Journal Watch
IEEE Transactions on Communications, September 2011 (Vol. 59 No.9)

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October 29, 2011

Energy Detection of Unknown Signals in Fading and Diversity Reception

Authors

S. P. Herath (McGill University, Canada)
N. Rajatheva (Asian Institute of Technology, Thailand)
C. Tellambura (University of Alberta, Canada)

- Problem: Energy detection of signals over fading channels with single antenna/antenna diversity reception
- Received signal process:

$$y(t) = \begin{cases} n(t) & : H_0 \\ hs(t) + n(t) & : H_1 \end{cases}$$

- Decision variable:

$$Y = c \int |y(t)|^2 \, dt \qquad (1)$$

- Y has non-central chi-square distribution under H_1 and central chi-square distribution under H_0

- P_d and P_f conditional on the fading channel gain:

$$P_d = Q_u(\sqrt{2\gamma}, \sqrt{\lambda}) \quad (2)$$

$$P_f = \frac{\Gamma(u, \frac{\lambda}{2})}{\Gamma(u)} \quad (3)$$

- No-diversity:
    - Nakagami-m distribution
        - PDF approach: $\bar{P}_{d,\text{Nak}}$ evaluated using alternative series representation of $Q_u(.,.)$
        - MGF approach: uses contour integral representation
    - Rician fading: $\bar{P}_{d,\text{Ric}}$ derived using MGF approach.
- MRC: $P_{d,\text{Nak,mr}}$ obtained using $\gamma_{mr} = g\frac{E_s}{N_0}$
- EGC: $\gamma_{eg} = \left(\sum_{l=1}^{L} |h_l|^2\right)^2 \frac{E_s}{LN_0}$
- Selection Combining (SC) also considered
- Proposed MGF method, along with PDF approach, provide general frame work for performance analysis of energy detector
- Performance of detectors compared

Downlink Interference Alignment

Authors

Changho Suh, David N. C. Tse (University of California at Berkeley, USA)
Minnie Ho (Intel Labs at Intel Corporation)

- New IA technique for *downlink* cellular systems that requires feedback only *within* a cell

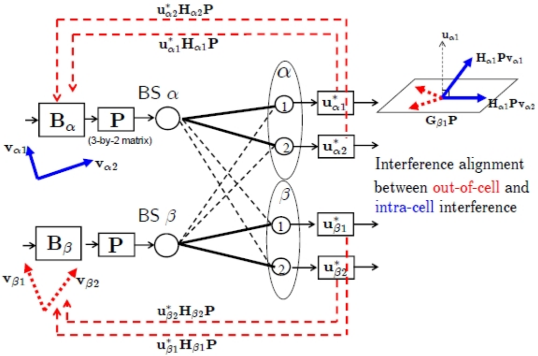

Figure: Downlink (Zero Forcing) Interference Alignment

- ZF IA provides significant performance gain over MF in 2-cell case
- For multi-cellular environments, $\gamma \triangleq \frac{\text{INR}_{\text{rem}}}{\text{INR}_{\text{dom}}}$
- For $\gamma = 0$ ZF IA provides significant performance, but for $\gamma \gg 1$ may not be good as it loses beamforming gain
- Motivates new technique balancing advantages of IC and MF gain depending on value of γ
- Goal is to *mimic* MMSE receiver, as straightforward design requires knowledge of transmitted vectors from other cell
- Proposed unified IA technique outperforms both ZF IA and MF for all values of γ
- Can be implemented with small changes to an existing cellular system supporting multi-user MIMO
- Shows even greater performance gains for macro-pico cellular networks where $\text{INR}_{\text{dom}} \gg \text{INR}_{\text{rem}}$

Cognitive MAC Protocols Using Memory for Distributed Spectrum Sharing Under Limited Spectrum Sensing

Authors

Jaeok Park, Mihaela van der Schaar (University of California, Los Angeles, USA)

