Joint LDPC Codes for Multi-User Relay Channel

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Bilayer LDPC codes for relay channel

: BS  : FRS  : MS
Bilayer LDPC codes for relay channel

\[
\begin{align*}
\text{BS} & : \text{Base Station} \\
\text{FRS} & : \text{Forward Relay Station} \\
\text{MS} & : \text{Mobile Station}
\end{align*}
\]
Joint LDPC codes for multiuser relay channel

- BS: Base Station
- FRS: Forward Relay Station
- MS: Mobile Station
Joint LDPC codes for multiuser relay channel

Overall code graph

Single user code graph
Optimization of Joint LDPC codes

By density evolution for Joint LDPC codes

\[
\max_{\lambda_{i,j}} R = 1 - \frac{\sum_{u \geq 1} \sum_{i \geq 2} \rho_{i(u)} / i(u)}{\sum_{u \geq 1} \sum_{i \geq 2} \lambda_{i(u)} / i(u)},
\]

s.t. \[
\sum_{i \geq 2, j \geq 0} \lambda_{i,j}(\frac{i}{i + j} e_i^{1} (p^l, q^l) + \frac{j}{i + j} e_i^{2} (p^l, q^l) < \mu_h (\eta p + (1 - \eta) q)),
\]

\[
\sum_{i(u) \geq 2} \lambda_{i(u)} e_{i(u)}(p) < \mu_h p,
\]

where \[
\lambda_{i(u)} = \frac{1}{\eta(u)} \sum_{j(u) \geq 0} \frac{i(u) \cdot \lambda_{i(u),j(u)}}{i(u) + j(u)},
\]

\[
err_{l,\text{max}}(u) \leq err_{th},
\]
## Performance of Joint LDPC codes

**Simulation environment**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel</td>
<td>AWGN</td>
</tr>
<tr>
<td>Number of Users</td>
<td>12</td>
</tr>
<tr>
<td>Overall Code Length</td>
<td>2304</td>
</tr>
<tr>
<td>Single User Code Length</td>
<td>96</td>
</tr>
<tr>
<td>Code Rate</td>
<td>$R_{SR or SD}=2/3, \ R_{RD}=1/2$</td>
</tr>
<tr>
<td>Maximum iteration</td>
<td>8</td>
</tr>
</tbody>
</table>
Performance of Joint LDPC codes

FER comparison of Joint LDPC code vs. Bilayer LDPC code
Performance of Joint LDPC codes

BER comparison of Joint LDPC code vs. Bilayer LDPC code
Conclusion

Merits:

Joint LDPC codes bring remarkable performance gain by user cooperation.

Joint LDPC codes guarantee achieved service quality by controlling the degree distribution.

Demerits:

The relay must be much more intelligent than before.

Overall code length decoded simultaneously at the destination becomes much larger than before.