Performance of Diversity
Combining Techniques with
Imperfect Channel Estimates in
Fading Channels

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Coherent vs Non-coherent

- Coherent receivers are designed with perfect channel estimation assumption
- Non-coherent receivers are designed when no channel information is available
- What if the channels are estimated with error?
- How can we use these imperfect channel estimates?
Two Options for Using Imperfect Channel Estimates

- Use the coherent receiver assuming channel estimates are perfect
  - Expect performance degradation due to channel estimation error

- Design a new receiver
  - Using statistical information of channel estimation error
  - Superior performance
Uplink of SIMO Wireless Systems

Base Station

1

2

N

MS-desired
Uplink of SIMO Wireless Systems
Uplink of SIMO Wireless Systems

Base Station

1

2

N

MS-desired

MS-1

MS-L
Combining Methods with Perfect Channel Estimates

Maximal Ratio Combining (MRC): Matched filter vector
- MRC vector: Desired user’s channel vector
- Optimal (maximizes SNR) for single user systems

Optimum Combining (OC): Linear MMSE
- OC vector: Inverse of interference covariance matrix multiplied by the desired user’s channel vector
- Optimal (maximized SINR) for multi-user systems
Imperfect Channel Estimates

- MRC and OC are designed for the systems with perfect channel estimates.
- Effect of channel estimation error?
- Gaussian-distributed channel estimation error.
- Variance of channel estimation error: $\sigma_e^2$.
- Correlation between the true channel and channel estimate:

$$\rho = \sqrt{1 - \sigma_e^2}$$
Performance Analysis

- Outage probability: Probability that the output SIR is less than a given threshold
- Flat Rayleigh fading channels
- Interference-limited system with equal-power interfering users
- Independent channels for different antennas
- Binary phase-shift keying modulation
- Number of interfering users is six.
- Threshold for outage probability is 5dB.
- Power of the desired user to the power of the interfering user is 10.
MRC
Comparison
Methodology in the Presence of Channel Estimation Error

Apply the coherent receiver assuming no channel estimation error

Find out the performance loss due to channel estimation error

Can performance degradation be tolerated?

No

Find the optimum receiver structure by using channel estimation error information such as its statistical information

Yes

Use the coherent receiver
References


A. A. Basri and T. J. Lim, “Performance of Maximal Ratio and Optimum Combining with Channel Estimation Errors and Multiple Interfererers in Rayleigh Fading Channels,” to be presented at the *IEEE Vehicular Technology Conference (VTC Fall’06)*, Montreal, Canada, Sept. 2006.