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A comparative analysis of compression techniques – the sparse coding and BWT

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Abstract

The process of image compression has been the most researched area for decades. Image compression is a necessity for the transmission of images and the storage of images in an efficient manner. This is because image compression represents image having less correlated pixels, eliminates redundancy and also removes irrelevant pixels. The most commonly known techniques for image compression are JPEG and JPEG 2000. But these two have certain drawbacks and thus various other techniques have been popping up, of late. Recently, a growing interest has been marked for the use of basis selection algorithms for signal approximation and compression. In the recent past, the orthogonal and bi-orthogonal complete dictionaries (like the Discrete Cosine Transform (DCT) or wavelets) have been the dominant transform domain representations. But, the DCT and the wavelet transform techniques experience blocking and ringing artefacts and also these are not capable of capturing directional

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information. Hence, sparse coding method (by Orthogonal Matching Pursuit (OMP) algorithm) comes into picture. Another, novel technique that has taken up recent interests of the image compression area is the Burrows-Wheeler transform (BWT). BWT is generally applied prior to entropy encoding for a better regularity structure. The paper puts forth the comparison results of the methods of sparse approximation and BWT. The comparison analysis was done using the two techniques on various images, out of which one has been given in the paper.

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Keywords: image compression; BWT; sparse coding; orthogonal matching pursuit; MTF coding

1. Introduction

In today's world, there is an increase in effective transmission (transfer) and storage of data. For the efficient transmission of data, data size needs to be less without degrading any necessary information. Data compression fulfils this criterion. Despite rapid progress in digital communication and mass storage devices, transmission of pictures/images still poses a challenge. Compression can be classified as either lossy or lossless compression technique. In lossless compression, the original data can be completely recovered after decomposition and in lossy compression, some amount of data is lost and that data cannot be recovered. Image compression reduces the file size without badly affecting/degrading the quality of the image. Lossless compression technique is often preferred for medical imaging. Lossy data compression has the potential to achieve higher compression ratio[1].

The well-known lossy image compression formats are JPEG, JPEG 2000. JPEG is a lossy compression technique. It stands for Joint Photographic Experts Group. It is an algorithm which can compress images with 24 bits depth or grayscale images. JPEG 2000 is another lossy compression technique. It is a wavelet-based compression standard. JPEG 2000 has better compression ratio than JPEG. Recently, Sparse Approximation Technique and Burrows-Wheeler Transform (BWT) have become topics of interest and are being used for image compression.

2. Background Work

The first international standard for continuous-tone (grayscale and color) still images was established by Wallace[1]. The JPEG standard included two basic methods, one DCT-based method for lossy compression and the other a predictive method for lossless compression. Mallat and Zhang[2] introduced Matching Pursuit algorithm for time-frequency analysis. This algorithm is considered as a popular algorithm for the sparse technique. Representation of image with retention of important properties (like scale, localization, amplitude, preferred orientation and phase of discontinuity) can be done using matching pursuit. Kapoor and Dhir[3] had proposed a lossless DCT-based compression technique, to be used in 2-D (two-dimensional images). This technique reduced encoding time but there was degradation in the image quality (though very little). Gan, et.al.[4] have worked in the area of sparse approximation and have provided a formula to determine the "the optimal amount of elements of the dictionary and the optimal quantization step that would minimize the number of bits required for storing the matching pursuit representation taking into consideration the upper bound of error". Pati, et.al[5] have used Orthogonal Matching Pursuit (OMP) and also conventional DCT can be replaced by dictionary-based approach.

3. Sparse Approximation Technique

The representation of the input image with the use of minimum number of atoms (from an over-complete dictionary) is the chief problem in sparse approximation. Very large sized representations are generated from this model. Instead of the decomposition of a given image over the entire set of Gabor functions, an adaptive algorithm (Matching Pursuit) is used to select Gabor elements which best approximate the image in correspondence to the