

**EE658 ADVANCED DSP APPLICATIONS
and
DATA COMPRESSION TECHNIQUES
For Speech, Image and Video Coding
By
Prof. Dr. Hüseyin Abut**

Fall 2006

Course Website: <http://anadolu.sdsu.edu/abut/Courses.html>

Class Schedule: Tuesdays and Thursdays 15:30 - 16:45

Classroom: E423B **Office:** 403F

Office Hours: Mondays & Wednesdays: 13:10-14:45; Tuesdays 17:00-18:00

Performance Evaluation:

1. One Midterm (30%) (2nd half of October)

1. Final (30%)

2. Project (40%)

TENTATIVE OUTLINE

1. Shannon's model for communication & information processing concepts
2. Goals of data compression (source coding/channel coding).
3. Lossless versus lossy compression.
4. Lossless coders including Huffman, run-length, and Lempel-Ziv.
5. Classical lossy techniques with examples.
6. Compression in vector quantization systems
7. Speech production and speech compression based on LPC models including CELP.
8. Still image compression including DPCM, DM, transform coders and JPEG.
9. Basics of H.261 and MPEG 1,2 Coders
10. Digital Video Systems
11. Hands-on Student Projects possibly on
 - Image blurring and de-blurring
 - Watermarking and image security.
 - Separation of objects in imagery
 - Video Codecs using H.261, JPEG, MPEG compression
 - Applications to noise and echo cancellation
 - Signal processing applications in CDMA and Wi-Fi systems
 - Digital TV

RECOMMENDED BOOKS

- A. Gersho and R.M. Gray, *Vector Quantization and Signal Compression*, Kluwer Academic Publishers, 1992. (Solid coverage on fundamentals and applications of VQ.)
- H. Abut, *Vector Quantization*, IEEE Press, 1990. (Collected papers on Vector Quantization through 1990.)
- H. Abut, J.H.L. Hansen, and K. Takeda, *DSP for In-Vehicle and Mobile Systems*, Springer Science, 2005. ISBN: 0-387-22978-7.
- V. Bhaskaran and K. Konstantinides, *Image and Video Compression Standards: Algorithms and Architectures*, Kluwer-Academic Publishers, 1995. (Good coverage on video standards.)
- T.C. Bell, J.G. Cleary, and I.H. Witten, *Text Compression*, Prentice-Hall, 1990. (Reference book on lossless compression algorithms.)
- T. Berger, *Rate-Distortion Theory*, Prentice-Hall, 1971 (Classical book on rate-distortion theory.)
- T.M. Cover and J.A. Thomas, *Elements of Information Theory*, Wiley, 1991. (Text on Information Theory including noiseless coding.)
- Y. Fischer, Ed., *Fractal Image Compression: Theory and Application*, Springer-Verlag, NY, 1991.
- R.C. Gonzalez, R.E. Woods, and S.L. Eddins, *Digital Image Processing Using Matlab*, Prentice-Hall, 2004, ISBN: 0-13-008519-7
- A. K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989. (Basic principles of early image processing techniques.)
- N.S. Jayant and P. Noll, *Digital Coding of Waveforms*, Prentice-Hall, 1984. (Good coverage on scalar quantization and compression.)
- A. M. Kondo, *Digital Speech: Coding for Low Bit Rate Communications Systems*, Wiley 1994. (Very good book on low rate speech coding techniques.)
- J. Lim, *Two-Dimensional Signal and Image Processing*, Prentice-Hall, 1990. (Good coverage on older image processing techniques.)
- S. J. Mitra, *Digital Signal Processing: A Computer-Based Approach, Third Edition*, McGraw-Hill, ISBN: 0-07-304837-2.
- K.N. Ngan, C.W. Yap, and K.T. Tan, *Video Coding for Wireless Communication Systems*, Marcel Dekker, Inc., New York, Basel, ISBN: 0-8247-04489-4.
- W.B. Pennebaker and J.L. Mitchell, *JPEG: Still Image Data Compression Standard*, Van Nostrand Reinhold, 1993.
- H.V.Poor and G. W. Wornell, *Wireless Communications: Signal Processing Perspective*, Prentice-Hall, 1998.
- B. Porat, *A Course in Digital Signal Processing*, Wiley, 1997. (Very good elementary text on signal processing techniques.)
- J.G. Proakis, M. Salehi and G. Bauch, *Contemporary Communication Systems*, Thompson Brooks/Cole, Belmont, CA, ISBN: 0-534-40617-3.
- K. Sayood, *Introduction to Data Compression*, Morgan-Kaufman, 1996. (Fundamental text on data compression based on Shannon Theory.)

- S.D. Stearns and R.A. David, *Signal Processing Algorithms in Matlab*, Prentice-Hall, 1996. (Excellent Matlab tools for DSP.)
- R. Steinmetz and K. Nahrstedt, *Multimedia: Computing, Communications and Applications*, Prentice-Hall, 1995.
- J.A. Storer, *Data Compression - Methods and Theory*, Computer Science Press, 1988.
- A. M. Tekalp, *Digital Video Processing*, Prentice-Hall, 1995. (Good reference book on image/video processing.)
- K.S. Thyagarajan, *Digital Image Processing with Application to Digital Cinema*, Elsevier Focal Press, 2005. ISBN: 0-240-80729-4 (Latest book on digital image coding including digital cinema.)
- J.W. Woods, *Subband Image Coding*, Kluwer Academic Publishers, 1991. (Very good coverage on subband coding principles & applications.)

ACKNOWLEDGEMENT

Throughout these lecture notes, we have extensively used, with permission, the following material and we would like acknowledge the cooperation from respective authors and colleagues:

1. EE372 Lecture Notes by Professor Robert M. Gray, Stanford University.
2. Lecture Notes by Professor A. Murat Tekalp, Koc University, Istanbul, Turkey
3. TE480 and EE557 Lecture Notes by Professor Hüseyin Abut, Sabanci University, Istanbul, Turkey.
4. EE657 Lecture Notes and Student Projects by Professors Hüseyin Abut and K.S. Thyagarajan, San Diego State University.
5. Earlier versions of EE658 Lecture Notes by Professor Hüseyin Abut and former Student Projects, San Diego State University.
6. A. M. Tekalp, *Digital Video Processing*, Prentice-Hall, 1995.
7. **VC Demo** used in image compression examples has been provided by Professor Reginald (Inald) Lagendijk of Delft University of Technology, The Netherlands.