Efficient CABAC Bit Estimation for H.265/HEVC Rate-Distortion Optimization

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ABSTRACT

The entropy coding of context-adaptive binary arithmetic coding (CABAC) has been utilized in the H.265/HEVC for higher coding efficiency. But the related complexity also causes a bottleneck for its low-delay applications, owing to the employment of inter-symbol dependency in CABAC. In this paper, a fast bit-rate estimation method is proposed to skip the actual entropy coding of CABAC in mode decision to meet the requirement of low-delay implementations. The presented scheme firstly parses the characteristics of syntax elements and then guided by the principle of CABAC, an efficient scheme is derived following. It is very beneficial for reducing the computational complexity and saving the encoding time in H.265/HEVC mode decision. Experimental results demonstrate that the proposed fast algorithm can reduce the CABAC encoding time by 68% in average with negligible degradation in the rate-distortion performance.

Keywords: Bit Estimation, CABAC, Entropy Coding, H.265/HEVC, Rate-Distortion Optimization

INTRODUCTION

The increasing popularity of high definition TV, mobile phone, digital camera, surveillance, broadcasting and so on stimulates the rapid evolution of multimedia technologies for meeting the demand of high quality and low delay while operating the intensively complicated processes. Since videos involved plenty of useful information gradually dominates the consumer market, the corresponding coding technologies become critical for effective storage or transmission, which has been gaining a wide interest in research and industrial communities.

Due to its high coding efficiency, the video codec of H.264/AVC (Wiegand et al., 2003) has been widely employed by industry. However, with the ever-growing diversification of video applications, e.g. large-screen digital video, mobile entertainment, the conventional codec of H.264/AVC is facing severe challenges in coding efficiency (Video and Requirements SGs, 2008). So the latest codec of H.265/HEVC (Sullivan et al., 2012) has been developed for achieving a significant improvement in coding performance, where numerous advanced tools, such as coding-
tree block structures, advanced motion vector prediction, unified directional intra prediction and so on, are adopted and contributed for high efficiency compression.

The video codec of H.265/HEVC employs the same “hybird” approach (intra/inter prediction, transform, quantization, entropy coding) used in compression standard H.264/AVC. Figure 1 depicts the block diagram of H.265/HEVC, where each candidate coding mode is firstly processed by a sequence of modules to achieve the distortion and bit-rate. Then the optimal option modeopt can be obtained by calculation and comparison of the Rate-Distortion (RD) cost (Sullivan et al., 1998):

$$\text{modeopt} = \arg \min_{\text{mode} \in C} \{D(\text{mode}_i) + \lambda R(\text{mode}_i)\},$$

(1)

where the $\text{mode}_i$ denotes the $i^{th}$ element in the candidate set $C$, the parameter of $\lambda$ represents the Lagrange multiplier. The symbols of $D$ and $R$ indicate the coding distortion and corresponding bits.

However the intensive computational complexity is simultaneously introduced into H.265/HEVC, which may cause a bottleneck for the actual application. It is known that videos relate to abundant data in storage or transmission, especially for the ultra high resolution services, which may probably make the task of low-delay coding difficult and eventually lead to users’ annoyance and dissatisfaction. Therefore, efficient and fast video coding scheme is indispensable for H.265/HEVC to conform the requirement of low-delay application.

In this paper, an effective rate estimation algorithm for H.265/HEVC encoder is developed and incorporated into the rate distortion optimization (RDO) for fast mode decision. The syntax elements of residuals and the principle of entropy coding are first analyzed, and then, a highly accurate and efficient model is constructed to skip the actual entropy coding of CABAC for the calculation of RD cost in mode decision. Experimental results show that the CABAC encod-

![Figure 1. The coding structure of H.265/HEVC](image-url)
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www.igi-global.com/article/multimedia-social-network-modeling-using-hypergraphs/158111?camid=4v1a

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www.igi-global.com/article/emocap-video-shooting-support-system/69521?camid=4v1a