- Assumptions
  - Slotted multiaccess system, single PU, N (fixed) SUs share a communication channel
  - SUs have limited sensing capability
  - Absence of explicit coordination messages
- Protocol design based on MAC protocols with memory
- Protocol
  - PU: Transmit whenever it has a packet to transmit
  - SU: Protocol with one-slot memory, represented by $f : \mathcal{Y}_s \rightarrow [0,1], \mathcal{Y}_s = \{idle, busy, success, failure\}$
  - θ-fair non-intrusive protocol: $f(idle) = q, f(busy) = 0, f(success) = 1 - \theta, f(failure) = r$
- Protocol design problem: $\max_{(q,r)\in[0,1]^2} C$ s.t. $P_c \leq \eta$
- Show that class of distributed MAC protocols can coordinate access among SUs while restricting interference to PU, overcoming limited sensing ability of SUs at PHY layer

Network Formation Games Among Relay Stations in Next Generation Wireless Networks

Authors

Walid Saad (University of Miami, FL, USA)
Zhu Han (University of Houston, TX, USA)
Tamer Basar (University of Illinois at Urbana Champaign, IL, USA)
Mérouane Debbah (Alcatel-Lucent Chair, SUPELEC, Paris, France)
(Late) Are Hjørungnes was with University of Oslo, Norway

- Study distributed formation of network architecture connecting RSs to serving BS in next gen. wireless systems (LTE-Advanced, WiMAX 802.16j)

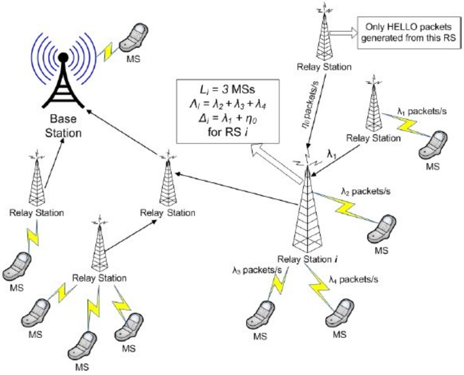

Figure: Prototype of uplink tree model

- Model proposed uplink tree formation problem as a network formation game among the RSs
- Cross-layer utility function takes into account performance measures in terms of packet success rate (PSR) and delay induced by multihop; concept of *system power*
- Utility of RS i

$$u_i(G) = \begin{cases} \frac{(\Lambda_i \cdot \rho_{i,q_i}(G))^{\beta_i}}{\tau_{i,q_i}(G)^{(1-\beta_i)}}, & \text{if } L_i > 0 \\ \frac{(\eta_0 \cdot \rho_{i,q_i}(G))^{\beta_i}}{\tau_{i,q_i}(G)^{(1-\beta_i)}}, & \text{if } L_i = 0 \end{cases} \quad (4)$$

- Utility of MS i connected to RS j

$$v_i(G) = \frac{(\lambda_i \cdot \zeta_{i,j}(G))^{\beta_i}}{\tau_{i,q_j}(G)^{(1-\beta_i)}} \quad (5)$$

- Network formation algorithm
  - Phase-I: Myopic Network Formation
  - Phase-II: Multi-Hop Transmission
- Show convergence of algorithm to a Nash network structure
- Through periodic runs of the algorithm, the RSs can adapt this structure to environmental changes
- Demonstrate that algorithm presents significant gains in terms of average achieved mobile station utility relative to the case with no RS and a nearest neighbor algorithm

Other Papers...

- Analysis of Diversity-Multiplexing Tradeoff in a Cooperative Network Coding System
  - Li-Chun Wang, Wei-Cheng Liu and Sau-Hsuan Wu (Nat. Chiao Tung Univ., Hsinchu, Taiwan)
- Linearly Coupled Communication Games
  - Yi Su and Mihaela van der Schaar (Univ. of California Los Angeles (UCLA), Los Angeles, CA, USA)
- Cooperative Amplify-and-Forward Beamforming with Multiple Multi-Antenna Relays
  - Yang-wen Liang and Robert Schober (Res. In Motion, Waterloo, ON, Canada)