Optik 127 (2016) 6291–6302

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

Original research article

Low complexity depth map intra prediction mode decision algorithm for 3D-HEVC

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ARTICLE INFO

Article history:
Received 28 February 2016
Accepted 19 April 2016

keywords:
3D-HEVC
Depth map
Intra prediciton

ABSTRACT

The presented 3D video coding extension of High Efficiency Video Coding (3D-HEVC) was developed for multiview video plus depth (MVD) format. MVD is depth-enhanced 3D video format that uses a few views to synthesize more immediate virtual views with depth map. In the original 3D-HEVC encoder, as a novel tool Depth Modeling Modes (DMM) is added into intra prediction mode candidate list, which aims at improving as much coding efficiency as possible for 3D-HEVC. However, this promotion leads to extremely complicated computation simultaneously which prevents 3D-HEVC encoder from real-time application. In this paper, we propose a low complexity depth map intra prediction mode decision algorithm, including fast angular modes decision algorithm and early skipping DMM decision algorithm. The basic idea of the proposed algorithm is to predict the current depth block intra prediction mode based on depth map texture feature and early skip DMM decision. Experimental results demonstrate that the proposed low complexity algorithm can achieve 38% coding time reduction with just 1.00% bitrate augment on average under "all-intra" case compared to the original 3D-HEVC encoder.

1. Introduction

With the development of video compression and transmission technologies, Free View Television (FTV) supports Multiview video that is populated in market currently, whose emergence has brought novel visual experience for audience. 3D displayer, such as Free View Television (FTV), employs multiview video plus depth (MVD) format that can provide stereoscopic video that is sensible to the unaided eye [1]. In order to reduce calculation of multview, Depth Image Based Rendering (DIBR) technique is utilized in MVD to synthesize additional virtual viewpoint at decoder side using a small number of depth map and corresponding texture video [2,3]. For Multiview texture video plus depth map format encoding, 3D extension of High Efficiency Video Coding (3D-HEVC) has been developed in July 2012 by Joint Collaborative Team on 3D Video Coding Extension Development (JCT-3V) which is cooperated by International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) and International Organization for Standardization/International Electrotechnical Commission (ISO/IEC). 3D-HEVC adopts traditional HEVC encoder and several new coding tools, which contribute to efficiency improvement of MVD format compression. In particular, depth information compression process exploits not only conven-

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http://dx.doi.org/10.1016/j.ijleo.2016.04.099
0030-4026/

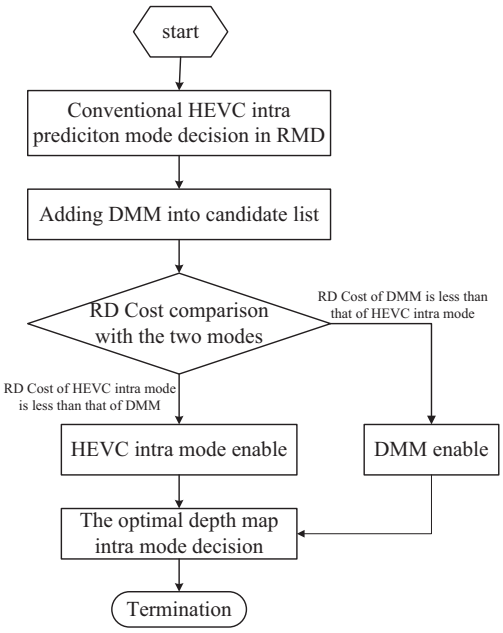

Fig. 1. The flow chart of depth map intra prediction mode decision process in current 3D-HEVC encoder.

tional HEVC intra mode decision but novel additional depth map intra coding mode, such as depth modeling modes (DMM) [4], region boundary chain (RBC) coding [5] and simplified depth coding (SDC) [6]. Fig. 1 shows the flow chart of depth map intra prediction mode decision process in current 3D-HEVC encoder.

The quality of the synthesized video is related to that of depth map. Although depth is non-visual for people, it still plays a very vital role in MVD format. However, since depth map, in contrast to natural video, is characterized by the large homogenous regions and sharp edges, if it is encoded only by HEVC encoder, it will introduce significant annoying artefacts at sharp edges. The sharp edges in depth map can be preserved completely using DMMs, consequently, DMMs are introduced into 3D-HEVC standard and many fast algorithms of them are investigated recently.

The rest of this paper is organized as follows. Section 2 introduces the recent works about low complexity intracoding for 3D-HEVC depth map and the original depth map intra coding is introduced in Section 3. The proposed low complexity depth map intra prediction mode decision algorithm for 3D-HEVC is represented in Section 4. Section 5 and Section 6 demonstrate the simulated experiment results analysis and the conclusion, respectively.

2. Related work

Recently, several low complexity algorithms have been proposed for 3D-HEVC intra prediction mode decision to reduce the coding complexity of 3D-HEVC through optimizing conventional HEVC intra prediction mode decision process. A fast method is presented in Ref. [7] that employs the edge direction of depth blocks to reduce intra prediction mode number and reduce the computational complexity of 3D-HEVC. An efficient intra prediction mode decision algorithm is proposed in Ref. [8] that takes use of the Low Complexity Rate-Distortion Cost information during rough mode decision process. Simplified Edge Detector (SED) approach is introduced in Ref. [9] that applies to a block which contains an edge or a constant area. A fast intra prediction mode decision algorithm optimizes the intra prediction process for 3D-HEVC by analyzing the texture frames and depth maps to find out prediction unit edge direction [10]. A new compression method is presented in Ref. [11] that applies the Reduced Resolution Depth Coding (RRDC) method to the depth videos. Single Depth Intra Coding Mode algorithm is introduced in Ref. [12] that encodes the smooth depth area. A fast CU size decision algorithm based on the relationship between texture video and depth map is also proposed in our previous work [13] to reduce the computation complexity for original 3D-HEVC encoder. The aforementioned low complexity algorithms efficiently save coding time of depth map intra coding in original 3D-HEVC encoder.

In addition, many low complexity algorithms have been presented that improve coding efficiency of DMM in 3D-HEVC to promote coding performance. A fast and low complexity DMM3 approach is introduced in Ref. [14] for 3D-HEVC encoder through reducing Wedgelet candidate number. An efficient intra predictive depth map coding algorithm is proposed in Ref. [15] using flexible block partitioning based on explicit edge representation. A down-sampling method is presented to improve coding efficiency for 3D-HEVC encoder by reducing the number of Wedgelet patterns [16]. An effective reference pixel selection algorithm is proposed in Ref. [17] that simplifies complicated computation for 3D-HEVC DMM through streamlining the CPV prediction. A fast depth map intracoding method is presented in Ref. [18] that skips unnecessary Wedgelet searches