Suggested Project Topics for EE 6353 (Spring 2007)

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Note: Extra bonus points for novel extensions of the results in the papers
Blind/Adaptive Channel Shortening (taken by Aditya)

- We will study in class channel shortening equalizers based on channel estimate (requires training sequence)
- Blind schemes avoid training overhead
- Adaptive schemes don’t need explicit channel estimates
- Investigate blind/adaptive channel shortening algorithms
- Refs :

  Adaptive equalization: transitioning from single-carrier to multicarrier systems
  Volume 22, Issue 6, Nov. 2005 Page(s):108 - 122

Joint Resource Allocation/Channel Shortening for MCM

- Resource (bandwidth, energy, bit) allocation algorithms depend on channel information.
- Channel shortening equalizer (TEQ) design also depends on channel. Moreover, it modifies the channel by shortening it (to reduce CP overhead).
- Problem: what is the effect of energy/bit/bandwidth optimization on TEQ design?
- Need an iterative algorithm where we first estimate channel, then compute TEQ and the overall channel response (with TEQ) and feed it back to transmitter to be used to optimize resource allocation (bandwidth, bit, energy). Then, we need to re-compute TEQ (to account for the modified transmitter) and so on ...
- Does this iterative algorithm converge? how many iterations typically needed?
- Compare the jointly-optimized scenario above with the case of fixed TEQ based on initial channel estimate (before transmitter optimization).
Initial Ranging Method for OFDMA with Application to WiMAX (by J. Zeng)

- **Motivation**: Propose a new initial ranging method to improve the ranging performance in time-varying channel.

- **References**:
  2. IEEE Standard 802.16e 2005
Forward-Backward Equalizer (Ali Milani)

- Forward equalizer is better for minimum-phase channels while backward equalizer is better for maximum-phase channels.
- For mixed-phase channels (as it is often the case in practice), investigate a combined forward-backward strategy.
- **Refs**: A decision feedback equalizer with time-reversal structure
  Ariyavisitakul, S.;
  Selected Areas in Communications, IEEE Journal on
  Volume 10, Issue 3, April 1992 Page(s):599 - 613

  A fast selective-direction MMSE timing recovery algorithm for spatial-temporal equalization in EDGE
  Zeng, H.H.; Ye Li; Winters, J.H.;
  Volume 3, 24-28 Sept. 2000 Page(s):1333 - 1337 vol.3

  BAD: bidirectional arbitrated decision-feedback equalization
  Communications, IEEE Transactions on
  Volume 53, Issue 2, Feb. 2005 Page(s):214 - 218

  Bidirectional decision feedback equalizer: infinite length results
  Balakrishnan, J.; Johnson, C.R., Jr.;
  Volume 2, 4-7 Nov. 2001 Page(s):1450 - 1454 vol.2
OFDMA Resource Allocation (Yupeng)

The problem of allocating subcarriers, rates, and powers to the different users in an OFDMA system has been an area of active research.

References

[1] Multiuser OFDM with adaptive subcarrier, bit, and power allocation
Cheong Yui Wong; Cheng, R.S.; Lataief, K.B.; Murch, R.D.;
Selected Areas in Communications, IEEE Journal on
Volume 17, Issue 10, Oct. 1999 Page(s):1747 – 1758
Abstract and paper are available online at
Abstract and paper are available online at
GMD Factorization and Application to MIMO Detection

- **Idea**: Use of Geometric Mean Decomposition for MIMO detection

**References**

- Some software available at [http://dsp.colorado.edu/~yjiang/research.htm](http://dsp.colorado.edu/~yjiang/research.htm)
I/Q imbalance effects on MCM (J. Mehta)

• I/Q imbalance for OFDM analyzed in the paper

• Bonus: extend the analysis to MCM based on Discrete Cosine Transform (DCT) instead of FFT based on the work in
Sphere Decoder (taken by Payam & Bala)

• Sphere decoder algorithm can be used for reduced-complexity ML detection of MIMO systems

• Problem: implement hard-decision sphere decoder algorithm and then generalize to soft-decision case and concatenate with an outer error correction code
Definition: CR is capable of dynamically sensing and utilizing unused spectrum without harming the primary (licensed) users of this spectrum.


Bonus: extend analysis and simulation to more realistic scenarios with multipath frequency-selective fading and shadowing.
Multi-User Water-Filling (Rownak)

• Extension of the single-user water-filling algorithm we studied in class to the multi-user case

Reference:
Throughput Optimization in Wireless Networks (Lakshmi & Anuj)

• Joint optimization of symbol rate, signal constellation size, and packet size


http://systems.stanford.edu/Publications/Taesan
g/CommLetters_2005_draft.pdf

Bonus: try to extend analysis to ISI channels
Viterbi Equalizer

- Implement the Viterbi equalizer for the general case of K-tap ISI channel with M-QAM/M-PSK signal constellations

- **Bonus**: compare the performance when a channel-shortening equalizer is inserted before the Viterbi equalizer to reduce its complexity

**Reference**:  
D. Falconer and F. Magee, "Adaptive Channel Memory Truncation for Maximum Likelihood Sequence Estimation", Bell System Technical Journal, 52(10), December 1973
Cyclic Delay Diversity for OFDM
(Syed Haider)

• Delay diversity is simple to implement and compatible with legacy systems
• For ISI channels, delay diversity can be combined with OFDM to improve performance against frequency-selective fading, but how to select the “delay parameter” to optimize performance?

Reference:
Parameter optimization, interleaving and multiple access in OFDM with cyclic delay diversity by G. Bauch and J. Malik, IEEE Vehicular Technology Conference 2004
Space-Time Coding for CPM (C. Teng)

- Problem: space-time code design for continuous phase modulated signals

- Refs:

  Space-time code design with continuous phase modulation Xiaoxia Zhang; Fitz, M.P.; Selected Areas in Communications, IEEE Journal on Volume 21, Issue 5, June 2003 Page(s):783 - 792

  Space-time coding using MSK
Space-Time Block Coding with Channel Information Feedback

- Space-time block coding is an open-loop MIMO scheme. Its performance can be further improved by estimating the channel at the receiver and feeding it back to the transmitter to perform beamforming.

Reference:
Combining beamforming and orthogonal space-time block coding, by Jongren, G. Skoglund, M. Ottersten, B., IEEE Transactions on Information Theory March 2002