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ORIGINAL ARTICLE

Improved entropy encoding for high efficient video coding standard

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Abstract The High Efficiency Video Coding (HEVC) has better coding efficiency, but the encoding performance has to be improved to meet the growing multimedia applications. This paper improves the standard entropy encoding by introducing the optimized weighing parameters, so that higher rate of compression can be accomplished over the standard entropy encoding. The optimization is performed using the recently introduced firefly algorithm. The experimentation is carried out using eight benchmark video sequences and the PSNR for varying rate of data transmission is investigated. Comparative analysis based on the performance statistics is made with the standard entropy encoding. From the obtained results, it is clear that the originality of the decoded video sequence is preserved far better than the proposed method, though the compression rate is increased.

1. Introduction

Efficient transmission of video through the Internet is of great concern in the recent years because of the wide growth of the Internet and the multimedia applications. This necessitates advanced video coding with limited bandwidth usage. Hence, the Joint Collaborative team on video coding enacted the High Efficiency Video Coding (HEVC) standard [8] for supporting high bit rates, more colour formats, spatial and fidelity scalability and multi-view video coding. The HEVC standard is the advanced form of H.264/MPEG4 part 10-Advanced Video Coding (AVC) standard [9,18]. It consists of multiple coding tools such as prediction unit, coding unit and transform unit in quadtree coding block partitioning tool [17]. The quadtree is a phenomenon used for subdividing the picture into many blocks, so as to enable coding and prediction [11]. In video coding, intra coding provides good quality videos [19]. As a result, the HEVC outperforms the conventional video coding standards. Yet, it has the drawback of computational complexity and storage problems, while encoding [10]. A lot of research works have been done in relation to the HEVC. From the literature review, it is found that few works are contributed towards the area of fast mode decision making in HEVC. In 2016, Honrubia et al. [2] have introduced a novel algorithm, named Adaptive Fast Quadtree Level Decision (AFQLD) algorithm, for making faster decisions on the coding unit split up in HEVC. Earlier, the faster decision making problem has

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been addressed in 2015 by Hu and Yang [5] and they have proposed a fast Intra Mode Decision (OIMD) algorithm for minimizing the computational complexity in HEVC. In the same year, Yeh et al. [6] have proposed a novel intra prediction model, which is based on two neighbouring predictor syntheses.

The overview of HEVC, particularly focussing on the recent developments in the 3D and multi view video, has been addressed in 2016 by Tech et al. [1]. They have studied the overview and various features of Multi View (MV) video and depth-based 3D video formats in High Efficiency Video Coding (HEVC). Increasing the coding efficiency by improving the bit allocation has been experimentally studied in 2014 by Wang et al. [7]. They have developed a gradient-based R-lambda (GRL) for controlling the intra frame rate in HEVC to minimize the BER and enhance the video quality. The algorithm has the capability to measure the frame-content complexity and it is an advanced method for improving the performance of the conventional R-lambda. Additionally, they have also developed a coding tree unit level bit allocation method. Several works were focussed on the transform coding techniques in HEVC. In 2013, Nguyen et al. [4] have studied various HEVC techniques that are used for transforming the codes and to perform entropy coding. They have used the quadtree-based partitioning, dubbed as residual quadtree, as one of the new transform coding techniques that support in increasing the size of the transform blocks and dividing the residual blocks into multiple blocks. In 2012, Sole et al. [3] have worked on transform coefficient coding in HEVC that includes the scanning patterns and coding methods, sign data, coefficient levels and significant map.

Our paper focuses on improving the entropy encoding of HEVC to accomplish better encoding performance [20]. The paper is organized into the following sections. In Section 2, the drawbacks in the existing works are pointed and the contributions of our paper are presented. Section 3 is about the HEVC and the encoding procedure. Section 4 explains about the construction of the improved entropy coding, which includes the weighted entropy and the optimization procedure. Section 5 discusses the results and Section 6 concludes the paper.

2. Problem definition and our proposed solution

2.1. Preliminaries

The HEVC has added features such as, parallel processing architectures and high video resolution, which are not present in H.264/MPEG-4AVC. Moreover, the syntax and the bit stream structure are completely standardized in HEVC and it have some features such as coding efficiency, data loss resilience, ease of transport system integration and implementation with parallel processing architecture. The quarter sample precision is applied for yielding the motion vectors in HEVC, but the half sample positions are used in H.264/MPEG-4AVC. For the interpolation of fractional sample positions, 7 or 8 tap filtering and 6 tap filtering are used in HEVC and H.264/MPEG-4AVC respectively. The HEVCs association syntax is very simple and it supports large TB sizes and prediction directions than the H.264/MPEG-4AVC that occupies 16×16 size of luma PB in plane prediction, which is opposite to the HEVCs' assistance to each block. Only one entropy coding and three probable modes in luma intrapicture prediction mode coding are supported by HEVC, which are quite contrast to the H.264/MPEG-4AVC that supports two entropy coding methods and one mode in luma intrapicture prediction mode coding. Also, the descaling operation feature in the dequantization step is a needed one for H.264/MPEG-4AVC, but not for HEVC.

2.2. Problem definition

The key motive of the digital video coding standard is the optimization of coding efficiency. The ability of a coding standard to reduce the bit rate that represents a video content with desired video quality level is known as the coding efficiency. It can also be defined as the ability of the coding standard to increase the quality of the video, with limited bit rate. The first version of the High Efficiency Video HEVC standard [12], approved as ITU-T H.265 and ISO/IEC 23008-2, has achieved the first motive and then they concentrated on the key extensions of its abilities to suit for the needs of a wide number of applications. The old version of the HEVC standard had a better scope. But, it has not given any importance to the key features for designing the core elements In the development of the new HEVC standard encoding scheme, the extensions that are considered, while preparing this paper (pointing to the present status that the Vienna meetings of July/August 2013 holds), can be divided into three areas: the range extensions, the scalability extensions and the 3D video extensions. In the range extension, the bit depth ranges and the colour sampling formats are enlarged. It also focuses on the performance of the high-quality coding, the screen-content coding and the lossless coding. The scalability extensions allow the usage of the embedded bit stream subsets and they are represented in the form of reduced-bit rate The 3D video extensions increase both the stereoscopic and the multi-view representations, in addition to the capability of the novel 3D that involves the use of depth maps and view-synthesis methodologies [13].

In the literature [13], it has been stated that both the quality and the loss of information have to be studied for the HEVC standard coding scheme. Improving the compression efficiency of the existing HEVC standard seems to be a great challenge. In [14] and [15], the architectural coding schemes have been discussed and they mainly focus on the improvement of the computational efficiency of the encoder and not on the loss of information loss and the preservation of the decoded videos quality. Similarly, the algorithm level encoding schemes in [16] and [5] have also focussed on reducing the computational complexity of the encoding scheme. The coefficient coding has been addressed in [3] and it has mainly focussed on the protection of encoding. But, those methods won't suit for all the video formats. So, for applying such types of encoding schemes, the adaptive coefficient selection schemes are needed. In [4], the entropy coding has been studied with the main concentration on the computational efficiency and the precision. Other than that, the bottlenecks for improving the performance of the HEVC also have a lot of drawbacks that persist still in the inter-prediction and intra-prediction methods of HEVC. The drawbacks are as follows:

- Decrease in the coding efficiency, due to misalignment.
- High computational time.

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