

Dual Mode Architecture for Deblocking Filtering in H.264/AVC Video Coding

Mahdi Nazm Bojnordi, Omid Fatemi, and Mahmoud Reza Hashemi
Nano-Electronics Center of Excellence
School of Electrical and Computer Engineering
University of Tehran, Tehran, Iran
m.bojnordi@ece.ut.ac.ir, omid@fatemi.net, hashemi@comnete.com

Abstract— Block based video codecs suffer from visible blocking artifacts in the reconstructed video frames. Eliminating the blocking artifacts improves output video quality, significantly. New video coding standards employ adaptive filtering tools to solve this problem. Because of huge computational load of these tools they became the implementation bottlenecks in real-time applications. This paper proposes a high-performance deblocking architecture suited for both dedicated hardware and platform-based implementation of H.264/AVC video codecs. The new architecture supports two operational modes for high-performance and low-power filtering. Working at high-performance mode, the proposed architecture offers 44% to 76% performance improvement compared to the existing state-of-the-art architectures. Half of this performance is achieved while working at low-power mode. In the low-power mode, however, up to 41% of power is saved. Operating at 100MHz, the new architecture supports processing resolution of 2208×2000 (4:2:0) at 30 fps.

Keywords—deblocking filter,

I. INTRODUCTION

H.264/AVC [1] is the latest standard in the sequence of video coding standards. In contrast to traditional standards, the new one offers more video quality and coding efficiency. The reason behind superior coding efficiency of H.264/AVC is the use of new coding tools. When these tools are used in an optimized mode allow for bit savings of about 50% compared to previous video coding standards like MPEG-4 and MPEG-2 for a wide range of bit rates and resolutions. This improvement, however, come at the cost of more computational complexity. The decoder is about two times as complex as an MPEG-4 Visual decoder for the simple profile [2]. In-loop deblocking filter tool used in both H.264/AVC encoding and decoding sides has a profound impact on conceptual video quality [3]. Experimental results show that one third of the decoder computational complexity is consumed by the deblocking filtering tools [4]. It becomes an implementation bottleneck for real-time applications. Therefore, designing high-performance deblocking filter architectures is a key issue. Recently, there are many proposed architectures for deblocking filtering in H.264/AVC video coding in the literature [5]-[10].

The new H.264/AVC standard is designed to provide a technical solution appropriate for a broad range of applications from high definition TV to mobile video streaming [11]. On the other hand, hardware implementations tend to be targeted at high-performance (e.g. broadcast-quality encoding) or low-power (e.g. mobile streaming, applications). The existing deblocking architectures have tended to achieve higher performance and computational rate. Power consumption, however, is an important issue and should be addressed by codec designers. In mobile applications it becomes a key issue.

In this paper scalable computation-rate architecture for deblocking (SCAD) is proposed. SCAD is suitable for both high-performance and low-power applications. SCAD supports two operational modes: High-Performance (HP) and Low-Power (LP). From 44% to 76% performance improvement is achieved while working at HP mode, compared to the existing state-of-the-art architectures. SCAD is flexible to reduce the computation rate for saving power consumption in lower bit-rates. Operating at LP mode, half of the performance of HP mode is achieved while up to 41% of power consumption is saved. SCAD follows a block-based filtering scheme and it is valuable for both platform-based and dedicated hardware H.264/AVC codecs.

Rest of this paper is organized as follows. An introduction to the H.264/AVC algorithm is given in Section 2. In Section 3, our proposed architecture is described. Different operational modes of the proposed architecture are described in Section 4. Comparison and experimental results are shown in Section 5. Finally, the paper ends by conclusion in Section 6.

II. THE H.264/AVC DEBLOCKING ALGORITHM

According to the latest H.264/AVC Recommendation [1], deblocking filtering algorithm is defined as a conditional process that has to be applied to vertical and horizontal edges of all $N \times N$ blocks of each macroblock. For luminance component (Y) N is selected equal to the size of the applied I-transform, i.e. 4 or 8. For chrominance components (U and V) N is selected equal to 4. Figure 1 shows the boundaries inside a macroblock need to be filtered. The boundaries indicated by bolded lines should be filtered anyway. However, the edges indicated by dotted lines need to be