Turbo Coding, Turbo Equalisation and Space-Time Coding

by

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Contents

[1] This chapter is based on B.L. Yeap, T.H. Liew, J.Hámorský and L. Hanzo: Comparative study of turbo equalization schemes using convolutional, convolutional turbo and block-turbo codes, to appear in IEEE Tr. on Wireless Communications, 2002

This books is dedicated to the numerous contributors of this field, many of whom are listed in the Author Index

Contributors of the book:

Chapter 4: J.P. Woddard, L. Hanzo

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Part II

Turbo Convolutional and Turbo Block Coding

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[2] For detailed contents please refer to http://www-mobile.ecs.soton.ac.uk

Blurb

For the sake of completeness and wide reader appeal, virtually no prior knowledge is assumed in the field of channel coding. In **Chapter 1** we commence our discourse by introducing the family of convolutional codes and the hard- as well as soft-decision Viterbi algorithm in simple conceptual terms with the aid of worked examples.

Chapter 2 provides a rudimentary introduction to the most prominant classes of block codes, namely to Reed-Solomon (RS) and Bose-Chaudhuri-Hocquenghem (BCH) codes. A range of algebraic decoding techiques are reviewed and worked examples are provided.

Chapter 3 elaborates on the trellis-decoding of BCH codes using worked examples and characterises their performance. Furthermore, the classic Chase algorithm is introduced and its performance is investigated.

Chapter 4 introduces the concept of turbo convolutional codes and gives a detailed discourse on the Maximum Aposteriory (MAP) algorithm and its computationally less demanding counterparts, namely the Log-MAP and Max-Log-MAP algorithms. The Soft Output Viterbi Algorithm (SOVA) is also highlighted and its concept is augmented with the aid of a detailed worked example. Then the effects of the various turbo codec parameters are investigated.

Chapter 5 comparatively studies the trellis structure of convolutional and turbo codes, while **Chapter 6** characterises turbo BCH codes. **Chapter 7** is a unique portrayal of the novel family of Redundant Residue Number System (RNS) based codes and their turbo decoding. **Chapter 8** considers the family of joint coding and modulation based arrangements, which are often referred to as coded modulation schemes. Specifically, Trellis Coded Modulation (TCM), Turbo Trellis Coded Modulation (TTCM), Bit-Interleaved Coded Modulation (BICM) as well as iterative joint decoding and demodulation assisted BICM (BICM-ID) are studied and compared under various narrow-band and wide-band propagation conditions.

In **Chapter 9 and 10** space-time block codes and space-time trellis codes are introduced. Their performance is studied comparative in conjunction with a whole host of channel codecs, providing guide-lines for system designers. As a lower-complexity design alternative to multiple-transmitter, multiple-receiver (MIMO) based schemes the concept of near-instantaneously Adaptive Quadrature Amplitude Modulation (AQAM), combined with near-instantaneously adaptive turbo channel coding is introduced in **Chapter 11**.

Based on the introductory concepts of **Chapter 12**, **Chapter 13** is dedicated to the detailed principles of iterative joint channel equalisation and channel decoding techniques known as turbo equalisation. **Chapter 14** provides theoretical performance bounds for turbo equalisers, while **Chapter 15** offers a wide-ranging comparative study of various turbo equaliser arrangements. The problem of reduced implemenattional complexity is addressed in **Chapter 16**. Finally, turbo equalised space-time trellis codes are the subject of **Chapter 17**.