A Review of Image Compression Techniques

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Abstract
In this modern era of communication, where time is of the essence, the development of better image compression and transmission techniques has been a topic of much interest.

In this paper, we will only investigate and explain the basic image-processing techniques, which are the fast Fourier transform, discrete cosine transform, and discrete wavelet transform. With the basic understanding the methodology used in JPEG and JPEG 2000 compression will be simulated and its results explained.

The aim of this paper is to provide the reader with a basic understanding of the various image compression schemes available before they are actually used with different modulation schemes to simulate performances in wireless transmission mediums.

Introduction

Images are signals with special characteristics. They are measures of parameters over space (distance), while most signals are measures of parameters over time. It is known that digital-imaging applications such as multimedia, internet publishing, and teleconferencing have grown significantly over the past decade. Many people now prefer to complement their messages with photos, images, and/or animations to better express themselves and to make it more attractive for other people to see. Some things simply cannot be described by words, but "A picture is worth a thousand words." These phenomena are found mostly in communication areas, such as instant-messaging, e-mails, and even cell phones. Also, in the corporate world, there are corporations that engage in online catalogs, which employ plentiful images and animations in their websites.

A digital image consists of a grid of dots, more commonly known as pixel (picture element). The more pixels an image has the better the resolution, hence the better its quality. A pixel consists of three primary color components--Red, Green and Blue (RGB)--which are associated with integer numbers that define the number of bits in a single pixel. Any other color can be represented by the mixture of these RGB colors. A typical color resolution for a solid black and white unrealistic image is one bit per pixel (bps); eight bps for grayscale images, unrealistic color images, and coarse realistic images; 24 bps for photographic quality realistic images; and 48 bps for ultrahigh quality images. The size of an image stored is calculated by the number of pixels (width x height) times the color bits per pixel. For example, an uncompressed 640 x 320 pixels image with eight bits will be equivalent to 640 x 320 x 8 bits = 1,638,400 bits or equal to 204,800 byte (note: 1 byte = 8 bits).

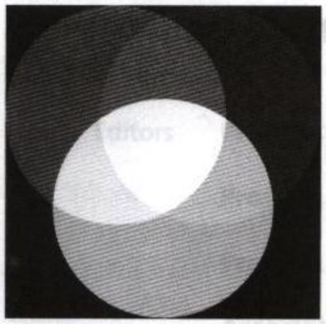

Figure 1: Primary colors of RGB (Red, Green and Blue) and their combinations

Images can generally be classified as "realistic" or "unrealistic". Realistic images include photographs and realistic artworks with many shades and few straight lines. Unrealistic images are those with block colors and lots of straight lines, for example graphics, block diagrams, graphic banners and cartoons.

Two types of image-compression methods available are lossless and lossy compression. As the names imply, the lossless compression method produces exactly the same image after decompression, while the lossy compression method brings about degraded image results after decompression, depending on the degree of compression--the more it is being compressed, the more degraded the image will be after decompression process. The lossless compression method is a necessity for image files in which high resolution imagery is required and larger file-size is not an issue, as with, for example, texts, engineering graphs and diagrams, or medical images. The lossy compression method is employed mostly for realistic images/artworks and photographic images where some of the picture elements are eliminated. For these kinds of images, the missing elements of an image will not be immediately obvious to the human eye.

Literature Review

To compress an image, the image is first divided into blocks. This method is called block encoding (BE).Once the image being broken down into blocks, vector quantization (VQ) can be done. This is just a quantization technique in which the input data is arranged to achieve maximum intra-vector and minimum inter-vector correlations, so that the compression ratio of VQ can be increased.

Another method of block encoding is called block truncation coding (BTC). This method divides the original images into small sub-images and then uses a quantizer, which adapts itself according to the image statistics to reduce the number of gray scale levels in the image. With this method the compression ratio is limited.

If the output of the block encoder is further transformed using the Fourier, cosine or wavelet transforms, then better compression ratios can be achieved. The transforms are described below.

Fast Fourier Transform

The fundamental principle in processing an image using Fourier [3] analysis is to manipulate the spectrum of an image by letting some of its elements equal zero, to get rid of unwanted frequencies (the frequencies that have zero or almost zero magnitude in the spectrum are neglected), and to then transform back the image using the inverse Fourier transform. Thus only a small fraction of the spectrum is needed to represent an image, with some tolerable losses.