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Channel Tracking and Transmit Beamforming with Limited Feedback (20140302, Dr. Nikos Sidiropoulos)

Technology No. 20140302

IP Status: Issued US Patent; **Application #:** 14/883,044

Limited Feedback for Wireless Systems

An approach for channel tracking and transmit beamforming with limited feedback exploits the spatial-temporal channel correlation. These methods considerably reduce computational burden and avoid the limitations of codebook-based feedback and Markov chain modeling. The transmitter periodically transmits a beamformed pilot signal in the downlink, while the receiver quantizes the corresponding received signal and sends the quantization bits to the transmitter through the uplink feedback channel. Therefore, instead of estimating the channel at the receiver and sending the quantized channel state information (CSI) to the transmitter, as in codebook-based beamforming, the receiver feeds back a quantized (noisy) linear measurement of the channel. Simulations confirm that by exploiting the spatiotemporal correlation of the channel, and with very limited feedback rate (i.e., 2 bits per block), the new frugal feedback approach achieves comparable performance to that with perfect CSI at the transmitter. Due to its simplicity and excellent performance, these methods show strong potential for next-generation wireless systems.

Transmit Beamforming for FDD Massive MIMO

Transmit beamforming can enhance the performance of multiple-input multiple-output (MIMO) systems by exploiting channel state information (CSI) at the transmitter. However, in frequency-division duplex (FDD) mode, the receiver must feed information about the downlink channel back to the transmitter. In systems with many transmit antennas, this feedback overhead can overwhelm the system. These new methods shift the bulk of the work to the transmitter instead of putting the burden of channel estimation and codebook search on the receiver. Using separate beamforming weight vectors for pilot and payload transmission, the transmitter sends a single pilot symbol per channel dwell time block, while the receiver simply sends back a coarsely quantized 2-bit measure based on the received pilot signal. This frugal feedback approach achieves performance comparable to traditional methods that require very

large-sized codebooks for codebook-based beamforming. Results advocate transmit beamforming for massive MIMO in FDD mode instead of TDD mode.

BENEFITS AND FEATURES:

- Exploits the spatial-temporal channel correlation
- Avoids limitations of codebook-based feedback
- Very limited feedback rate (i.e., 2 bits per block)
- Performance comparable to traditional methods requiring very large-sized codebooks or perfect CSI at the transmitter
- Much lower pilot overhead in the downlink (pilot reduction can be exploited to increase downlink data rate or increase downlink capacity)
- Much lower feedback rate in the uplink (reduced feedback can be exploited to increase the uplink data rate or increase uplink capacity)
- Lower computational complexity at the receiver and less memory is necessary (no codebook search and storage)

APPLICATIONS:

- Wireless communication protocols using multiple transmit antennas
- Transmit beamforming
- MIMO communications
- Massive MIMO
- Next-generation wireless systems

Phase of Development - Proof of Concept

Researchers

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Publications

Channel Tracking and Transmit Beamforming With Frugal Feedback
IEEE Transactions on Signal Processing , Volume: 62, Issue: 24, Dec.15, 2014; ppg 6402 – 6413