Block Merging Motion Estimation for Fast Mode Decision in H.264/AVC Video Coding

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Abstract

Recent video coding standards have introduced the notion of variable block size motion estimation in order to improve the coding efficiency. However, supporting various block sizes significantly increases the encoder computational complexity. H.264/AVC supports seven different block sizes for inter frame coding. This paper proposes an efficient block merging method for motion estimation resulting in a 51% speedup in the mode decision operation in average, compared to the H.264/AVC reference software. The proposed technique introduces no impact on rate distortion and no SNR degradation of the encoded video sequences. The lower computational complexity of the proposed technique makes it suitable for low power applications, such as video on mobile devices.

Keywords: H.264/AVC, Fast mode decision, Motion estimation.

1. Introduction

H.264, also known as MPEG Advanced Video Coding (AVC) [1], achieves a higher coding efficiency compared to the previous standards such as MPEG-1,-2,-4 and H.263. In contrast to MPEG-4, the H.264/AVC encoder further reduces the bit-rate by up to 50% preserving the video quality. Hence, the new standard is very suitable for low bit-rate applications, such as video on mobile devices. This higher coding efficiency is due to the new context based entropy coder, but also because of the following new concepts in the prediction component:

- variable block-size motion estimation,
- intra prediction,
- multiple reference frames and
- sub-pixel motion compensation [2].

These new techniques, however, result in higher complexity and computational load. Consequently, more power is consumed during coding/decoding process; a critical issue in mobile devices.

Mode decision uses the motion estimation tool for selecting the proper coding mode while encoding a macro-block. Experimental results indicate that motion estimation consumes up to 80% of the encoding time [2]. Many fast motion estimation techniques have been introduced in the literature that indirectly help reducing the mode decision complexity [3]. More importantly, several fast mode decision algorithms have been proposed recently [4]-[13]. Sum of absolute difference (*SAD*) is the criterion used for evaluating the best prediction vector and is calculated redundantly in various mode examination. Discarding redundant computations has a profound impact on reducing the codec complexity and results in lower cost and power consumption. In this paper, we propose a new block merging motion estimation (*BMME*) technique for fast mode decision. In comparison to the optimized full search algorithm presented by JM9.5 [15], the *BMME* method offers 51% complexity reduction in mode decision time in average with no SNR loss and no bit-rate distortion.

The paper is organized as follows. In Section 2 the existing fast mode decision methods are reviewed. The H.264/AVC mode decision algorithm is described in Section 3. In Section 4, the block merging approach for *SAD* calculation is described. The proposed fast mode decision is introduced in Section 5. Simulation and experimental results are presented in Section 6. Finally, the paper ends with the conclusion in Section 7.

2. Related Work

Recently, many fast mode decision methods have been proposed in the literature in order to reduce the computational load of the H.264/AVC video encoder. Each method uses its own criterion to predict the best mode. A typical approach classifies the inter block types into two groups: (16×16, 16×8, 8×16) and (8×8, 8×4, 4×8, 4×4). By predicting the group that contains the best mode we can discard the other. The method described in [4] begins with the calculation of the cost of three modes, 16×16, 8x8, and 4x4, and checks if the cost tends to monotonically increase or decrease with the block size. If there is a monotonic tendency, only the modes in between the best two modes