سامية محمد مصطفى

شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

سامية محمد مصطفى

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

سامية محمد مصطفى

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

سامية محمد مصطفى

شبكة المعلومات الجامعية

بعض الوثائق الأصلية تالفة

سامية محمد مصطفى

شبكة المعلومات الجامعية

بالرسالة صفحات لم ترد بالأصل

PERFORMANCE ANALYSIS OF TURBO CODES WITH APPLICATION IN MOBILE SYSTEMS

by

Yasmine Aly Hassan Fahmy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRONICS AND COMMUNICATIONS ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
August 2001

B
1C-02

PERFORMANCE ANALYSIS OF TURBO CODES WITH APPLICATION IN MOBILE SYSTEMS

by

Yasmine Aly Hassan Fahmy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRONICS AND COMMUNICATIONS ENGINEERING

Under the Supervision of

Prof. Dr. Magdi M.S. El-Soudani

M. Said

Dr. Hala A.G. Abdel Kader

Hala Galal

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
August 2001

PERFORMANCE ANALYSIS OF TURBO CODES WITH APPLICATION IN MOBILE SYSTEMS

by

Yasmine Aly Hassan Fahmy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
ELECTRONICS AND COMMUNICATIONS ENGINEERING

Approved by the Examining Committee:

Prof. Dr. Safwat Mahrous Mahmoud
Faculty of Engineering - Ain Shams University

Prof. Dr. Emad K. Al-Hussaini
Faculty of Engineering - Cairo University

Prof. Dr. Magdi M. S. El-Soudani
Faculty of Engineering - Cairo University **Thesis Main Advisor**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
August 2001

CONTENTS

	Page
LIST OF TABLES	v
LIST OF FIGURES	vi
LIST OF ABBREVIATIONS	viii
LIST OF SYMBOLS	ix
ACKNOWLEDGMENTS	x
ABSTRACT	xi
Chapter 1. INTRODUCTION	1
1.1 An Introduction to Turbo Codes	1
1.1.1 Encoder Structure	2
1.1.2 Decoder Structure	4
1.1.3 Turbo Codes Performance Bound	4
1.1.4 Interleavers for Turbo Codes	6
1.2 Objectives of the Thesis	6
1.3 Overview of the Thesis	6
Chapter 2. ENCODER DESIGN ISSUES	9
2.1 The Constituent Encoder	9
2.2 The Interleaver	10
2.2.1 Interleaver Design Rules	10
2.2.2 Types of Interleavers	12
2.2.2.1 Block Interleavers	12
2.2.2.2 Helical Interleavers	13
2.2.2.3 Pseudo-random Interleavers	14
2.2.2.4 Convolutional Interleavers	14
2.3 Termination Schemes	15
2.3.1 Tail Biting	16
2.3.2 Simile Interleaver	16
2.3.3 Self Concatenated Block Encoders	18
2.4 Puncturing	19

Chapter 3. DECODER DESIGN ISSUES **23**
3.1 Iterative Decoding 23
3.2 The Maximum *Aposteriori* Algorithms 24
3.2.1 Extrinsic Information of the Decoder 27
3.2.2 Decoder Exchange of Information 29
3.2.3 Simplification of MAP 30
3.2.3.1 MAX-Log-MAP Algorithm 30
3.3 Soft Output Viterbi Algorithm 32
3.3.1 BR-SOVA 35
3.3.2 HR-SOVA 37
3.4 Decoder Convergence 38
3.5 Stopping Criteria 39
3.5.1 Cyclic Redundancy Check (CRC) 39
3.5.2 Cross Entropy (CE) 39
3.5.3 Sign Change Ratio (SCR) 40
3.5.4 Sign Difference Ratio (SDR) 40
3.6 Conclusion 40

Chapter 4. CHANNEL MODEL **41**
4.1 Fading Channel Statistical Models 42
4.2 Other Channel Characteristics 43
4.3 Modified BCJR Algorithm for Rayleigh Fading Channel 44
4.4 Channel Estimation 45

Chapter 5. SIMULATION RESULTS **47**
5.1 Simulations Programs 47
5.2 Encoder Parameters 48
5.2.1 Different Encoder Rates 50
5.2.2 Tail Termination 52
5.2.3 Puncturing to Get Different Coding Rates 54
5.3 Decoder Parameters 55
5.3.1 The SOVA 55
5.4 Simulations of Turbo Codes in Rayleigh Fading Channel 60
5.5 Conclusions 63

Chapter 6. APPLICATION OF TURBO CODES IN FUTURE GENERATIONS OF MOBILE COMMUNICATION **65**
6.1 Introduction to GPRS 65
6.2 GPRS Coding Schemes 68
6.3 Proposed Turbo Coding Schemes 72
6.4 Simulation Results 74

Chapter 7. SUMMARY AND CONCLUSIONS **81**

REFERENCES **85**

Appendix A. THE BCJR ALGORITHM **89**

Appendix B. THE SOVA DERIVATIONS **95**

Appendix C. SAMPLE SIMULATION PROGRAM **97**