SCANNING THE LITERATURE

EDITED BY PAN LI

Whole-Home Gesture Recognition Using Wireless Signals

Q. Pu, S. Gupta, S. Gollakota, and S. Patel, ACM Mobicom, Miami, Florida, September–October, 2013

This paper presents WiSee, a novel gesture recognition system that leverages wireless signals (e.g., Wi-Fi) to enable whole-home sensing and recognition of human gestures. Since wireless signals do not require line of sight and can traverse through walls, WiSee can enable whole home gesture recognition using few wireless sources. Furthermore, it achieves this goal without requiring instrumentation of the human body with sensing devices. The authors implement a proof-of-concept prototype of WiSee using USRP-N210s, and evaluate it in both an office environment and a two-bedroom apartment. The results show that WiSee can identify and classify a set of nine gestures with an average accuracy of 94 percent.

Optimal Relay Selection for Physical-Layer Security in Cooperative Wireless Networks

Y. Zou, X. Wang, and W. Shen, IEEE Journal on Selected Areas in Communications, 31(10), 2099–2111, October, 2013

In this paper, the authors explore the physical layer security in cooperative wireless networks with multiple relays where both amplify-and-forward (AF) and decode-and-forward (DF) protocols are considered. They propose the AF- and DF-based optimal relay selection (i.e., AFbORS and DFbORS) schemes to improve the wireless security against eavesdropping attack. For the purpose of comparison, they examine the traditional AFbORS and DFbORS schemes, denoted by T-AFbORS and T-DFbORS, respectively. They also investigate a so-called multiple relay combining (MRC) framework, and present the traditional AF- and DF-based MRC schemes, called T-AFbMRC and T-DFbMRC, where multiple relays participate in forwarding the source signal to the destination, which then combines its received signals from the multiple relays. The authors derive closed-form intercept probability expressions of the proposed AFbORS and DFbORS (i.e., P-AFbORS and P-DFbORS) as well as the T-AFbORS, T-DFbORS, T-AFbMRC, and T-DFbMRC schemes in the presence of an eavesdropping attack. They further conduct an asymptotic intercept probability analysis to evaluate the diversity order performance of relay selection schemes, and show that no matter which relaying protocol is considered (i.e., AF and DF), the traditional and proposed optimal relay selection approaches both achieve diversity order M, where M represents the number of relays. In addition, numerical results show that for both AF and DF protocols, the intercept probability performance of proposed optimal relay selection is strictly better than that of the traditional relay selection and multiple relay combining methods.

Continuous Power Allocation Strategies for Sensing-Based Multiband Spectrum Sharing

Z. Chen, X. Wang, and X. Zhang, IEEE Journal on Selected Areas in Communications 31(11), 2409–2419, Nov. 2013

In this paper, the authors propose continuous power allocation strategies for secondary users (SUs) based on sensing the primary user (PU) channels in a multiband cognitive radio (CR) network. Unlike conventional sensing-based spectrum sharing, where there are two transmit power levels corresponding to whether the PU is sensed as present or not, in the proposed strategy, the power levels are continuous functions of the sensing statistics, and optimized with respect to the achievable rate of the SU. The continuous power allocation function is parameterized by some channel parameters of the PU and SU, and the authors treat the cases of perfect and quantized channel state information (CSI) separately, where the former provides an upper bound on the achievable rate with full channel information, and the latter constitutes an efficient practical power allocation method for the SU with statistic/partial channel information. The power control process consists of two phases: in the first phase, the SU listens to the multiple bands licensed to the PU and obtains the sensing statistics (e.g., the received signal energies on these bands); in the second phase, the SU adjusts its transmit power levels on these bands based on the sensing results. Optimal power allocation schemes are derived to maximize the achievable rate at the SU under several possible combinations of the peak/average transmit power constraints at the SU and the peak/average interference power constraints at the PU. Simulation results demonstrate that the proposed strategies can significantly improve the achievable throughput of the SU compared to conventional methods.

Cooperative Beamforming for Cognitive Radio Systems with Asynchronous Interference to Primary User

M. H. Hassan and M. J. Hossain, IEEE Transactions on Wireless Communications, 12(11), 5468–5479, November 2013

In a CR network, when a group of CR users act as relays for a given CR user, cooperative beamforming can be used to improve the quality of communications. However, this cooperative beamforming can introduce asynchronous interference at the primary receiver due to different propagation delays between different CR relays and the primary receiver. In this paper, the authors propose an innovative beamforming method that maximizes the received signal power at the secondary destination while keeping the asynchronous interference at the primary receiver below a target threshold. The presented numerical results show that the proposed beamforming method can significantly reduce the interference at the primary receiver compared to the zero forcing beamforming as well as the joint leakage suppression method and thereby decreases the outage probability. This beamforming method is further extended for the case when the channels between the primary receiver and the CR relays are not known perfectly. Moreover, in this paper, they propose and investigate two relay selection strategies in conjunction with cooperative beamforming. The presented numerical results show that the relay selection schemes in conjunction with the cooperative beamforming method can further improve the received signal power at the secondary destination.

