Compression

- The need for Compression:

  Assume 640 x 480 pixels = 307200 pixels
  1 second

  – Text: 8 x 8 pixels/char = 2 bytes/char

  – Image: 1 byte/pixel = 256 colors
  30.7 Kbytes/image

Compression (cont.)

- Audio:
  - Speech:
    Sampled @ 8 KHz
    Quantized @ 8 bits/sample =
    64 Kbits/sec
  - CD Quality Stereo:
    Sampled @ 44.1 KHz
    Quantized @ 16 bits/sample =
    705.5×10^3 bits/second

Compression (cont.)

- Full Screen Video:

  3 bytes/pixel for luminance & chrominance

  30 frames/second =

  2.2×10^8 bits/second =

  27.5 Mbytes/second

Modes of Media Accessing

- Dialogue mode
  - interaction among human users via multimedia information
- Retrieval mode
  - retrieval of multimedia information by a human user from a multimedia database

Requirements

- Dialogue mode
  - end-to-end delay (compression and decompression) must be no more than
    - » 150 milliseconds
    - » 50 milliseconds for face to face
    - » these are subjective

Requirements (cont.)

- Retrieval mode
  - fast forward & backward data retrieval with simultaneous display and search
  - random access of single frames at 0.5 seconds
  - decompression of single frames without accessing other frames

Requirements (cont.)

- Dialogue and Retrieval mode
  - scaleable frame size & rate
  - adjustable quality as needed
  - synchronization of audio and video
  - compression techniques compatibility - generate data on one system & reproduce it on another

    e.g., CD systems → PC, MAC, WIN

Basics of Information Theory

- Entropy
  - a measure of disorder
  - Entropy is a measure of the information contained in message, it's the lower bound for compression

Basics of Information Theory

- the average amount of information represented by a symbol in a message, is a function of the model used to produce that message and can be reduced by increasing the complexity of the model so that it better reflects the actual distribution of source symbols in the original message.

- Energy
- the number of bits necessary to transmit the message

Basics of Information Theory

According to Shannon, the entropy of an information source S is defined as:

$$H(S) = \eta = \sum_i p_i \log_2 \frac{1}{p_i}$$

where p_i is the probability that symbol S_i in S will occur.

Basics of Information Theory

$\log_2 1/p_i$ indicates the amount of information contained in S_i, i.e., the number of bits needed to code S_i.

For example, in an image with uniform distribution of gray-level intensity, i.e. $p_i = 1/256$, then the number of bits needed to code each gray level is 8 bits. The entropy of this image is 8.

Classification of Compression Techniques

- Lossy vs. Lossless
- Symmetric vs. Asymmetric

Basics of Information Theory

- Entropy encoding
  - a generic term which refers to to the encoding and compression techniques which do *not* take into account the nature of the information to be compressed.
  - ignores the *semantics* of the information.
  - provides *lossless* compression.

Basics of Information Theory

- Source encoding
  - transformations take place which are dependent on the characteristics of the original signal.
  - highly dependant on the semantics of the original signal.
  - may produce higher compression ratios than strict entropy encoding.
  - may operate in either a lossless or in a lossy mode.

Basics of Information Theory

- Entropy and source encoding are not two mutually exclusive techniques.
- In the compression of sound, image, or motion video, they are usually combined to achieve the highest possible compression ratio.

Data Compression Techniques

Entropy coding	**Repetitive sequence suppression**	• Zero supression • Run-length encoding
	Statistical encoding	• Pattern substitution • Huffman-like encoding
Source coding	**Transform encoding**	• FFT • DCT • Others
	Differential encoding	• DPCM • Delta modulation • ADPCM
	Vector quantization	

Classification of Compression Techniques

- General Purpose
  - Run Length Encoding
  - Relative Encoding
  - Huffman Coding
  - Arithmetic Coding
  - Lempel-Ziv Coding

Classification of Compression Techniques

- Intraframe
  - Sub-sampling
  - Course quantization
  - Vector quantization
  - Transform encoding

Classification of Compression Techniques

- Interframe Compression
  - Sub-sampling
  - Difference coding
  - Block based difference coding
  - Block based notion compensation

Compression Techniques