Simulation of an LDPC decoder using Min-Sum algorithm

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Outline

- Introduction
- Problematic Situation
- LDPC Codes
- Simulation of an LDPC decoder
- Results
- Conclusions
- Future Work
Introduction

Digital Television Deployment since 2013
Introduction

Technological Transference Process

- ASSIMILATION
- REPRODUCTION
- INNOVATION
- DEVELOPMENT
- KNOWLEDGE DIFFUSION
Introduction

- DTMB Transmission/Reception Simulation Model
Problematic Situation

- LDPC decoding identified as a critical processing stage.

- **Problem:** LDPC Parity Check Matrix used in DTMB is not compatible with MATLAB LDPC decoding block

- **Solution:** Development of an LDPC decoder in MATLAB that works with LDPC Parity Check Matrix used in DTMB.
LDPC Codes

- LDPC Introduced
- Renewed interest in LDPC

- 1950: Hamming codes, Reed Solomon codes
- 1960: BCH codes
- 1970: Convolutional codes
- 1980: Practical implementation of codes
- 1990: Turbo codes
- 2000:
LDPC codes

Low Density Parity Check

- Linear block code.
- Defined by a Parity Check Matrix with low density of “1”s.

Encoding:
- Based on Generator Matrix

Decoding:
- Based on iterative process

Processing Complexity
LDPC codes

Message-Passing Decoding Algorithms

Binary information
(Hard decision)

Probability
(Soft decision)
LDPC codes

Log-Likelihood Ratio (LLR)

- Estimation of the transmitted bits.
- **Sign**: Transmitted bit is 0 (+) or 1 (-)
- **Magnitude**: Reliability of being 0 or 1
LDPC codes

Check Nodes (CN)

Variable Nodes (VN)

Tanner Graph
LDPC codes
LDPC codes

\[ \prod \text{ (Based on tanh)} \approx \text{ Minimum value} \]

Sum-Product Algorithm (SPA)

Reduced Complexity SPA Approximation

Min-Sum
Simulation of an LDPC decoder

Received data from channel

Variable Processing → Check Processing

→ Code Estimation

Yes → Syndrome & Max Iteration Check

No

End

14/22
Results

BER vs SNR (0.4, 0.6 and 0.8 code rates)
Results

BER vs SNR (0.4, 0.6 and 0.8)

<table>
<thead>
<tr>
<th>Working Mode</th>
<th>FEC Code-rate</th>
<th>Constellation</th>
<th>C/N threshold (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.4</td>
<td>16QAM</td>
<td>8.0</td>
</tr>
<tr>
<td>2</td>
<td>0.8</td>
<td>4QAM</td>
<td>6.0</td>
</tr>
<tr>
<td>3</td>
<td>0.6</td>
<td>16QAM</td>
<td>10.7</td>
</tr>
<tr>
<td>4</td>
<td>0.8</td>
<td>16QAM</td>
<td>12.6</td>
</tr>
<tr>
<td>5</td>
<td>0.8</td>
<td>16QAM</td>
<td>13.2</td>
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<tr>
<td>6</td>
<td>0.6</td>
<td>64QAM</td>
<td>15.7</td>
</tr>
</tbody>
</table>

GB/T 26686—2011
Results

Time Performance

- Delay for a 740-microsecond frame: 1000 seconds

  Non-practical delay

- Software Optimization
- Hardware implementation
Conclusions

- The BER vs SNR graphics for the LDPC decoder simulated in MATLAB approximates DTMB specifications.

- When inserting the LDPC decoder in the Reception Model, it shows a high processing delay.
Future Work

- Software optimization of current LDPC decoder.
- Hardware implementation of optimized LDPC decoder to achieve parallel processing.
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