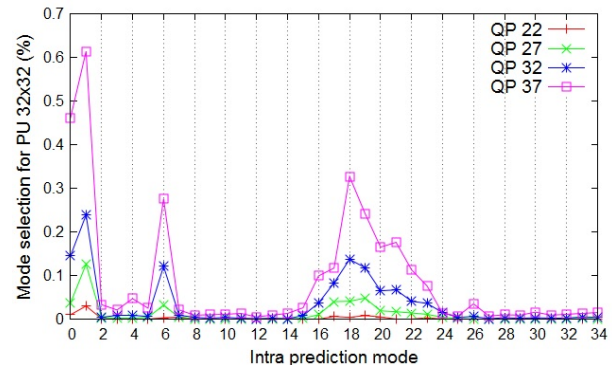

Fig. 8. Intra prediction modes selection frequencies for PU 32×32 of BasketballDrill sequence

The results show (Fig. 5–8), that the higher the QP value is, the bigger the sizes of PUs are. However the most frequently used modes are the same regardless of QP value or PU size.

Conclusion

All HEVC intra-prediction modes are used for intra-compression. However, Planar and DC prediction are the most frequently used modes for any video sequence. The higher the quantization parameter is, the more frequently these modes are used.

Also each video sequence has its unique angular prediction usage frequency distribution. The HM encoder tends to increase a usage of angular modes with the decrease of quantization parameter.

The research shows the obvious tendency in intra-prediction mode selection. The trend should remain if the features of a video frame are reserved. Thus in case of a scene change the frequencies may also change. The observation could be usefull, e.g., for probability estimation of intra-prediction mode selection in order to speed-up intra-prediction search process.

References

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