Chapter 48
3D Medical Images Compression

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ABSTRACT

Medical images are digital representations of the body. Medical imaging technology has improved tremendously in the past few decades. The amount of diagnostic data produced in a medical image is vast and as a result could create problems when sending the medical data through a network. To overcome this, there is a great need for the compression of medical images for communication and storage purposes. This chapter contains an introduction to compression types, an overview of medical image modalities, and a survey on coding techniques that deal with 3D medical image compression.

IMAGE COMPRESSION

Image compression is the appliance of data compression on digital images which are made up of large number of pixels. Compression is the reduction in the amount of image data (the number of bytes) while preserving information (image details) with the intention of optimizing and putting to maximum use the data storage and data transmission facilities. Images transmitted over the internet are an excellent example of why data compression is important. Suppose we need to download a digitized color photograph over a computer's 33.6 kbps modem. If the image is not compressed (a TIFF file, for example), it will contain about 600 kilo bytes of data. If it has been compressed using a lossless technique (such as used in the GIF format), it will be about one-half this size, or 300 Kbytes. If lossy compression has been used (a JPEG file), it will be about 50 Kbytes. The download time for these three equivalent files are 142 seconds, 71 seconds, and 12 seconds, respectively which is a huge difference.

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The following table (Table 1) shows the qualitative transition from simple text to full-motion video data and the disk space transmission bandwidth, and transmission time needed to store and transmit such uncompressed data (Sachin Dhawan, 2011).

Table 1. Multimedia data types and uncompressed storage space, transmission bandwidth, and transmission time required; the prefix kilo- denotes a factor of 1000 rather than 1024

Multimedia Data	Size / Duration	Bits/Pixel or Bits/ Sample	Uncompressed Size (B for Bytes)	Transmission Bandwidth (b for bits)	Transmission Time
A page of text	11" x 8.5 "	Varying resolution	4-8 KB	32 – 46 kb / page	1.1 – 2.2 sec
Telephone Quality Speech	10 sec	8 bps	80 KB	64 kb / sec	22.2 sec
Gray Scale Image	512 x 512	8 bpp	262 KB	2.1 Mb / image	1 min 13 sec
Color Image	512 x 512	24 bpp	786 KB	6.29 Mb / image	3 min 39 sec
Medical Image	2048 x 1680	12 bpp	5.16 MB	41.3 Mb / image	23 min 54 sec
SHD Image	2048 x 2048	24 bpp	12.58 MB	100 Mb / image	58 min 15 sec

There are two major components of compression which are Redundancy and Irrelevancy Reduction. Redundancy Reduction aims to eliminate duplication from the image. Irrelevancy Reduction neglects parts of the signal that will not be noticed by the signal receiver, namely the Human Visual System (HVS). The mechanism of compression can be achieved by removing one or more of three basic data redundancies:

- **Coding Redundancy (Spectral Redundancy):** This is caused by correlation between different color levels or spectral bands.
- **Interpixel Redundancy (Spatial Redundancy):** This is caused by correlation or dependence between neighboring pixel values.
- **Psycovisual Redundancy (Temporal Redundancy):** This is caused by correlation between different frames in images.

Various techniques could be used to compress the images and could be classified into two ways; Lossless compression techniques and Lossy compression techniques.

Lossless compression techniques are where the reconstructed image after compression is numerically identical to the original image. No noise or any losses are found in the reconstructed image. Lossless compression includes: Run Length Coding, Dictionary Coding, Transform Coding, and Entropy Coding. Entropy Coding includes: Huffman Coding which is a simple Entropy Coding and commonly used as the final stage of compression, Arithmetic Coding, Golomb Coding which is a simple Entropy Coding for infinite input data with a geometric distribution and finally the Universal Coding which is also an Entropy Coding for infinite input data with an arbitrary distribution.

Lossy compression techniques are where the reconstructed image after compression is not identical to the original image; some losses are found in sense of noise, blurring etc. in reconstructed image. Lossy techniques cause image quality degradation in each compression or decompression step. Lossy techniques have greater compression ratio as compared to Lossless techniques.