Trellis Decoding of Block Codes
A Practical Approach

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Bahram Honary dedicates this book to his wife Farideh and his son Souroush

Garik Markarian dedicates this book to his wife Karina, to his daughters Rimma and Nina and to his Parents

PREFACE

It is a great pleasure to be asked to write the Preface for this book on trellis decoding of error correcting block codes. The subject is extremely significant both theoretically and practically, and is very timely because of recent developments in the microelectronic implementation and range of application of error-control coding systems based on block codes. The authors have been notably active in signal processing and coding research and development for several years, and therefore very well placed to contribute to the state of the art on the subject of trellis decoding. In particular, the book represents a unique approach to many practical aspects of the topic.

As the authors point out, there are two main classes of error control codes: block codes and convolutinal codes. Block codes came first historically and have a well-developed mathematical structure. Convolutional codes come later, and have developed heuristically, though a more formal treatment has emerged via recent developments in the theory of symbolic dynamics. Maximum likelihood (ML) decoding of powerful codes in both these classes is computationally complex in the general case; that is, ML decoding fails into the class of NP-hard computational problems. This arieses because the decoding complexity is an exponential function of key parameters of the code. The structure of convolutional codes is such that they can be represented by means of compact, regular trellises, however; which is turn leads to an efficient ML decoding method, the Viterbi algorithm (VA). In addition,efficient near-ML decoding algorithms exist for both tree and trellis repreentations of convolutional codes. Though the complexity of these algorithms remains asymptotically exponential, the way in which the computation is organised means that it is feasible to implement practical decoders for powerful convolutional codes. Until recently, corresponding methods for the decoding of block codes did not exist, because the trellis (and tree) structure of these codes was not well understood. This is the reason for the current dominance of convolutional codes in applications requiring ML or near-ML decoding performance.

Interestingly, trellis representations of block codes began to emerge in the 1970's, but their implications for the efficient decoding were not properly recognised until quit recently. Effective near-ML decoding algorithms based on both trellis and tree representations of block codes were developed first (just as sequential decoding preceded the VA), and quit recently, as a result of the work of the authors of this book and other researchers, representations of block codes by means of compact, regular trellises have been devised. These trellises are based on the generalised array code (GAC) construction of block codes, as described in this text. Almost all members of the most important classes of error-control codes can be constructed in the form of GACs, and the GAC construction joins the squaring, cubing and generalised concatenated code (GCC) construction as a way of facilitating ML (and near-ML) trellis decoding of block codes using the VA. Previously intractable problems, like the soft decision decoding of non-binary block codes (e.g., the Reed-Solomon (RS) codes) also yield to the power of the GAC approach.

All aspects of the trellis decoding of block codes based on the GAC construction are described in this book, with the emphasis on the practical approach. The authors are to be congratualted for bringing together the results of many research investigations into a clear, coherent, and up-to-date presentation of great value to the community.

Prof. Farrell P.G.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES