# Chapter 52
# A Novel Adaptive Scanning Approach for Effective H.265/ HEVC Entropy Coding

**Wei Li**
*Xi'an University of Technology, Xi'an, China*

**Fan Zhao**
*Xi'an University of Technology, Xi'an, China*

**Peng Ren**
*Xidian University, Xi'an, China*

**Zheng Xiang**
*Xidian University, Xi'an, China*

## ABSTRACT

*The block transform video coder of H.265/HEVC has been formulated for a more flexible content representation to satisfy various implementation demands. Here three coefficient-scanning methods of diagonal, horizontal and vertical scan are employed for mapping a 2-D array to a 1-D vector for further reducing redundancy in entropy coding. However, the fixation scanning pattern does not fully exploit the correlation among quantized coefficients and the coding redundancy still exists. In this paper, a new adaptive coefficient scanning (ACS) method is proposed for effective H.265/HEVC entropy coding. Here the characteristic of syntax elements of quantized coefficients is first studied and then the related context probability of symbol is estimated through combining local property. Guided by the principle of entropy coding, the scanning approach is established for higher coding performance. Experimental results demonstrate that a reduction of about 3.6%–4.2% in bit-rate can be observed with almost no loss in coding complexity.*

## INTRODUCTION

Rapid development of technologies in multimedia and communication network has led to a proliferation of video applications such as ultra HDTV, digital camera, broadcasting, surveillance, video conference, and so on. In these scenarios, various kinds of devices are involved in different resolutions, computing capabilities and network bandwidths, which creates a real problem: how to meet these demands efficiently. Traditional video coding schemes are hard to work well and therefore the advanced solutions are beginning to emerge that could potentially form the basis of the next substantial step forward in coding efficiency.

Recently the premier video coding standard named as H.265/HEVC (Sullivan et al., 2012) has been developed to satisfy various implementation requirements, which achieves a higher compression ratio while providing good image quality. H.265/HEVC is still based on the conventional block-based hybrid coding scheme, including intra- and inter-prediction, residual transform coding, quantization, entropy coding, and in-loop filtering. Additionally, multiple advanced coding tools have been also jointly incorporated into H.265/HEVC targeting outstanding coding performance.

In H.265/HEVC, a hierarchical structure of transform unit (TU) (JCTVC, 2014) is introduced for flexible and effective representation of predicted residuals, where the size of TU covers $4\times4$, $8\times8$, $16\times16$, and $32\times32$. Following transform and quantization, the residual data in one TU are scanned and mapping into one-dimensional array for subsequent entropy coding. Here the scanning is a very significant procedure which directly affects the extent to save the coded bits. From a rate-distortion optimization perspective, the scanning order should always select the next coefficient to visit so that it maximizes the quality of the image while minimizing the coded bit-rate.

A zigzag scanning has been employed into H.264/AVC (Wiegand et al., 2003) for encoding the transform coefficients of both intra- and inter-blocks, where residuals are scanned in fixed order regardless of local characteristics. In (Fouak et al., 2011), an adaptive scanning (adopting zigzag, horizontal, vertical and Hilbert) is proposed to face the standard zigzag scanning for compression. In (Gu et al., 2012), by exploring the statistical redundancy of the predicted residuals, a new scanning based on mode-dependent template is constructed for H.264/AVC intra lossless coding. Although the existing scanning methods have been proved to achieve a superior performance to H.264/AVC, they do not sufficiently take the statistical properties of the quantized coefficients into consideration and coding redundancy remained.

A diagonal scanning starts in the top right corner and proceeds to the bottom left corner and reduces the data dependency. So, the diagonal scanning substituting zigzag scanning, horizontal scanning and vertical scanning are all incorporated into H.265/HEVC for entropy coding (Sole et al., 2012). In (Zhong et al., 2014), based on energy distribution, a scanning pattern is built for non-square quadtree transform (NSQT) (Bross et al., 2011) which is not adopted into H.265/HEVC finally. The above mentioned scanning schemes are at most adaptive at the transform block level, but these fixation scanning patterns could limit the coding performance due to the neglect of entropy coding characteristic. For an efficient scanning approach, if nonzeros quantized coefficients are grouped and located at the start of a 1-D array, and the number of zeros before the last nonzero is reduced, a significant bit-rate could be achieved.

In this paper, a novel adaptive coefficients scanning (ACS) approach for effective entropy coding is developed and applied into H.265/HEVC. The syntax elements of quantized coefficients and the principle of entropy coding are first analyzed. Then based on the spatial correlation, the Krichevsky-Trofimov (K-T) estimator (Krichevski et al., 1981) is utilized to predict the probability of next nonzero quantized coefficient. Combining the context model of entropy coding, the new scanning scheme is ultimately constructed for further improving coding performance, which reduces the coefficient level redundan-

## Related Content

Modeling Trust Relationships for Developing Trustworthy Information Systems
Michalis Pavlidis, Shareeful Islam, Haralambos Mouratidisand Paul Kearney (2018). *Computer Systems and Software Engineering: Concepts, Methodologies, Tools, and Applications (pp. 1632-1655).*
www.irma-international.org/chapter/modeling-trust-relationships-for-developing-trustworthy-information-systems/192939

Blockchain and Its Integration as a Disruptive Technology
Dhanalakshmi Senthilkumar (2020). *AI and Big Data's Potential for Disruptive Innovation (pp. 261-290).*
www.irma-international.org/chapter/blockchain-and-its-integration-as-a-disruptive-technology/236342

Actors in the Emerging Internet of Things Ecosystems
Seppo Leminen, Mervi Rajahonkaand Mika Westerlund (2020). *Disruptive Technology: Concepts, Methodologies, Tools, and Applications (pp. 265-285).*
www.irma-international.org/chapter/actors-in-the-emerging-internet-of-things-ecosystems/231191

Interval-Valued Fuzzy H-Ideals on ß-Algebra
Prakasam Muralikrishna, Tapan Senapatiand Perumal Hemavathi (2020). *Handbook of Research on Emerging Applications of Fuzzy Algebraic Structures (pp. 244-274).*
www.irma-international.org/chapter/interval-valued-fuzzy-h-ideals-on--algebra/247658

Lattice Boltzmann Shallow Water Simulation With Surface Pressure
Iñaki Zabalaand Jesús M. Blanco (2018). *Analysis and Applications of Lattice Boltzmann Simulations (pp. 293-336).*
www.irma-international.org/chapter/lattice-boltzmann-shallow-water-simulation-with-surface-pressure/203093