Preface

Algebraic-geometric (AG) codes are a new paradigm in coding theory which promise performance improvements for point-to-point communications systems. AG codes offer several advantages over state-of-the-art Reed–Solomon (RS) codes. First, their construction is based on selecting points on a curve creating a non-binary code with long code length and effective decoding. The bit error rate (BER) performance of AG codes is impressive and attractive for wireless networks with severe fading conditions. Second, AG codes are more flexible than RS codes because they are easily extendable to high finite fields with minimal additional complexity. Third, the decoding approach gets all required information from the received data without the need for a decoding list. It is very attractive from the perspectives of both reliability and buffering capacity. Finally, construction of AG codes from curves offers an endless supply of AG codes with different properties and parameters applicable for different applications.

In this book, AG codes are designed, constructed and implemented from Hermitian curves. Simulations were carried out in Matlab to make comparisons of BER performance of AG codes and RS codes using different modulation schemes and various channel models such as additive white Gaussian noise (AWGN) and Rayleigh fast fading. Simulation results of BER performance for AG codes using quadrature amplitude modulation (16QAM and 64QAM) schemes are presented for the first time (to our knowledge) and shown to outperform RS codes at various code rates. Results for the AWGN channel are presented in this book; results for the Rayleigh fast fading channel are contained in the first author's Ph.D. dissertation.

To further improve the BER performance, algebraic-geometric block turbo codes (AG-BTCs) are proposed and implemented in this book. Their design, construction and implementation are investigated. Their performance is evaluated by simulations in Matlab, and results are presented for the first time in the literature. They show significant performance improvements but at the expense of high system complexity due to the use of Chase-Pyndiah's algorithm for AG codes.

In order to reduce system complexity while maintaining high BER performance, this book proposes algebraic-geometric irregular block turbo codes (AG-IBTCs). The design, construction and implementation of AG-IBTCs are presented along with new simulation results. Again appearing for the first time in the literature, results show that significant reduction in system complexity can be achieved while maintaining the high BER performance of AG-BTCs.

This book is intended to be useful to researchers and students in digital communications. The reader is assumed to have an appropriate background in mathematics and telecommunications. The presentation is intended to be self-contained with a substantial amount of background material included in the first half of the book. The second half concentrates on new research results. The advanced sections of the book may require a graduate level of education in communications.

This book is a result of the Ph.D. work carried out by the first author at the College of Engineering in Swansea University, Wales. The authors are grateful to Dr. Martin Johnston at Newcastle University for his invaluable assistance at the early stages of the research. Special thanks are given to Dr. Martin Crossley in the Mathematics Department at Swansea University for mathematical assistance throughout this work.

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