Position of the work

✓ Classic Cyclic Prefix-OFDM (CP-OFDM):
  • Idea: FFT + Cyclic Prefix appending = block redundant transmissions
  • Advantage: very simple (FFT-based) equalization scheme for TR channels
  • Drawback: symbols sent on subcarriers subject to strong attenuations are irretrievably lost
  • Classical remedy: channel coding but does not eliminate performance losses incurred by channel
    nulls

✓ Zero Padded-OFDM (ZP-OFDM):
  • Idea: replace the CP appending by trailing zeros (TZ) insertion at the tail of the block to be transmitted
  • Advantage: guarantees symbol recovery regardless of channel zero locations & allows performance vs complexity trade-offs in the receiver
  • Drawback: a priori increased receiver complexity, ranging from simple techniques (Overlap-Add) to high performance / high complexity approaches (MMSE)

✓ Pseudo Random Prefix-OFDM (PRP-OFDM):
  • Idea: instead of TZ, use pseudo-randomly weighted deterministic sequence = exploitation for simple channel estimation and tracking
  • Advantage: keep advantages of ZP-OFDM, while introducing possibility to estimate channel with minimum pilot/pramble overhead
  • Drawback: depending on decoding approach, slight to medium increase of complexity
  • Contribution: proposition of an efficient channel estimation/tracking scheme for PRP-OFDM
  • Context: any wireless system requiring: i) a minimum pilot overhead, ii) the possibility of simple channel tracking (e.g. high mobility context) and iii) adjustable receiver complexity/performance trade-offs without requiring any feedback loop to the transmitter.

Discrete Model of the PRP-OFDM transceiver

✓ Parameters: consider a N carrier OFDM system with a length D prefix leading to a block size of P = N + D samples


PRP-OFDM Postfix based Channel Estimation

✓ General Idea: Separate OFDM data symbols from PRP-OFDM position by channel. Extract channel impulse response by deconvolution.

Low Complexity Approach: Separation by Mean Value Calculation

Low Complexity Approach: Explicit time-domain estimation of OFDM data symbols - A simple mean-value calculation is sufficient in order to extract PRP-OFDM positions in a noisy channel.

Based on the received vector:

\[ y(k) = \left( H_0[k] \alpha_{\text{PRP}}(k) + \eta_k \right) H_0[k] + w_\alpha(k) \]

- \( H_0[k] \alpha_{\text{PRP}}(k) \): is the D x D channel matrix of the first row \( \alpha_{\text{PRP}}(k) \)
- \( H_0[k] \): is the D x D channel matrix of the first row \( \alpha_{\text{PRP}}(k) \)
- \( \eta_k \): Note that \( H_0[k] \) and \( \eta_k \) contain respectively the lower and upper triangular parts of \( H_0[k] \)
- \( w_\alpha(k) \): the transmitted data symbol is \( w_\alpha(k) \)
- \( x(k) \): \( x(k) \) is a series of independent and identically distributed (i.i.d.) complex Gaussian random variables with zero mean and unit variance.

The posterior channel is estimated as follows:

\[ \hat{H}_0[k] = \frac{\sum_{k=1}^{D} \gamma(k)x(k)}{\sum_{k=1}^{D} \gamma(k)} \]

where \( \gamma(k) \) is the autocorrelation of the channel.

- For high-MSE requirements on CIR, mean value window must be very large
- For small-MSE requirements on CIR, mean value window must be very small
- For large-MSE requirements on CIR, mean value window must be in between

Improved Novel Proposal: Iterative Interference Suppression

✓ Novel Proposal: Re-encode the encoded data pattern from channel estimation and sum these estimates from transmitted data stream with Mean Value calculation over few symbols is sufficient in order to extract possible coefficients of the channel.

\[ \hat{H}_0[k] = \sum_{k=1}^{D} \gamma(k)x(k) + w_\alpha(k) \]

where \( \gamma(k) \) is the autocorrelation of the channel.

- For small-MSE requirements on CIR, mean value window must be very large
- For small-MSE requirements on CIR, mean value window must be very small
- For large-MSE requirements on CIR, mean value window must be in between

Results and Conclusion

✓ One iteration is sufficient in order to decrease the CIR estimation MSE by more than 10dB.

✓ The following iterations are required in order to approach quasi-asymptotic performances (3-4 iterations).

✓ Iterative interference suppression makes PRP-OFDM applicable to higher-order constellation applications.

✓ Constraints: soft-output decoding should be inherent to the system implementation in order to justify PRP-OFDM.

✓ The usefulness of PRP-OFDM is proven if the target application requires: i) a minimum pilot overhead, ii) low-complexity channel tracking (e.g. high mobility context and iii) adjustable receiver complexity/performance trade-offs without requiring any feedback loop to the transmitter.