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

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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:
  - Khalid Sayood, "Introduction to Data Compression, Third Edition", Morgan Kaufmann Publishers, 2006
- Reference books:
  - J. D. Gibson, “Multimedia Communications”, Academic Press 2001.
  - R. Steinmetz and K. Nahrstedt, "Multimedia: computing communications and applications", Prentice Hall, 1995.
  - F. Kuo, W. Effelsberg, and J. J. Garcia-Luna-Aceves, "Multimedia Communications", Prentice Hall, 1998.
  - Brad Perry et.al, "Content-Based Access to Multimedia Information From Technology Trends to State of the Art", Kluwer Academic Publishers, 1999
  - V.S. Subrahmanian, "Principles of Multimedia Database Systems", Morgan Kaufmann Publishers, Inc. 1998.
  - C. Faloutsos, "Searching Multimedia Databases by Content", Kluwer Academic Publishers, 1996

Grading System

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

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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

224 GB

- Compressed video on DVD: (MPEG-2)
- compression ratio: 50:1

approx. 4.7 GB

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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

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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