FREQUENCY-DOMAIN DECOUPLING FOR MIMO-GFDM SPATIAL MULTIPLEXING
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Introduction

Generalized Frequency Division Multiplexing (GFDM)
- Generalization of traditional OFDM
- Low out-of-band (OOB) emissions
- Relaxed time-frequency synchronization requirements
- Potential inter subcarrier interference (ICI) w/ prototype filters
- ICI-free ↔ frequency-domain (FD) decoupling

System Model & Problem Formulation

MIMO-GFDM SM (w/ Tx and Rx antennas)
- GFDM transmitter matrix (D = K × M)
- GFDM prototype filter: \( g \in \mathbb{C}^D \) (FD prototype filter: \( g = \sqrt{D} \mathbf{w} \), \( \mathbf{w} \) is an i.i.d. Gaussian vector)
- Pulse-shaping: \( G_{\text{C}}[k] = \mathbf{w}^T e^{j2\pi k/K}, n = 0, 1, ..., D - 1, m = 0, 1, ..., M - 1, k = 0, 1, ..., K - 1 \)
- The signal at receive antennas

\[
\begin{bmatrix}
    y_1 \\
    \vdots \\
    y_D
\end{bmatrix} = \begin{bmatrix}
    H_1 A & H_2 A & \ldots & H_{K-1} A
\end{bmatrix} \begin{bmatrix}
    d_1 \\
    \vdots \\
    d_{K-1}
\end{bmatrix} + n
\]

Complexity Analysis

- Complexity: # of complex multiplications (CMs) required to detect KMT symbols at the receiver

Table 1: Computational Complexity of SQRD and successive interference cancellation (SIC)

<table>
<thead>
<tr>
<th>Scheme</th>
<th>CMs</th>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFDM</td>
<td>( KMT^2 + (KMT + K)M \times M + (KMT^2 - KMT)/2 )</td>
<td>( \delta )</td>
</tr>
<tr>
<td>Near-ML MIMO-GFDM [4]</td>
<td>( KMT^2 + (KMT^2 - KMT)/2 + (KMT^2 - KMT + K^2M^2)/2 + KMT^2 \times 3/2 + KMT \times M + KMT \times M + M \times 2 )</td>
<td>( \delta )</td>
</tr>
<tr>
<td>Proposed</td>
<td>( KMT^2 + KMT + (KMT^2 - KMT)/2 )</td>
<td>( \delta )</td>
</tr>
</tbody>
</table>

Simulation

- Modulation: QPSK, symbol energy: \( E_s = 1 \), and CP length: \( L = D/8 \)
- # of SM-mode MIMO spatially uncorrelated Rayleigh-fading multi-path channel realizations: 500
- Chan. power delay profile: exponential from 0 to -10 dB with L taps
- # of independent data blocks for each channel realization: 100
- \((T, R) = (2, 2)\)

Conclusion

- MIMO-GFDM achieves FD decoupling w/ proposed prototype filters.
- Dirichlet filter w/ proposed scheme outperforms widely-applied RC filter in terms of SER and complexity performances for MIMO-GFDM.

References


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