559 Course Notes  
Lossy Compression  

Mike Gleicher  
Fall 2006 (taken from Fall 2005)  
Notes for lecture – not shown in class

JPEG

• Key Ideas  
  – Frequency Domain (small details are less important)  
  – Block Transforms (works on 8x8 blocks)  
  – Discrete Cosine Transform (DCT)  
  – Control Quantization of frequency components  
    • More quality = use more bits  
    • Generally, use less bits for HF  
  
..\2005\2005-09.ppt

JPEG

• Multi-stage process  
  intended to get very high compression with controllable quality degradation  
• Start with YIQ color  
  – Why? Recall, it’s the color standard for TV

Discrete Cosine Transform

• A transformation to convert from the spatial to frequency domain – done on 8x8 blocks  
• Why? Humans have varying sensitivity to different frequencies, so it is safe to throw some of them away  
• Basis functions:

Quantization

• Reduce the number of bits used to store each coefficient by dividing by a given value  
  – If you have an 8 bit number (0-255) and divide it by 8, you get a number between 0-31 (5 bits = 8 bits – 3 bits)  
  – Different coefficients are divided by different amounts  
  – Perceptual issues come in here  
• Achieves the greatest compression, but also quality loss  
• "Quality" knob controls how much quantization is done

Entropy Coding

• Standard lossless compression on quantized coefficients  
  – Delta encode the DC components  
  – Run length encode the AC components  
    • Lots of zeros, so store number of zeros then next value  
    – Huffman code the encodings
Lossless JPEG With Prediction

- Predict what the value of the pixel will be based on neighbors
- Record error from prediction
  - Mostly error will be near zero
- Huffman encode the error stream
- Variation works really well for fax messages

Video Compression

- Much bigger problem (many images per second)
- Could code each image separately
  - Motion JPEG
  - DV (need to make each image a fixed size for tape)
- Need to take advantage that different images are similar
  - Encode the Changes?

MPEG

- Motion Picture Experts Group
  - Standards organization
- MPEG-1 simple format for videos (fixed size)
- MPEG-2 general, scalable format for video
- MPEG-4 computer format (complicated, flexible)
- MPEG-7 future format
- What about MPEG-3? – it doesn’t exist (?)
  - MPEG-1 Layer 3 = audio format

MPEG Concepts

- Keyframe
  - Need something to start from
  - “Reset” when differences get too far
- Difference encoding
  - Differences are smaller/easier to encode than images
- Motion
  - Some differences are groups of pixels moving around
  - Block motion
  - Object motion (models)