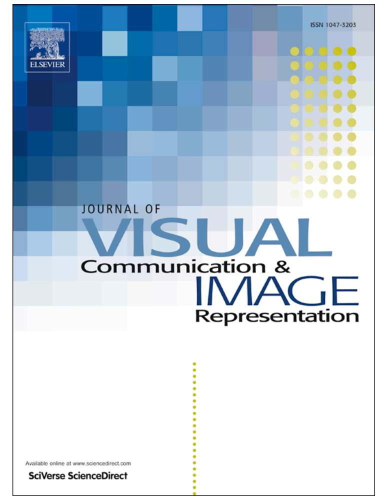

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A Highly Efficient Method for Improving the Performance of GLA-based Algorithms

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Abstract

Motivated by the observation that most methods for accelerating the generalized Lloyd algorithm (GLA) normally lack the capability to improve the quality of its end result and that most methods for improving the quality of the end result of GLA usually lack the capability to speed it up, an efficient and effective method is presented in this paper to enhance the performance of GLA and its variants, in terms of both the computation time and the quality of the end result, by leveraging the strengths of several reduction methods and the multiple stage mechanism. Simulation results show that the proposed method can efficiently and effectively reduce the computation time of GLA by up to about 93% while at the same time improving its quality by up to about 1 dB in terms of the peak-signal-to-noise-ratio in most cases.

Keywords: Generalized Lloyd algorithm, reduction method, multiple stage vector quantization.

1. Introduction

Apparently, vector quantization (VQ) [1, 2] is one of the most well-known compression techniques for signal processing. Its importance can be easily found in several successful applications presented recently, such as speaker recognition [3], face recognition [4], and image compression [5, 6]. Although VQ has been out there for over 3 decades, it still attracts the attention of many researchers [7, 8, 9]. A variety of methods for VQ and its applications have been presented in recent years, such as video coding [10, 11, 12] and text detection [13] techniques. VQ generally is composed of three parts: a codebook generator, an encoder, and a decoder. The codebook generator (i.e., codebook generation algorithm) is aimed at finding a table of codewords for the image[1] in question, a problem which is generally referred to as the codebook generation problem (CGP). The encoder and decoder will then use the table thus obtained to compress and decompress the image. Among the numerous algorithms presented for the codebook generation problem, because generalized Lloyd algorithm (GLA) [14, 15] (also known as Linde-Buzo-Gray algorithm (LBG) [16]) is the simplest and easiest to implement, it has become one of the most well-known codebook generation algorithms for VQ. Since the codebook generator is computationally expensive, it strongly impacts the performance of VQ, especially for large images.

Generalized Lloyd algorithm (GLA) [14, 15] (also known as Linde-Buzo-Gray algorithm (LBG) [16]) is one of the most well-known codebook generation algorithms for VQ because it is simple and easy to implement. Since most codebook generation algorithms are computationally expensive, the computation time they take may strongly impact the performance of VQ, especially for large images. Studies on enhancing the performance of GLA can be divided into two categories: quality and computation time. On one hand, although most methods for improving the quality of GLA are capable of obtaining a significantly better result, they normally take a much longer computation time than simple GLA does, such as multiple stage vector quantization (MSVQ) [17, 18]. On the other hand, most methods for reducing the computation time of GLA usually end up with a worse result than simple GLA does, such as tree structured vector quantization [19, 20]. All these lead to a conclusion that there still lacks a perfect solution that is capable of enhancing the performance of GLA in terms of both the quality and computation time. For instance, in [21], Tsai et al. took into account removing the computations of GLA that are essentially redundant, but not into account improving the quality of the end result.

Unlike those that are designed to employ one, and only one, reduction method for speeding up the performance of GLA, an efficient algorithm, called multiple reduction, multiple stage (MRMS), that leverages the strengths of several methods for reducing as much as possible the computation time of GLA while at the same time providing a better result than GLA alone does, is presented in this study. MRMS is aimed at reducing the computation time of GLA from three different perspectives: patterns, codewords, and dimensions. It can significantly reduce the computation time of GLA though the quality may be degraded. To compensate for the loss of quality that may be caused by these reduction methods, a multiple stage mechanism [18, 22] is used to restart the search process when the solutions are converged to a particular direction.

The main contributions of the paper can be summarized

[1]Or even a set of images.