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REVIEW ARTICLE

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IMAGE & VIDEO COMPRESSION WITH RATE DISTORTION APPROACH: A REVIEW

Preeti
M.Tech Scholar,
ECE Department, D.C.R.U.S.T,Murthal

Gitanjali Pandove
Associate Professor,
ECE Department, D.C.R.U.S.T, Murthal

Abstract:In this paper, a rate distortion approach is studied to solve the optimization purpose. Now a day, digital video compression technique is most popular for cost reduction. Many applications such as digitized music or internet broadcasting the movie, provided by the digital video industry cannot be forgotten. These attributes of digital video provides continue progression in compression technology & improvement on different media storage or audio / video service streaming. A RDO(Rate distortion optimization) technique is an optimization technique which involves diamond and exhaustive search. An exhaustive search process is involved to determine the optimal quantized transform coefficient, used in block code. The computational cost of exhaustive search quantization is more expensive than conventional quantization.

Keywords:Rate distortion approach, High definition television, Spatial smoothness map, Support vector machine, Rate distortion optimization, DCT, Quantization parameter.

I. INTRODUCTION

A conventional system setting for researching on video compression is the pair of encoder and decoder, assuming abundant computation power for encoding, limited computation power for decoding, and no diversity for spatial and temporal resolutions. Under this circumstance, a critical question is what the best rate distortion (RD) trade-off is, which is the first problem to be tackled [1]. Furthermore, if we consider the spatial resolution diversity between the capturing unit and the displaying unit, there is a transcoding problem, which involves converting the spatial resolution for a compressed source. This transcoding task with spatial resolution conversion motivates the second major work in this thesis for image/video down-sampling in the discrete cosine transformation (DCT) domain [2]. Lossy video compression under the conventional system setting with abundant encoding power generally adopts a hybrid structure, where several different compression techniques such as motion prediction, transform, quantization, and entropy coding are employed together. In general, this is referred to as hybrid video compression. This structure follows an intuitive understanding of video data about the temporal redundancy (similarity between Video compression in a practical multimedia system may be customized by different system settings such as its device diversities and the data delivery method [3] Conventional hybrid video compression assumes only the pair of encoder and decoder, overlooking the device diversities and the data delivery method. Transcoding considers the spatial resolution diversity, and/or the temporal resolution diversity, and/or channel bandwidth diversity through a network. Distributed video coding addressesthecomputationpowerdiversity, technically speaking[4].

The rest of research paper is design as follows. The overall previous work is described in Section II. Section IIIdescribes problem formulation. Performance parameter describe in section IV. Finally, Section V describes the conclusion of paper.

II. LITERATURE REVIEW

This section will provide the brief description and highlights the contribution, remarks and factors of the work done by the researchers. Many attempts have been made in the past to achieve the maximum peak signal to noise ratio.
Qin Huang et.al described about RBF technique.Linear Kernel and Non-linearKernel technique was used. For linear kernel technique GM,SSM and STSM was 2.39 2.49 and 2.43 respectively. For non-linear kernel techniques GM,SSM and STSM were2.55,2.38and 1.88 respectively [1].

Takashi Tanaka et.al discussed about SRD Approach for Gaussian SRD problem, Linear Gaussian sensor design problem, SRD optimization as max-det problem and Max-det problem as SDP respectively. The result was found that it provides min. downlink bandwidth for satellite attitude determination[2].

AlexandreMercat et.al described about Quad-tree partitioningIntra encoding and RD-cost technique.The best results were obtained for the video sequences of class F with up to 36% BD-BR savings between CDC and the inverse allocator [3].

MohammadrezaStephane et.al described about Promising Rate distortion approach and non -promising modes of Rate distortion approach. The major findings from his research were encoding time reduction,BD PSNR,BD Rate were 41.8 %, 0.058 db and 1.24% respectively [4].

YanboGeo et.al described about a layer-based temporal dependent RDO method for RA-HVC and Embedded

Temporal propagation Chain for Random- Access Hierarchical Video Coding. The average BD-rate gain,BD-rate saving was 1.4% and 3.8% respectively. For the proposed method, theaverage ETR of each class was about 103%~105%, and the average ETR of all sequences is about 104% [5].

