Multimedia Communications
ECE 728
(Data Compression)
Multimedia Communications

• Course number: ECE 728
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Course Objectives

• Goal: to develop a deep understanding of principles, theory, and application of data compression
• State-of-the-art compression techniques will be introduced.
• Compression standards: H.26x, MPEG, and JPEG, JPEG2000
Course Outline

• Introduction
• Multimedia representation and compression:
  – Huffman coding
  – Arithmetic coding
  – Dictionary techniques
  – Predictive coding
  – Scalar quantization
  – Vector quantization
  – Differential coding
  – Transform coding
  – Subband coding
Course Outline

– Bit allocation
– Wavelet based compression
– Fractal coding

• Multimedia communication standards
  – Visual compression standards JBIG, JPEG, MPEG 1,2,4 and H.261, H.263, H.26L
  – Audio/speech coding standards: MPEG audio coding, ITU-T speech coding
Textbook & References

• Textbooks:

• Reference books:
Grading System

• Homework: 35%
• Exam: 45%
• Project: 20%
Project

• The project can be in the form of a survey about a multimedia related topic, part of a multimedia related research or developing a multimedia related application
• A one-page project proposal is due by October 17th.
• The project report is due at the end of the term
• A presentation will be scheduled for the end of the term
Project

- Multimedia authentication and data hiding (watermarking, encryption, security, authentication)
- Multimedia databases, indexing and retrieval:
  - Indexing methods
  - Access methods (hashing, B-trees, Inverted Files, Space filling curves, R-trees)
  - Retrieval: text, speech recognition and retrieval, image and video retrieval
  - Digital Libraries
- Wireless multimedia networking
- Applications
  - IP telephony
  - Video-on-demand
Why Compression?

- The amount of information needed and available has increased.
- Limited-bandwidth communication channels.
- Fast communication, access, and processing is desirable.
- Limited storage capacity
Example: A Two-Hour Digital Movie

- **Uncompressed video:**
  - 30 frames per second
  - 720 by 480 pixels per frame
  - 3 color components (R, G, B)
  - 8 bits per component pixel

- **Compressed video on DVD:**
  (MPEG-2)

- **compression ratio:** 50:1

\[ \text{224 GB} \]

\[ \text{approx. 4.7 GB} \]
Compression

• **Compression:** Art or science of representing information in a compact form.

• **How the compression is achieved?**
  – Identify and exploit the structure that exists in the data
    • Statistical structure in English Language used in Morse code
    • Mechanism of speech production imposes structure on speech
  – Use the characteristics of the user of the data
    • If something presented in the data cannot be perceived by the user (e.g., human) it can be discarded.
Lossless and Lossy Compression

• **Lossless compression: no loss of information**
  – applied to: text, computer data, most medical images
  – limited amount of compression

• **Lossy compression: loss of information**
  – applied to various signals (speech, audio, video, image), some text
  – higher compression ratios
Measure of performance

- Compression ratio: ratio of number of bits required to represent the data before compression to number of bits required to represent the data after compression.
- Rate: number of bits required to represent a single sample after compression.
- Example: a 256x256 8-bit image requires 65,536 bytes before compression.
  - Compressed to 16,384 byte the compression ratio is 4
  - Rate is 2 bits.
- In lossy compression we have to quantify the difference between original data and reconstructed data.
- Distortion criteria:
  - Subjective: measured by the effect the distortion has on the receiver.
  - Objective: use mathematical formula to measure distortion.
Applications

- Storage and archiving
- Facsimile, document image analysis
- CD-ROM, DVD
- Digital TV broadcasting
- World Wide Web

- Wireless image transmission
- Digital audio broadcasting
- Digital photography
- Medical imaging
- Video telephony and video conferencing