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:
 - 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%



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 February 18th.
- 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





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