Shuichi Ohno et.al describedAboutquantizewith an error feedback filter and design of the Noise Shaping Filters. The result was found that MSEs of the optimal feedback quantize,the optimal feedback quantize is-10, -20, -30 dbrespectively[6].

SichuanGoo et.al described about Syntax-based context-adaptive Binary Arithmetic Coding the Gloom coding, which was widely used in HEVC. The PSNR loss, Rate computation reduction were 0.0428 and 28.4% respectively [7].

Yi Liu et.al described about Locally Adaptive Resolution, Quad tree Partitioning, Quantization Process and Proposed RDO Model. The result was found that Gradient Entropy and Bit Rate for Lossless Coding was 5.892 and 12.460 respectively [8]

Table1. Literature Review Table

Authors	**Paper Title**	**Research Methodology used**	**Major Findings**	**Research prospects**
Qin Huang, Haitian Wang, Sung Chang Lim, Hue Yong Kim,	Measure and Prediction of HEVC Perceptually Loss /Lossless Boundary QP Values	Linear Kernel Non-linear RBF Kernel JND-based quality assessment dataset for HEVC-coded video	Linear Kernel GM : 2.39 SSM : 2.49 STSM : 2.43 Non Linear RBF Kernel GM : 2.55 SSM : 2.38 STSM : 1.88	By characterizing major artifacts and deriving effective features, the proposed SVR based prediction system can predict the first JND value for each Goop.
Takashi Tanaka, Kwang-Ki K. Kim, Pablo A. Parrilo, and Sanjoy K. Mitter	Semi definite programming Approach to Gaussian Sequential Rate-Distortion Trade offs	SRD Approach for 1. Gaussian SRD problem 2. Linear Gaussian sensor design problem 3. SRD optimization as max-det problem 4. Max-det problem as SDP	It provides min. downlink bandwidth for satellite attitude determination	The implication is that Gaussian SRD problems are efficiently solvable using standard SDP solvers.
AlexandreMercat , Florian Arrestier, WassimHamidouche, MaximePelcat, Daniel Menard	Constrain the Docile CTUs: an In-Frame Complexity Allocator for HEVC Intra Encoders	Quad-tree partitioning Intra encoding RD-cost	The best results are obtained for the video sequences of class F with up to 36% BD-BR savings between CDC and the inverse allocator.	1.RD-cost is linked to the partitioning depths of CTUs. 2. CTUs with low RD-cost have less increase of bit rates and/or distortion than CTUs with high RD-cost when constrained
Mohammadreza StephaneCoulombe	RDO Cost Modeling for Low Complexity HEVC Intra Coding	Promising Rate distortion approach Non promising modes of Rate distortion approach	Encoding time reduction : 41.8 % BD PSNR : 0.058 db BD Rate : 1.24%	RDO Cost Modeling to reduce the computational complexity of HEVC intra coding
Yambol Ago, Coe Zhu, Shay Li and Tawny Yang	Layer-Based Temporal Dependent Rate-	A layer-based temporal dependent RDO method for RA-HVC	average BD-rate gain : 1.4% BD-rate saving :	It is shown that the Temporal

	Distortion Optimization in Random-Access Hierarchical Video Coding	Embedded Temporal propagation Chain for Random- Access Hierarchical Video Coding	3.8% For the proposed method, the Average ETR of each class is about 103%~105%, and the average ETR of all sequences is about 104%.	dependent RDO can be formulated as minimizing the Aggregated distortions of the to-be-coded unit and its affected Units subject to a rate constraint.
Shuichi Ohio, Teriyaki Shitake, M. Rowan Tariq, and Masaaki Niagara	Rate-Distortion Analysis of Quantizes with Error Feedback	1. Quantize with an error feedback filter 2. Design of the Noise Shaping Filters	MSEs of the optimal feedback quantize , the optimal feedback quantize is -10 , -20, -30 db respectively	The amplitude response of the optimal error feedback filter that minimizes the MSE can be parameterized by one parameter and can be found numerically.
SanchuanGuo, Zhenyu Liu, Dongsheng Wang, Qingrui Han and Yang Song	Linear Rate Estimation Model for HEVC RDO Using Binary Classification Based Regression	Syntax-based context-adaptive Binary Arithmetic Coding the Golomb coding which is wildly used in HEVC, we devise the fast method to estimate its rate cost	PSNR loss : 0.0428 Rate computation reduction : 28.4%	The classification based linear regression method to derive the fast estimation model of rate Cost.
Yi Liu, Olivier Defogs, François Pasteur, KhouloudSamrouth	Low Complexity RDO Model for Locally Subjective Quality Enhancement in LAR Coder	Locally Adaptive Resolution 1. Quad tree Partitioning 2. Quantization Process 3. Proposed RDO Model	Gradient Entropy : 5.892 Bit Rate for Lossless Coding : 12.460	Although objective quality is not improved from the experimental results, the subjective quality is enhanced visibly

