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THE CHINESE UNIVERSITY OF HONG KONG

Institute of Network Coding

Short Course

Advanced Algebraic Coding Theory and Practice

by

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Date	**:**	**20 - 22 August 2012 (Monday - Wednesday)**
Time	**:**	**1:30 - 5:30 pm (everyday)**
Venue	**:**	**Room 833, Ho Sin Hang Engineering Building The Chinese University of Hong Kong**

Course Abstract

This course attempts to provide a comprehensive treatment of the most celebrated algebraic codes, namely, Reed-Solomon and BCH codes. It is composed of three parts.

The first part introduces the basics, including finite fields, code constructions, basic code properties, and the conventional hard-decision decoding algorithms.

The second part introduces the recent advances. Building on the view of polynomial evaluation (time domain), the Guruswami-Sudan algorithm list decodes Reed-Solomon codes up to the Johnson bound. The Koetter-Vardy algorithm inherently incorporates probability into Guruswami-Sudan algorithm. An optimal combination of Chase flipping and Koetter-Vardy algorithm is also presented. Building on the view of generator polynomial (transform domain), one-pass GMD and Chase decoding is achieved through linear-feedback-shift-register (LFSR) synthesis. Following the suit, the Wu algorithm alternatively achieves the Johnson bound for RS and binary BCH/Goppa codes. Moreover, its soft-decision conversion in an optimal combination with Chase flipping demonstrates impressive performance gain at a very practical complexity. Finally, binary images of RS codes are preliminarily investigated. The complexity of maximum-likelihood decoding is dramatically reduced by incorporating intrinsic block bi-diagonal structure. It is also shown that binary RS codes are always asymptotically "bad", overturning the sweeping conjecture that binary RS codes are asymptotically "good" or even "great".

The last part presents high-speed VLSI implementations. It starts with introducing efficient implementation of finite field operations. It then presents a unified VLSI architecture for RS encoder and decoders. Algorithmic transformation is used to convert the Berlekamp-Massey algorithm into a VLSI amenable algorithm. It is further shown that the proposed architecture can be naturally extended to handle erasure-and-error decoding and encoding. It closes by presenting efficient architectures for fast Chase decoding, which is achieved by transforming theoretical algorithm into VLSI amenable implementation through slightly compromising performance and forming systolic elements.

Biography

Dr. Cody (Yingquan) Wu received both the B.S. and M.S. degrees in mathematics from Harbin Institute of Technology, P.R. China in 1996 and 1997, respectively. He received the M.S. degree in electrical engineering from the State University of New York at Buffalo in 2000. In 2004, he received the Ph.D. degree in electrical and computer engineering from the University of Illinois at Urbana-Champaign. From 2004 to 2011, Dr. Wu was a principal engineer at Link-A-Media Devices Corp., Santa Clara, CA, where he was responsible for developing algorithms and architectures for error control coding and digital signal processing in hard-disk-drive and solid-state-drive controllers. Since September 2011, he has been with SandForce Inc. (recently acquired by LSI Corp), as a Distinguished System Architect. Dr. Wu's research interests cover across a wide range of computational mathematics, algebraic coding theory, soft-decision decoding techniques, digital signal processing, and efficient design of VLSI micro-architectures.

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ALL ARE WELCOME *

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