

EE586 Digital Video Coding Systems

Catalog Data: Credits: 4. Introduction to digital image and video compression algorithms and standards. Theoretical and practical aspects of important topics on digital image and video compression standards.

Textbook (optional):

Standard Codecs: image compression to advanced video coding, 3rd edition, Mohammed Ghanbari, 2011, ISBN: 978-0-86341-964-5.

Description: Video streaming, video conferencing, digital TV, video surveillance and other multimedia applications have a large impact to our society. Digital image and video compression algorithms are key technologies for these applications. Increasing amount of image and video contents are compressed in various standard formats (JPEG, MPEG-1, MPEG-2, MPEG4, H.264, HEVC/H.265, ...) for transport over networks or store in the server for retrieval applications. VLSI circuits are being designed for real-time video encoding and decoding. Many applications require to process the video in the compressed domain. It is important to know the capability, limitations, and format of the compressed video coding technologies and standards. Different from other kinds of standards, video coding standards do not specify everything, but leave many things unspecified for optimization and product differentiation. This course intends to explain up-to-date video coding technologies and standards, and give students an in-depth understanding of the subject including how to optimize for better video quality, low complexity, low delay, and error resilience.

Prerequisite: Basic understanding of digital signal processing (filtering, DFT), graduate standing or permission of instructor.

Topics:

Part I: Fundamentals

1. Digital image and video processing fundamentals
2. Image/video quality assessment
3. Lossless compression and predictive coding
4. Quantization
5. Discrete Cosine Transform (DCT)
6. Motion compensated predictive coding

Part II: Image and Video Compression Standards

7. JPEG
8. Development process of video coding standards
9. H.261, MPEG-1, MPEG-2, H.263, H.264
10. MPEG-4, H.264/MPEG-4 AVC, HEVC/H.265
11. Scalable video Coding
12. 3D video coding
13. Wavelet transform and JPEG-2000

Part III: Video Codec Optimization and Other Advanced Topics

14. Rate-distortion optimization
15. Rate-control
16. Fast algorithms and computation reduction
17. Current research activities in image and video processing

Grading: Homeworks 20%, Midterm Exam: 30%, Final Report: 20%, Final Exam: 30%.

References:

1. I. E.G. Richardson, "The H.264 Advanced Video Compression Standard," Wiley, 2nd Ed. 2010.
2. R.C. Gonzales and R.E. Woods, "Digital Image Processing," 3rd Ed., Prentice Hall, 2008.
3. T. Wiegand and H. Schwarz, "Source Coding: Part I of Fundamentals of Source and Video Coding," 2011.
4. M.T. Sun and A. Riebman, "Compressed Video over Networks," Marcel Dekker, 2001.
5. Y.Q. Shi and H. Sun, "Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards," Second Edition, CRC Press, 2008.
6. IEEE Transactions on Circuits and Systems for Video Technology.

Prepared by:

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