III. PROBLEM FORMULATION

The quantization is not implemented on residues for lossless model in HEVC and to avoid distortion. As due to this a new method i.e. lambda model is implemented in Rate-Distortion Optimization (RDO), where lambda is an factor that is based on quantization, which is independent to the lossless coding [9]. This paper firstly shows the role of lambda that it played in RDO of HEVC. It also shows the simulation results that are based on the annealing algorithm. This techniques is proposed to get the most appropriate lambda result for every large coding unit. If we consider the complexity of computer than these methods are not so efficient for this we proposed some prediction to improve RDO process [10].

The main objective of the paper is to study and analyze various rate distortion optimization in HVEC and H.264/AVC to improve the video encoding efficiency propose and design HEVC with variable size of coding unit using Rate-Distortion Optimization (RDO).

IV. PERFORMANCE PARAMETER

The performance ofimage and video compressionis measure with compression ratio, global PSNR, average PSNR, SSSIM and gradient entropy.

1. Compression Ratio

Compression ratio basically an ration between the sizes of files that are before compression process and after compression process respectively. This ration gives an theoretical value that by how much times the files is compressed from original file. For an algorithm the compression ratio must be larger [11].

$$\text{Compression Ratio} = \frac{\text{Size after Compression}}{\text{Size before Compression}}$$

2. Compression Factor

The inverse of compression ratio is called compression factor or it is an ratio of file before compression and after compression respectively [12].

$$\text{Compression Factor} = \frac{\text{Size before Compression}}{\text{Size after Compression}}$$

3. Compression Time

For calculation the time take by compression and to decompress the file has to be taken in separate account. Because in some application the decompression time is more important factor while in some other application the combination of both compression and decompression time plays an important role. For an acceptable result the time taken by compression and decompression must be smaller than algorithm [12]. The time taken for compression and decompression is totally depended on the computing devices.

4. Global PSNR Rate

MPEG-4Signal-to-noise ratio (often abbreviated SNR or S/N)is an measure that are being used in technology field now a day's which gives an comparison between the required signal with the background noise. So in mathematical terms this can be defined as the ration between signal power and noise power. This term is defined in decibels. If the ration is greater than 1:1 (greater than 0 dB) then this shows that signal is more than the noise. As a SNR is only applicable for the electrical signal but this technique can be employed for any kind of signal and gives satisfactory results. (such as isotope levels in an ice core or biochemical signaling between cells) [13].

5. Average PSNR Rate Video Samples ($PSNR_{global}$)

The difference between "PSNR" and "APSNR" is in the way of average PSNR calculation for a sequence. The requisite way to compute average PSNR for an sequence is to first find the mean square error for all the frames and after this we can calculate the PSNR value by the conventional simple equations of PSNR [14].

6. SSIM Rate Video Samples (SSIM)

SSI basically is based on the results of three factors after finding the results of these three factors all the results are combined to give a final result i.e. (luminance similarity, contrast similarity and structural similarity). There are mainly two implanted SSIM present which are fast and precise. The difference between these two implementation is that in Fast SSIM it uses box filter and in precise SSIM it uses gauss blur[15].

V. CONCLUSION

In this review paper different video and audio compression techniques with its simulation parameters global PSNR ,average PSNR and SSIM are studied. The different techniques are used to improve the performance parameter.These video are used for personal and commercial used.A rate distortion is more efficient than other video compression technique like quad tree partition technique, syntax based arithmetic coding. In context to complete survey it is clear that RDO technique have less time complexity in comparison to RBF kernel technique.

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