Department of Electrical Engineering
University of Southern California

EE 599 — Underwater Acoustic Communications: Spring 2015
a case study in fast, time-varying wireless channels and sparse approximation

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Course Objectives: To provide a fundamental understanding of communications over a highly time-varying wireless channel which exhibits key structure (sparsity). The emphasis will be on developing the analysis and design tools needed to apply such methods to research. While the focus will be on underwater acoustic communications, state-of-the-art methods are applicable to high speed radio communiations, ulrawideband radio, and radar.

Course Statistics: 3 unit course, two meetings per week, each of 80 minutes

Prerequisites: EE441 (linear algebra) and EE503 (probability)

Other Requirements: Basic computer skills (*i.e.* programming and plotting, familiarity with Matlab).

Recommended Courses: EE563 (estimation theory), EE564 (digital communications), EE535 (mobile communications), EE553 (optimization)

Text: there is no required text, we shall exploit course notes and seminal journal articles; however, the following are recommended

1. Principles of Underwater Sound, 3rd Edition, Robert Urick, Penninsula Publishers (1996)
2. Sparse and Redundant Representations: From Theory to Applications in Signal and Image Processing, Michael Elad, Springer (2010) (ISBN: 978-1441970107)
3. A Wavelet Tour of Signal Processing, Third Edition: The Sparse Way, Stephane Mallat, Academic Press 2008 (ISBN: 978-0123743701)
4. Compressed Sensing: Theory and Applications, edited by Yonina Eldar and Gitta Kutyniok, Cambridge University Press 2012
5. "Underwater acoustic communication channels: Propagation models and statistical characterization," Milica Stojanovic and James Preisig, *Communications Magazine*, IEEE 47.1 (2009): 84-89.

Grading: (tentative) 30% Homework and journal article summaries
30% Midterm
40% Final Project
Final grades will be assigned by a combination of student score distribution (curve) and the discretion of the instructor.

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Outline: (each item roughly corresponds to one week's material, dates provided)

1. (1/12/15) Underwater acoustic channels and networks
2. (1/14/15) Vector spaces review
3. (1/21/15,1/26/15) Estimation and detection review
4. (1/28/15,2/215)Mulitpath channel descriptions, wideband signal modeling, Doppler scales
5. (2/4/15) Mellin transforms versus Fourier transforms
6. (2/9/15 and 2/11/15) Multipath channel estimation, Doppler estimation
7. (2/18/15 and 2/23/15) Single carrier systems and synchronization
8. (2/25/15, 3/2/15) Single-carrier equalization, decision feedback equalization
9. (3/4/15,3/23/15) Multicarrier systems
10. (3/9/15) Midterm
11. (3/11/15) inter-carrier interference and Doppler compensation
12. Spring Break
13. (3/25/15) Compressible and sparse signals, l_1 minimization
14. (3/30/15,4/1/15) Probabilistic approach to compressed sensing
15. (4/6/15, 4/8/15) large deviations theory, concentrations of measure
16. (4/13/15,4/15/15) Sparse Approximation in noise/optimality statements
17. (4/20,15,4/22/15) Structured channel estimation, exploiting sparsity
18. (4/27/15, 4/29/15) Other Applications: UWB, radar, high speed train communications *etc.*
19. Final Exam Date: Final Project Presentations