Objective:
Utilize relay with a distributed turbo encoding of source’s message for cooperative diversity on the block fading channel.

Assumptions:
- Half-duplex terminals; use time slotting for the orthogonality of transmission.
- Source-destination and relay-destination links are statistically equal with quasi-static, independent, non-selective Rayleigh fading.
- Source-relay link is “reliable.”

Overview

Cooperative Turbo-Coded Diversity

Turbo Encoder \(\rightarrow\) Half-Duplex Terminals \(\rightarrow\) Turbo Encoder

Iterative Decoder \(\rightarrow\) Half-Duplex Terminals \(\rightarrow\) Iterative Decoder

Related work

- Madsen derived the capacity for relay networks with half-duplex relay terminals.
- Sendonaris et al introduced the “user cooperation diversity.”
- Laneman and Wornell studied the orthogonality between source and relays.
- Zhao and Valenti proposed “distributed turbo codes” to gain the performance promised in these cooperation strategies.
- Knopp and Humbert studied convolutional codes which maximizes the diversity gain.
- Stefanov and Erkip proposed a convolutional coding scheme which utilizes the ideas in Knopp et al.
- Zhang and Duman developed an iterative decoding scheme which operates over the superposition of transmitted blocks jointly.

Block-Fading channel

Objective:
- Turbo encoders with alternating parities punctured at the source and the relay.
- UMTS code generator (1,15/13) and interleave for message length K=640 bits.
- QPSK modulation with R=1/2 bits/symbol
- Maximal Ratio Combining (MRC) with perfect knowledge of fading coefficients at the destination.
- 100 frame errors for every Eb/N0, value

Outage Probability Summary

Outage probability for R=1/2 bits/symbol

QPSK inputs, repetition

- \(P_{\text{out}} = P \left[ g_1 + g_2 \leq \frac{2^R - 1}{RE_b/N_0} \right] \)
- \(P_{\text{out}} = 1 - e^{-\gamma_{GR}} - \gamma_{GR} e^{-\gamma_{GR}}\)

Outage event: \(R > I(\mathbf{X} | \mathbf{Y})\)

Outage Probability vs. Repetition - Turbo QPSK (R=1/2)

Concluding Remarks

- Proposed repetition turbo method performs within 0.5-1 dB of outage limit for single relay scenario.
- Repetition turbo outperforms “distributed turbo code” by more than 1 dB.
- Repetition turbo outperforms the convolutional scheme proposed in Sendonaris et al by more than 1.5 dB for a frame length of 640 bits
- Combining the channel measurements by MRC prior to iterative turbo decoding gives the best performance.
- Repetition turbo provides a stronger source-relay link.

Relay Decoding Options:
- Turbo decoding provides strongest source-relay link
- Simpler is merely extracting the uncoded systematic bits