



Topics in Coding, Cryptography and Information Security

Editors:

Mohammad Umar Siddiqi
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Contents

List of Contributors	ii
Editorial Introduction	vi

PART I: SOURCE CODING

1. Performance Analysis of Image Data Compression using Zero-Tree Wavelet Transform <i>Othman O. Khalifa, Emir Tabakovic, Zlatko Memisevic and Aisha-Hassan Abdullah</i>	2
2. Scalable and Robust Streaming Video System Challenges <i>Othman O. Khalifa, Sinzobakwira Issa and Mohammad Umar Siddiqi</i>	12

PART II: CHANNEL CODING

3. Golay Codec: An Overview <i>Othman O. Khalifa</i>	23
4. Reed-Muller Codes: An Overview <i>Othman O. Khalifa</i>	35
5. Viterbi Decoder: A Review and Implementation <i>Noorainani Ainina Bt. Md Noor Albakri and Othman O. Khalifa</i>	42

6.	Zigzag Codes: High Rate Low Complexity Iterative Codes <i>Sigit P.W. Jarot</i>	53
7.	Convolutional Coded OFDM in Broadband Mobile Communication <i>Sigit P.W. Jarot</i>	66
8.	Channel Coding Techniques in Mobile Communication Systems <i>Othman O. Khalifa and Rashid A. Saeed</i>	77
9.	Channel Coding in CDMA 2000 <i>Othman O. Khalifa</i>	85
10.	Channel Coding in Mobile WiMAX <i>Rashid A. Saeed and Othman O. Khalifa</i>	91
11.	Turbo Codes: An Error Correction Technique for 4G <i>Mosharraf Hussain Masud and Mohammad Umar Siddiqi</i>	99
12.	Combined Source Channel Decoding for Image Transmission over Noisy Channels <i>Jalel Chebil</i>	108

PART III: CRYPTOGRAPHY AND INFORMATION SECURITY

13.	Cryptographic Boolean Functions: Transform Domain Perspective <i>Hashum Mohamed Rafiq and Mohammad Umar Siddiqi</i>	120
14.	Implementation of RSA Algorithm <i>Hafizul Azizi Rasid, Mohd Azmi Jabar and Othman O. Khalifa</i>	141
15.	GSM Security: Problems and Solutions <i>Rashid A. Saeed and Othman O. Khalifa</i>	152
16.	Recent Approaches to Wireless Physical Layer Security <i>M. Tahir, Sigit P.W. Jarot and M.U. Siddiqi</i>	161
17.	Securing OFDM-based Systems from the Physical Layer <i>Sigit P.W. Jarot</i>	169
18.	Simulation of Artificial Noise based Physical Layer Security <i>Muhammad Izzat bin Zurkiple and Sigit Puspito Wigati Jarot</i>	174

19. Secure IPv6 Address Generation 183
Nashrul Hakiem, Mohammad Umar Siddiqi, and Sigit Puspito Wigati Jarot
20. Video Streaming and Encrypting Algorithms 190
Mohammed Abumuala, Othman O. Khalifa, and Aisha-Hassan A. Hashim
21. Wireless IP Camera based on Motion Detection Surveillance System 217
Zeeshan Shahid and Khaizuran Abdullah
22. Design of Mobile Phone Jammer 223
Fauzum Abdullah Asuhaimi, Nur Fatin Mohd Zakki, and Khaizuran Abdullah

Index

Chapter 4

Reed-Muller Codes: An overview

Othman O. Khalifa

4.1. Introduction

Reed-Muller codes are amongst the oldest and most well known of codes. They were discovered and proposed by D. E. Muller and I. S. Reed in 1954. In 1972, a Reed-Muller code was used by Mariner 9 to transmit black and white photographs of Mars. Reed-Muller codes have many interesting properties that are worth examination; they form an infinite family of codes, and larger Reed-Muller codes can be constructed from smaller ones. This particular observation leads us to show that Reed-Muller codes can be defined recursively. Unfortunately, Reed-Muller codes become weaker as their length increases. However, they are often used as building blocks in other codes. One of the major advantages of Reed-Muller codes is their relative simplicity to encode messages and decode received transmissions. We examine encoding using *generator matrices* and decoding using one form of a process known as *Hadamard transform*. Reed-Muller codes, like many other codes, have tight links to design theory; we briefly investigate this link between Reed-Muller codes and the designs resulting from affine geometries.

4.2. Coding theory of reed-muller codes and the parameters

Reed-Muller can be defined as follow: r rank RM code $R(r,m)$ is the code we get when the true table of a m elements Boolean function whose order is not larger than r is treated. In other words, an r^{th} order of Reed-Muller Code $R(r, m)$ is the set of all binary string (vectors) of length $n = 2^m$. RM codes consist of three theorems that could be deduced from the definition above^[2].

Theorem 1: If check matrix of Hamming Code is H and its column vectors equal to the correspondent column serial number, then the dual code of increased Hamming code is:

$$H_c = \begin{bmatrix} 1 & 1 & L & 1 \\ 0 & & & \\ M & & H & \\ 0 & & & \end{bmatrix}$$