

Contents

1	Introduction	1
1.1	Channel Coding	1
1.2	Channel Capacity	3
1.3	Hard and Soft Decision Decoding	3
1.4	Turbo Codes	4
1.5	Thesis Overview	5
2	Principles of Turbo Codes	6
2.1	Introduction	6
2.2	Preliminaries of Coding Theory	6
2.2.1	Types of Codes	6
2.2.2	Properties of Codes	10
2.3	Turbo Encoder Structure	11
2.4	Turbo Decoding	14
2.4.1	Log Likelihood Ratio Representation	14
2.4.2	Turbo Decoder Structure	16
2.4.3	The SISO Decoder	17
2.4.4	Iterative Decoding Process	17
2.5	Interleavers	18
2.5.1	Purpose of the Interleaver	18
2.5.2	Interleaver Types	19
2.6	Trellis Termination	22
2.7	Puncturing	23
2.8	Stopping Rules for the Iterative Decoder	23
3	Turbo Decoding Algorithms	25
3.1	Introduction	25
3.2	The MAP Algorithm	26
3.3	Approximations to the MAP Algorithm	29
3.3.1	Representation of The MAP Algorithm in the Log Domain	29
3.3.2	The Max-Log-MAP Algorithm	31
3.3.3	The Log-MAP Algorithm	31
3.3.4	The Constant-Log-MAP Algorithm	31
3.3.5	The Linear-Log-MAP Algorithm	32
3.4	The Soft Output Viterbi Algorithm (SOVA)	32

3.5	The Modified SOVA Algorithm (MSOVA)	34
3.6	Comparison of the Turbo Decoding Algorithms	36
4	Case Study: UMTS and cdma2000 Turbo Codes	39
4.1	Introduction	39
4.2	UMTS Turbo Codes	39
4.2.1	Encoder Structure	39
4.2.2	Trellis Termination	41
4.2.3	UMTS Turbo Interleaver	41
4.3	The cdma2000 Turbo Codes	42
4.3.1	Encoder Structure	42
4.3.2	Puncturing Patterns	43
4.3.3	cdma2000 Turbo Interleaver	44
5	Simulation Results	46
5.1	Introduction	46
5.2	Simulation Setup	46
5.2.1	Basic Processing	46
5.2.2	Channel Model	47
5.3	Results for the UMTS turbo codes	48
5.3.1	Effect of the Decoding Algorithm	48
5.3.2	Effect of Frame Size	49
5.3.3	Effect of the Interleaver Type	51
5.3.4	Effect of the Number of Decoding Iterations	51
5.4	Results for the cdma2000 turbo codes	53
5.4.1	Effect of the Decoding Algorithm	53
5.4.2	Effect of Frame Size	56
5.4.3	Effect of Code Rate	56
6	Conclusions and Future Work	59
6.1	Summary of Work	59
6.2	Conclusions	59
6.3	Future Work	60