Target Localization in Wireless Sensor Networks Using Error Correcting Codes

A. Vempaty, Y. S. Han, and P. K. Varshney, IEEE Transactions on Information Theory, 60(1), 697–712, January 2014

In this paper, the authors consider the task of target localization using quantized data in wireless sensor networks. They propose a computationally efficient localization scheme by modeling it as an iterative classification problem. They design coding-theory-based iterative approaches for target localization where at every iteration, the fusion center (FC) solves an M-ary hypothesis testing problem and decides the region of interest for the next iteration. The coding-theory-based iterative approach works well even in the presence of Byzantine (malicious) sensors in the network. They further consider the effect of non-ideal channels. The authors suggest the use of soft decision decoding to compensate for the loss due to the presence of fading channels between the local sensors and the FC. They evaluate the performance of the proposed schemes in terms of the Byzantine fault tolerance capability and probability of detection of the target region. They also present performance bounds, which help them in designing the system. The researchers provide asymptotic analysis of the proposed schemes and show that the schemes achieve perfect region detection irrespective of the noise variance when the number of sensors tends to infinity. Their numerical results show that the proposed schemes provide similar performance in terms of mean square error when compared to traditional maximum likelihood estimation, but are computationally much more efficient and resilient to errors due to Byzantine sensors and non-ideal channels.

Optimal Power Allocation for Outage Probability Minimization in Fading Channels with Energy Harvesting Constraints

C. Huang, R. Zhang, and S. Cui, IEEE Transactions on Wireless Communications, 13(2), 1074–1087, Feb. 2014

This paper studies the optimal power allocation for outage probability minimization in point-to-point fading channels with the energy harvesting (EH) constraints and channel distribution information (CDI) at the transmitter. Both the cases with non-causal and causal energy state information (ESI) are considered, which correspond to the EH rates being known and unknown prior to the transmissions, respectively. For the non-causal ESI case, the average outage probability minimization problem over a finite horizon of N EH periods is shown to be non-convex for a large class of practical fading channels. However, the globally optimal "offline" power allocation is obtained by a forward search algorithm with at most N one-dimensional searches. The optimal power profile is shown to be non-decreasing over time and have an interesting "save-then-transmit" structure. In particular, for the special case of $N = 1$, the result revisits the classic outage capacity for fading channels with uniform power allocation. Moreover, for the case with causal ESI, the authors propose both the optimal and suboptimal "online" power allocation algorithms by applying the technique of dynamic programming and exploring the structure of optimal offline solutions, respectively.

Performance Analysis of Chunk-Based Resource Allocation in Multi-Cell OFDMA Systems

Huiling Zhu and Jiangzhou Wang, IEEE Journal on Selected Areas in Communications, 32(2), 367-375, February 2014

In the orthogonal frequency division multiple access (OFDMA) system, one of the efficient and low complex methods to allocate radio resources among multiple users is chunk-based resource allocation, which groups a number of adjacent subcarriers into a chunk and allocates resources chunk by chunk. In this paper, performance analysis of chunk-based resource allocation is studied in the multi-cell OFDMA environment. Fractional frequency reuse (FFR) is considered in the cellular OFDMA. Basically, FFR divides each cell into central and edge areas where two different values of the frequency reuse factor are assumed. This paper analytically evaluates how spectral efficiency performance is affected by system parameters, including radius ratio of the central area to the whole cell, transmit signal to noise ratio (SNR), number of users, number of subcarriers per chunk, and coherence bandwidth. The numerical results show that there exists an optimal radius ratio to achieve the highest spectral efficiency in the proposed research. The optimal radius ratio is about 0.7, which is almost irrespective of the SNR, number of users, and number of subcarriers per chunk. In other words, the sizes of the central area and the edge area of the whole cell are almost equal when achieving the optimal performance.

Full Duplex MIMO Radios

Dinesh Bharadia and Sachin Katti, USENIX NSDI'14, Seattle, WA, April 2014

This paper presents the design and implementation of the first in-band full duplex WiFi-PHY based MIMO radios that practically achieve the theoretical doubling of throughput. The proposed design solves two fundamental challenges associated with MIMO full duplex: complexity and performance. The design achieves full duplex with a cancellation design whose complexity scales almost linearly with the number of antennas. This complexity is close to the optimal possible. The authors also design novel digital estimation and cancellation algorithms that eliminate almost all interference and achieves the same performance as a single antenna full duplex SISO system, which is again the best possible performance. The authors prototype their design by building their own analog circuit boards and integrating them with a WiFi-PHY compatible standard WARP software radio implementation. They show experimentally that their design works robustly in noisy indoor environments, and provides close to the expected theoretical doubling of throughput in practice.

Data Offloading in Load Coupled Networks: A Utility Maximization Framework

Chin Keong Ho, Di Yuan, Sumei Sun, IEEE Transactions on Wireless Communications, 13(4), 1921-1931, April 2014

This paper provides a general framework for the problem of data offloading in a heterogeneous wireless network, where some demand of cellular users is served by a complementary network. The complementary network is either a small-cell network that shares the same resources as the cellular network, or a WiFi network that uses orthogonal resources. For a given demand served in a cellular network, the load, or the level of resource usage, of each cell depends in a non-linear manner on the load of other cells due to the mutual coupling of interference seen by one another. With load coupling, we optimize the demand to be served in the cellular or the complementary networks, so as to maximize a utility function. Three representative utility functions that balance, to varying degrees, the revenue from serving the users vs the user fairness are considered. The conditions for which the optimization problem has a feasible solution and is convex are established. Thus, numerical computations are tractable. Finally, a strategy with theoretical justification is proposed to constrain the load to some maximum value, as required for practical implementation. Numerical studies are conducted for both under-loaded and over-loaded networks.