Analysis and design of channel interleavers for terrestrial broadcast
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Motivations

- In terrestrial broadcast standards such as DVB-T2, channel interleaving is achieved through stacking several specific interleavers
- Aim: propose design criteria for channel interleavers based on span properties in the time and frequency domains and on the distribution of mutual information (MI)

Span properties

- **Frequency span**: $S_f(i) = \min \{|f_i - f_j| + |f_{i(0)} - f_{j(0)}|\}$
- **Time span**: $S_t(i) = \min \{|t_i - t_j| + |t_{i(0)} - t_{j(0)}|\}$
- **Design criterion**: maximize time and frequency spans

Analysis of DVB-T2 interleaver

- $N_f = 357$ OFDM symbols
- $N_f = 1705$ carriers

Design of interleavers with good span and MI distribution properties

- **Studied interleavers**
  - Regular interleaver (RI): $\Pi(i) = P \times i \mod N_f$ with $P = P_t \times N_f + P_f$, $N_f$ being the number of cells in an OFDM frame
  - Double regular interleaver (2RI): $\Pi(i) = N_f \times f_{i(0)} + f_{i(0)}$ with $f_{i(0)} = (P_t \times i \mod N_f) + S_f \times i \mod N_f$ and $f_{i(0)} = P_f \times i \mod N_f$
  - Almost regular permutation (ARP): same as RI with cyclic shift in $\Pi(i)$ expression
  - Double almost regular permutation (2ARP): same as 2RI with cyclic shifts in $f_{i(0)}$ and $f_{i(0)}$ expressions

Mutual information distribution

- **Average mutual information (MI) per FEC block**
  \[ AMI = \log 2 - \frac{1}{N} \sum_{i=1}^{N} \left( \max \{0, z_i \times (-1)^b \} \right) \]
- **Design criterion**: minimize the variance of MI distribution over FEC blocks in the OFDM frame => uniform distribution of the MI

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FEC block number
No Interleaver
CI
TI
FI
T2-Interleaver

BER
Es/N0 (dB)

Frequency histogram
Time histogram

TU6 channel

P1 channel

TU6 channel, LDPC code rate 37/45
P1 channel, LDPC code rate 37/45