A NEW CRITERION AND ASSOCIATED BIT ALLOCATION METHOD FOR CURRENT AUDIO CODING STANDARDS

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ABSTRACT

This paper presents a new noise-shaping criterion. Based on the new criterion, we derive an efficient bit allocation method. The bit allocation method is applicable to the current audio standards like MPEG1 Layer 3 and MPEG4 AAC. The bit allocation method has gained a speed up for more than ten and has resulted in better quality over the traditional two nested loop method presented in ISO draft. The experiments illustrated the correction of the objective measurement criterion and the new allocation has shown the deterministic method instead of the iteration method to achieve the high allocation efficiency and best quality.

1. INTRODUCTION

The bit allocation aims to assign suitable parameters to the encoder to achieve the best audio quality under the restricted bit number. Hence control over the quality and the bit number are two fundamental requirements for the bit allocation. The complexity of the task depends on the difficulties to have the quality and bit control. For MPEG Layers 1 and 2 [1], both the quality and the bit requirement are controlled by a uniform quantizer. Hence the bit allocation is just to apportion the total number of bits available for the quantization of the subband signals to minimize the audibility of the quantization noise. For coders such as MPEG Layer 3 [1], MPEG-2 AAC [2], and MPEG4 T/F coding [3], controls over the quality and the bit rate are difficult. This is mainly due to the fact that they both use a non-uniform quantizer whose quantization noise is varied with respect to the input values. In other words, it fails to control the quality by assigning quantizer parameters according to the perceptually allowable noise. In addition, the bit-rate control issue can be examined from the variable length coding used in MPEG Layer 3 and MPEG-2 AAC. The variable length coding assigns variable bit-length to different values, which means that the bits consumed should be obtained from the quantization results, and cannot be from the quantizer parameters alone. Thus, the bit allocation is one of the main tasks leading to the high complexity of the encoder. This paper presents a new bit allocation method to ease the complexity. We take MPEG Layer 3 as the detail derivation and experiment example.

The above two difficulties lead to the problem in evaluating the quantization parameters. A two-nested loop iterative method referred to as the OCF (optimum coding in the frequency domain) has been proposed in [4] to solve the problem. Te OCF method evaluates the quantization parameters through two iteration loops: the rate-controlling loop and the quality-controlling loop. The rate-controlling loop adjusts in iteration the parameter values to fit to the limited bits the consumed bits which are obtained by performing quantization and Huffman coding for spectral lines. The quality-controlling loop adjusts in iteration the parameter values to fit to a perceptual criterion the quantization noise that needs to be evaluated by performing the inverse quantization. The method can be examined from the complexity and the induced audio quality. The complexity of the method for a frame with F spectral lines is \(O(FR·\eta·FQ·\gamma)\), where \(Q\) and \(R\) are respectively the numbers of quality-controlling iterations and rate-controlling iterations while the \(\eta\) and \(\gamma\) are the computation complexity to handle a spectral line in the rate-controlling loop and the quality-controlling loop, respectively. The rate-controlling loop complexity \(\eta\) will be from the quantization and the Huffman coding of a spectral line while the quality-controlling loop complexity \(\gamma\) from the dequantization and noise evaluation. Both the complexity \(\eta\) and \(\gamma\) are high. Also, the numbers of iterations \(Q\) and \(R\) depend on the initial values of quantization parameters and the adjust manners. The second problem is on the quality of the coded audio. The method of assigning bits to quantization bands in the quality-controlling loop decides the quality. There have been two approaches in the assigning manners. One method is to assign in each iteration only the band with the worst noise-to-masking ratio. The method leads to a large number of iterations in the quality-controlling loop, which means the immense complexity. Another method assigns in iteration to all the bands with noise-to-masking ratio higher than one until all available bits are consumed. This method has a much lower complexity than the first method. However, the quality of the method is the concerns. The first method can shape the noise so that the masking threshold will be in parallel to the noise threshold, which has been a widely accepted criterion [5]. The second method that has been in the draft provided by ISO can be referred to as the approximate method on the first method. Since that there are two separate rules controlling the quality and bits consumed in two loops, there may lead to infinite loops, generally referred to as “deadlock problem”. A general method to handle the deadlock problem is to set the maximum number of iterations; however, the quality may be sacrificed to meet the bit rate constraint. This paper presents a new bit-allocation method that has merits in both complexity and audio quality.

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